We shall not cease from exploration
And the end of all our exploring
Will be to arrive where we started
And know the place for the first time.

T.S. Eliot, from '*Little Gidding*'

Dedicated to my parents

The Development of Project Management Capability in Complex Organisational Settings: Towards a Knowledge-Based View

TERENCE AHERN

BE, MBA

Thesis Submitted for the Award of the Degree of

Doctor of Philosophy - PhD

January 2013

Dublin City University Business School

Dublin City University

Supervisors - Prof. Brian Leavy & Dr. P.J. Byrne

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of **Doctor of Philosophy (PhD)** is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: _____ **ID No.:** 57117021 **Date:**_____

(Candidate) Terence Ahern

Acknowledgements

While often an individual pursuit, a research journey is seldom a solitary endeavour. Many people have contributed to this dissertation and deserve my appreciation and gratitude. Firstly, my family has been fully supportive of this personal goal and understanding of my absences 'upstairs at the computer' - my wife Ana and sons John and Brian.

My employer, Iarnród Éireann - Irish Rail (IE), has generously part-funded this study and allowed me to interview members of staff for field data in a private capacity. I am also indebted to the Electricity Supply Board (ESB) for allowing me access to members of staff for interview data, also in a private capacity. I am deeply grateful to the management, staff, and colleagues in both organisations that participated in this study.

My doctoral supervisors, Prof. Brian Leavy and Dr. P.J. Byrne, have been consistently supportive, encouraging, and insightful during this qualitative research journey and ensured that, although I ventured down many byways, we never lost sight of our course. I also acknowledge the value of the doctoral studies programme in DCU, especially the seminars on research perspectives by Dr. Siobhain McGovern.

Doctoral programme colleagues Lucy Fallon-Byrne and Louise Chalkley provided valuable feedback on various chapters of the thesis and the mutual support of many programme colleagues added an important collegiate dimension to the research experience. Finally, I wish to thank the library staffs at DCU and DIT (Dublin Institute of Technology, where I lecture part-time), for their support in accessing academic material, internal and external.

T. Ahern
January 2013

Table of Contents

The Development of Project Management Capability in Complex Organisational Settings: Towards a Knowledge-Based View

TERENCE AHERN

ABSTRACT

This exploratory case-based study investigates the development of project management (PM) as an organisational capability in two public sector organisations (PSO) during a period of rapid environmental change. Within the PM literature, the concept of project management capability (PMC) and how it develops over time through organizational learning is still an emerging tradition led to date by mainly European scholars (Lindkvist, Söderlund, Davies, Brady, Hobday, etc.). This investigation locates itself within this emerging tradition and represents a unique empirical opportunity to study the learning processes involved in PMC development in a complex setting that shows these processes in greater relief. In both of the organizations studied, the elevation and enhancement of PMC from a relatively low-level activity to a strategic supporting competence was triggered by radical and rapid change in the external environment during the 2000s. The main process insight is that PMC is found to be developed as a dynamic organisational capability in complex PM settings through organisational complex problem-solving (CPS).

The overall outcomes of the study build upon and extend the emerging PMC literature in at least three important respects, with implications for traditional PM research and practice. Firstly, in contrast to the mechanistic view of traditional PM, this study supports an integrated knowledge-based view of 'projects as process' and 'PM as practice'. In this view, a project is seen to be 'a mode of organising to accomplish a temporary undertaking' and PMC is seen as a strategic organisational practice in organising complex projects. Secondly, PMC is honed as a practice through goal-directed organisational CPS. This builds upon and extends the work of Popper on the evolutionary growth of knowledge by revealing problem-solving as a two-stage process of differentiation-integration, or disorder-order. In contrast to traditional PM which follows a path from 'order to order', the development of PMC as an organisational capability is found to proceed from 'order to *disorder* to order'. Thirdly, using the lens of PM as practice, a 'distributed organising' approach is suggested for coordinating the formation of 'complex knowledge' under organisational CPS, which is inherently emergent and dynamic. This contrasts with the 'centralised planning' approach of traditional PM, which assumes that knowledge is manifest in pre-given plans that are executed with little organisational learning expected beyond the application of prior knowledge.

Keywords
Project management, dynamic organisational capability, practice, complex problem-solving, distributed organising, disorder, entropy

GLOSSARY OF TERMS

AG	Advisory Group
APM	Association for Project Management, UK
BOM	Bill of Material
CCE	Chief Civil Engineer (Division of IE)
CER	Commission for Energy Regulation
CEO	Chief Executive Officer
CMP	Contract Management Procedures
CIE	Córas Iompair Éireann (Holding Company of Irish Rail - IE)
CME	Chief Mechanical Engineer (Division of IE)
CPS	Complex Problem-Solving
CoP	Community of Practice
CoPS	Complex Products and Systems
CRS	Customer Requirements Specification
CSF	Critical Success Factors
CTC	Central Traffic Control
CU	Construction Unit
CWMF	Capital Works Management Framework
D&KR	Dublin & Kingstown Railway
DART	Dublin Area Rapid Transit
DC	Dynamic Capabilities
DoF	Department of Finance
DoT	Department of Transport
DTT&S	Department of Transport, Tourism, & Sport
ERP	Enterprise Resource Planning
ESB	Electricity Supply Board
ESBI	Electricity Supply Board International (ESB subsidiary)
GCCC	Government Construction Contracts Committee
GN	Guidance Notes
HRM	Human Resource Management
HRP	Heuston Redevelopment Project
IE	Iarnród Éireann - Irish Rail
IPMS	Integrated Project Management System
IRNOP	International Research Network on Organizing by Projects
km	kilometre (1,000 metres)

KPI	Key Performance Indicators
kv	kilovolt (1,000 volts)
MRP	Materials Requirements Planning
MW	Megawatt (1 million watts)
NDP	National Development Plan
NIE	Northern Ireland Electricity
NIR	Northern Ireland Railways
NPM	New Public Management
NRP	Networks Renewal Programme
NTA	National Transport Authority
OJPS	Organizational Joint Problem-Solving
PACT	Programme to Achieve Competitiveness and Transformation
PBO	Project Based Organisations
PCB	Project Capability Building
PDM	Project Delivery Model
PERT	Project Evaluation and Review Technique
PIMS	Project Integrated Management System
PLC	Project Life Cycle
PM	Project Management
PMBoK	Project Management Book of Knowledge (PMI, USA; APM, UK)
PMC	Project Management Capability
PMD	Project Management Deliverable Instruction
PMF	Project Management Framework
PMI	Project Management Initiative (ESB)
PMI	Project Management Institute, USA
PMJ	Project Management Journal
PMO	Project Management Office
PMP	Project Management Procedure
PPM	Project Portfolio Management
PR	Price Control Review
PSO	Public Sector Organisation
RPA	Railway Procurement Agency
SECI	Socialisation, Externalisation, Combination, and Internalisation
SET	Signalling, Electrical, and Telecoms (Division of IE)
UIC	International Union of Railways (Union Internationale des Chemins de Fer)
UK	United Kingdom
USA	United States of America

VFM	Value For Money
WMS	Work Method Statement
WP	Work Package

LIST OF FIGURES

Chapter 6 Case Study No. 2: Electricity Supply Board (ESB)

Chapter 7 Empirical Findings & Elaboration of Concepts

LIST OF TABLES

Chapter 2 Literature Review

Chapter 4 Research Methodology

Chapter 7 Empirical Findings & Elaboration of Concepts

Chapter 8 Study Conclusions & Future Research

Chapter 1

Introduction to the Study

1.1 INTRODUCTION [1]

This exploratory research investigates the development of project management (PM) as an organisational capability (PMC) in two complex organisations in the public sector during a period of rapid environmental change in the 2000s. The principal interest of the study is to explore how learning processes underpin the development of PMC as a strategic capability in complex organisational settings. Within the PM literature, the concept of PMC and how it develops over time is still an emerging tradition, in which the development of PMC in complex organisational settings revolves around various forms of organisational learning. This investigation locates itself within this emerging tradition and represents a unique empirical opportunity to study the learning processes involved in PMC development in a setting that shows these processes in greater relief. In both of the organisations studied, the development of PMC from a relatively low-level activity to a strategic supporting competence was triggered by radical change in the external environment during the 2000s. The study is informed by a strategic management perspective of developing project management as an organisational capability through learning processes.

1.2 MOTIVATION FOR THIS STUDY

The research interest motivating this study revolves around how PMC was developed as a new organisational capability in complex organisations, such as public sector organisations (PSO), which were subject to a radical change in their external environment. In other words, how do complex organisations develop new and significant strategic capabilities from a pre-existing low base? Within the PM literature, the concept of PMC and how it develops over

[1] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)

time is still an emerging tradition, in which the development of PMC in complex organisational settings revolves around various forms of organisational learning. Importantly, developing PMC as a 'core supporting competence' in PSOs from a near-zero base requires organisations to learn to change rapidly, which means that dynamic organisational learning processes are a central aspect of PMC development. Existing empirical research in PMC development is largely based on project-based organisations (PBO) in the private sector rather than PSOs in the public sector. In PBOs, PMC is largely a 'core competence' and its development is more incremental from an existing base.

This researcher has been working on the financial side of major infrastructure projects in a PSO for more than ten years. During the 2000s, due to the stimulus of an expanding economy and a government-led capital investment programme, this PSO and many others needed to develop a new organisational capability to deliver infrastructure projects on a sustained basis. However, there is little research on PMC development in organisations that are subject to radical and rapid environmental change and even less so in relation to PSOs. With a background in engineering and business and over thirty years of management experience in the private and public sectors, this study was undertaken to leverage practical career experiences to enrich PM research and enhance subsequent practice.

1.3 TRENDS IN PM RESEARCH

1.3.1 PM - APPLIED SCIENCE OR SOCIAL SCIENCE?

The traditional approach to PM research follows the model of technical rationality that is applied to professional practice, which is characterised by "instrumental problem solving made rigorous by the *application* of scientific theory and technique" (Schön, 1983, p. 21, italics added). This approach is reflected in its definition of PM by the Project Management Institute (PMI), based in the USA, as "the *application* of knowledge, skills, tools and techniques to project activities to meet project requirements" (PMI, 2004, p. 8, italics added). This focus on PM as a discipline of instrumental purpose assumes the availability of up-front resources, such as designs, materials, and equipment, like an array of building blocks awaiting selection by the PM professional for *application* on a specific project. In this view,

projects are objects to be delivered and PM is an instrument, or tool, for project delivery and the PM professional is a practitioner of an applied science.

In 1959, PM became the focus of academic interest in the business literature when the first article on PM appeared in the *Harvard Business Review* by Gaddis entitled 'The Project Manager'. What this article brought into relief was the underlying tension in PM between viewing PM as an applied science that is grounded in technical rationality or as a social science that facilitates the negotiation and interpretation of project boundaries between project actors or as a combination of both (Cooke-Davies, 2002; Winter, Smith, Morris, & Cicmil, 2006). This was not merely a question of academic interest but of practical importance to wider society as well. Moreover, there was growing evidence in the literature that the 'scientific management' approach to PM was seriously deficient in terms of delivering the key success parameters on its own terms of scope, budget, and timescale for capital projects in both the private and government sectors (Hall, 1980; Morris & Hough, 1987; Standish Group, 2003; Flyvbjerg, Bruzelius, & Rothengatter, 2003).

In contrast, the social science approach to PM research views a project as a social process involving stakeholder actors, who collectively enact the process of delivering the project over its life cycle, during which they construct and interpret the meaning of the project (Packendorff, 1995; Engwall, 1998). This is a processual approach, in which knowledge is a combination of pre-given 'known' information at the outset (goals, designs, etc.) and a collective process of 'knowing' by the project team that is driven forward by the problem-solving pacing of the project life cycle (Pettigrew, 1990, 1997; Engwall, 2002; Lindkvist & Söderlund, 2002; Söderlund, 2010). In this view, projects are arenas of problem-solving learning that promote knowledge creation and utilisation (Lundin & Midler, 1998). In this research approach, the aim is to look inside the 'black box' of PM as a variable process in flux rather than focusing on the inputs and outputs, as if PM were a predictable clockwork mechanism over time (Sapolsky, 1972; Spinardi, 1994). This tension between PM as a management 'tool' and PM as a generative social 'process', or practice, persists to the present day and informs this study (Söderlund, 2002, 2004a).

1.3.2 PMC DEVELOPMENT - LEARNING PROCESSES

As the study inquires into the development of PMC in complex organisational settings, problem-solving learning processes represent a 'central research theme' throughout the investigation. Problem-solving in projects is much underrated in the PM literature as an

engine of knowledge growth and a key innovation process that demarcates PM from management disciplines in operational settings. The issue revolves around how knowledge in PM settings is viewed, given PM's traditional self-image as an applied science in association with the engineering sciences. By viewing PM as an applied science, knowledge in the form of abstract 'known' knowledge is pre-given at the outset of a project as designs, plans, etc. and the role of the PM professional is to assemble the knowledge to build the project, i.e., the Lego block model of knowledge. In this view, objective knowledge is 'out there', detached from the knowing subject, and independent of context. Thus, the need for problem-solving is an inconvenience, if not an embarrassment, that reflects on poor design. As practitioners of an applied science, PM professionals see themselves following a deterministic path of designs and plans, which reflect abstract 'known' knowledge, or 'hard' knowledge. In this milieu, learning is often regarded as a post-project event associated with 'lessons learned' workshops that focus on abstract 'known' knowledge.

In contrast, a practice-oriented approach to PM sees learning as an integral part of the exercise of PM as a practice (Wenger, 2001), which synthesises the essential aspects of knowledge - abstract 'known' knowledge (designs, plans, etc.), contextual 'knowing' knowledge (know-how, etc.), and the 'tacit dimension' of knowledge. In this view, rather than pre-given at the outset, knowledge is created over the journey of the project life cycle (Engwall, 2002; Suchman, 2003), as theory and practice interplay in problem-solving, a central aspect of enacting PM as practice.

1.4 SUITABILITY OF THE PUBLIC SECTOR FOR PMC RESEARCH

PMC development is under-researched in respect of three important conceptual themes: (1) problem-solving as an engine of knowledge creation in PM/PMC; (2) projects as process and PM/PMC as practice; and (3) PMC development through complex learning processes beyond single-loop and double-loop learning. Taken together, this emphasises organisational learning processes in PMC development as a central research theme.

In the empirical capability literature, PMC development is also under-researched in certain areas, which present an additional empirical opportunity in which to investigate the foregoing conceptual themes. Firstly, PSOs are under-researched in the PMC literature. Secondly, PMC research is mainly focused on project-based organisations (PBO) in the

private sector for which PMC is a 'core competence' rather than on organisations for which it is a 'core supporting competence'. Thirdly, little research is available for PMC development in organisations that have been subject to radical and rapid environmental change. Fourthly, PMC development is under-researched as a multi-level construct comprising a PM ecology.

In the lead-up to the millennium in Ireland, two significant macro-economic events were converging to set the scene for a dramatic expansion in the national economy over the following decade. Firstly, the Euro was launched in 1999 with notes and coins in circulation three years later in 2002. Secondly, in 2000, the government launched the first seven-year National Development Plan (NDP, 2000) with a budget of €52bn. This was followed by a successor seven-year plan, from 2007 to 2013, with a budget of €184bn (NDP, 2007)[2]. Together, they represented a 14-year programme of government-led investment in national infrastructure totalling approximately €236bn with economic multiplier effects across the wider economy. This set in train an expansion of investment in capital infrastructure projects by the government and the development of PMC across PSOs that were charged with delivering capital projects. Therefore, because of the scale of national investment in projects during the 2000s, it was timely to undertake this study in 2007 to investigate an interesting and significant development in the public sector in its own right, namely, the development of PMC as a strategic organisational capability.

1.4.1 PMC DEVELOPMENT - ORGANISATIONAL LEARNING

The organisational response to an environmental stimulus, either external or internal, is a driver of organisational capability development and is normally presented in the literature as a guided-evolutionary cycle of variation, guided-selection, and retention. This is regardless of the underlying view of capabilities, whether routines (Nelson & Winter, 1982), resources (Teece, Pisano, & Shuen, 1997; Teece, 2007; Söderlund, 2008), or learning (Brown & Duguid, 1991; Zollo & Winter, 2002; Lindkvist, 2008). However, in the literature, the response of organisations more closely resembles a teleological problem-solving dialectic that follows a deterministic course with pre-defined start and end points, rather than a guided-evolutionary course with possible random outcomes. Even reformulating the approach as 'guided-evolution' still suggests a process with random tendencies (Lovas & Ghosal, 2000). However, regardless of the evolutionary perspective, the cycle of variation, guided-selection, and retention is grounded in knowledge growth, or knowledge creation,

[2] Revised in 2011

through the Greek problem-solving dialectic of antithesis and synthesis (Popper, 1972/1979). This emphasises the central importance of learning processes in developing organisational capabilities.

In this study, PMC is developed as a 'core supporting competence' from a near-zero base in two PSOs that were subject to radical and rapid external change over a sustained period in the 2000s. In order to develop PMC, the two PSOs needed to "up their game" and learn to change in a way that was rapid rather than incremental. When PMC is developed in PSOs from a near-zero base as a 'core supporting competence', it is conjectured by this study that more rapid learning takes place than in PBOs. In the latter, PMC is an existing 'core competence' and is developed further by incremental learning from an existing base. This implies the prospect of studying in greater relief the complex learning processes for PMC development in PSOs undergoing rapid change than in typical PBOs. This perspective of PMC development as a manifestation of knowledge creation through organisational complex learning processes based on problem-solving acts as a unifying 'central research theme' throughout the investigation.

In order to appreciate the 'step-change' in organisational learning that was required to develop PMC on the part of the two PSOs in this study, a brief review of investment levels in the 2000s now follows.

Iarnród Éireann - Irish Rail (IE)

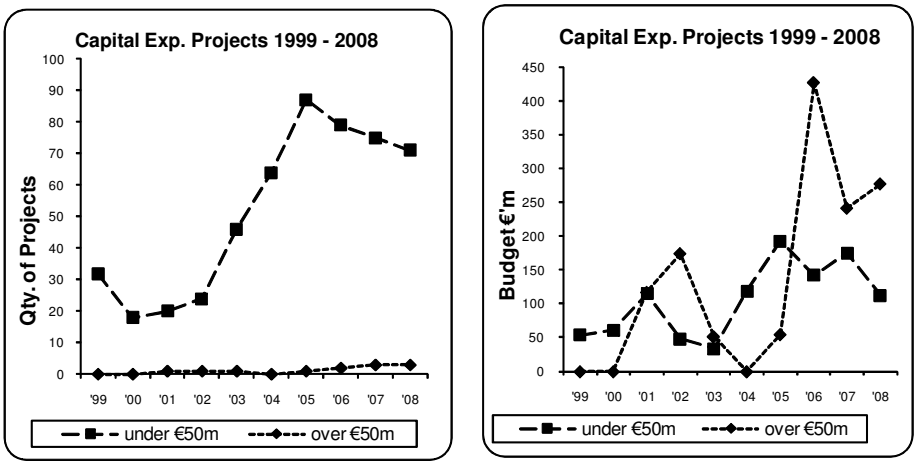
IE is a government wholly-owned PSO with responsibility for the national railway service in Ireland. In the ten year period from 1999 to 2008, IE received government and EU funding of approximately €3.5bn for capital expenditure, of which €2.4bn was for infrastructure projects and approximately €1.1bn for the upgrading of rolling stock. The data presented in Fig. 1.1 shows the number of infrastructure projects by budget level, excluding rolling stock projects, and it can be seen that small and medium projects (under €50m) together represented 98% of all project quantities and 44% of the capital budget over the ten year period. In the same ten year period, a quantity of 12 large and major infrastructure projects (over €50m), excluding rolling stock projects, represented 2% of all projects but, nevertheless, accounted for over half the capital budget (56%), Fig. 1.1. Indeed, three of the major projects over €100m accounted for €649m or 27% of the total budget.

Proj. Scale	Budget	Qty.	%	Cum %	€'m	%	Cum %
Small	under €2m	403	76.3%		€204	8.5%	
Medium	€2m to €50m	113	21.4%	98%	€847	35.4%	44%
Large	€50m to €100m	7	1.3%		€428	17.9%	
Major	over €100m	5	0.9%	2%	€915	38.2%	56%
		528	**100%**	**100%**	**€2,395**	**100%**	**100%**

(Source: This Study)

Fig. 1.1 IE Capital Projects 1999 to 2008 - Quantity & Budget

In order to view the trends in project quantity and budget over the decade, the projects are grouped into two categories, small and medium (under €50m) and large and major (over €50m), Fig. 1.2. In terms of the project quantity trends in the left-hand graphic, there is a sharp rise in the quantity of under-€50m capital projects approved from 2000/2001 onwards, which coincides with the commencement of the NDPs (2000, 2007). This rate of increase continues to a peak quantity of nearly 90 projects approved in 2005, after which the annual approval quantity of under-€50m projects declines to 71 in 2008. The over-€50m group of capital projects shows a barely perceptible rise from about one large/major project per annum to three such projects in 2007 and 2008. This increase starts to occur around 2005, which is the same time period that the under-€50m group of projects reaches its peak.



(Source: This Study)

Fig. 1.2 IE Capital Projects 1999 to 2008 - Quantity & Budget Trends

In Fig. 1.2 from 2002 to 2005, the right-hand budget trend for the under-€50m projects follows the same profile as the left-hand trend for project quantities. However, from 2004 onwards, the right-hand budget approval trend for the over-€50m projects shows a precipitous increase to the extent that, in the three years from 2006 to 2008, the budget approval for over-€50m projects is more than double that of the under-€50m projects.

Electricity Supply Board (ESB)

ESB is a government wholly-owned PSO with a remit for the generation, transmission, and supply of electricity in Ireland, which was in a dominant market position until the EU deregulation of the energy sector in the late 1990s. By this time, it was appreciated by the ESB that a major investment programme was required to upgrade its transmission and distribution networks. It can be seen in Fig. 1.3 that investment levels in the 1990s in the distribution network were approximately €150m p.a., which increased rapidly to approx. €400m p.a. as the ESB undertook its Network Renewal Programme (NRP) from 2000 to 2005, the subject of the ESB case in this study.

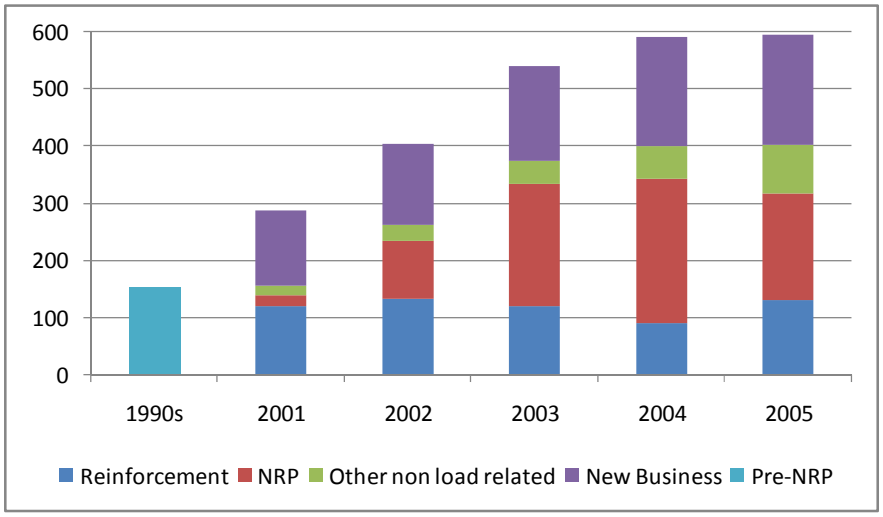


Fig. 1.3 ESB Networks Renewal Programme - Distribution Network[3]

[3] Adapted from IEE Presentation by ESB Networks, Nov 2005

1.5 RESEARCH AIMS

The principal aim of this exploratory study is to investigate the learning processes involved in developing project management (PM) as an organisational capability (PMC) in the complex setting of public sector organisations (PSO) during the 2000s. A process insight into organisational learning processes would enhance management practice and enrich the literature on the development of organisational capabilities. In Ireland, the 2000s was an era of continuous economic expansion that was set against a background of entry into the Euro and government-led National Development Plans (NDP). The radical and dynamic change in the economic environment during the 2000s was a 'game-changer' for PSOs with responsibility for delivering capital projects, which meant that they needed to respond by developing a PMC to successfully deliver projects on a sustained basis.

1.6 OUTLINE OF THE THESIS CHAPTERS

Introduction, Literature Review, Initial Conceptual Development

This present chapter is a brief introduction to the study, in terms of why the study of this topic area is warranted, timely, and relevant for organisations in both the public and private sectors. In addition, the chapter structure of the study is outlined in the paragraphs that follow next, which are presented to the reader in a linear sequence, even though it has been an interactive exploratory investigation of data, literature, and conceptual development throughout.

In chapter two, the literature is reviewed through different lenses, in order to frame the study in a relevant literature and to inform the Research Question. Firstly, as a historical overview of PM research, the major trends in PM research are reviewed in four theme groups - Optimisation (1945+), Success Factors (1975+), Framework Process (1985+), and Organisation (1995+). This study takes its point of departure from the latter 'organisation' theme group, which includes developments in PM theory with an emphasis on projects as 'temporary organisations' and as 'actors/becoming'. Using Weick's (1979, 1995) insight that organisations are primarily about *organising* and *sense-making*, this study proposes a reformulation of projects as modes of organising for temporary undertakings. This is consistent with a process view of projects within a practice-oriented approach to PMC development, which together reflect an integrated knowledge-based view of PM.

The literatures on organisational capabilities are also reviewed, including dynamic capabilities (DC) and PMC development, and it is in the latter emerging research tradition that this study locates itself. After reviewing the literature, three interrelated conceptual themes were identified as under-researched and were adopted as research themes for this study: (1) problem-solving as an engine of knowledge creation in PM/PMC; (2) projects as process and PM/PMC as practice; and (3) PMC development through complex learning processes beyond single-loop and double-loop learning. In addition, the empirical PMC development literature is under-researched in certain areas, in respect of which the two PSO organisations in this study represent an additional empirical opportunity in which to investigate the foregoing conceptual themes. Firstly, PSOs are under-researched in the PM literature. Secondly, PMC research is mainly focused on project-based organisations (PBO) in the private sector for which PMC is a 'core competence' rather than on organisations for which it is a 'core supporting competence', such as the two PSOs under study. Thirdly, little research is available for PMC development in organisations that have been subject to radical and rapid environmental change. Fourthly, PMC development is under-researched as a multi-level construct comprising a PM ecology.

Informed by the conceptual gaps in the literature above, the main Research Question revolves around how organisational learning processes underpin the development of PMC as an organisational capability in complex PM settings. However, as early data analysis was showing that complex learning processes are under-developed in the capability development literature, which is the central research theme of this study, it was decided to develop initial concepts of capability development through organisational complex problem-solving (CPS). This is done in chapter three after the literature review and before the subsequent chapters on research methodology and the full presentation of the empirical case studies. In this way, from the outset, the data are playing a dual role of inspiring conceptual development and illuminating the concepts by illustrating their working in different practical settings (Siggelkow, 2007). Accordingly, chapter three on capability development through organisational CPS reformulates the work of Popper (1972/1979) on knowledge growth by problem-solving with the addition of 'entropy' as a covering concept for 'disorder' and 'order'. This becomes a two-stage process of differentiation (disorder) and integration (order) activities, which implies a progression from 'order to *disorder* to order' rather than from 'order to order' under traditional PM. Capability development is discussed as a form of organisational CPS, including dynamic capabilities (DC) and PMC.

Methodology, Case Studies 1 & 2, Empirical Findings & Conceptual Elaboration

Chapter four on research methodology discusses research perspectives for PM based on the root metaphors of Pepper (1942), where Mechanism (Positivism) is associated with traditional PM and Contextualism (Pragmatism) with the practice-oriented approach of this study. This chapter also discusses different approaches to theory development in case study research, in terms of whether the data is "inspiring" theory development at the end of the study through the findings or whether the data is "illustrating" the theory development that is inspired by the data and presented before the full empirical case studies (Siggelkow, 2007). This study adopts a dual approach of developing initial concepts that are inspired by the dataset but presented before the full case studies, which then illuminate the concepts by illustrating their working in different practical settings. In the later chapter seven on empirical findings, the conceptual development is elaborated further through the study findings. This sequencing of conceptual development and data reflects the nature of this exploratory case study investigation, which is presented to the reader in linear sequence, even though it has been a multi-stranded and parallel process of inquiry throughout.

Chapters five and six present the empirical case studies on Iarnród Éireann - Irish Rail (IE) and Electricity Supply Board (ESB). IE is a government-owned utility with responsibility for the national train service. During the 2000s, IE developed a PMC from a near-zero base in response to government-led National Development Plans (2000, 2007), which included the upgrading of the railway network and rolling stock. The PMC was an important 'core supporting competence' for IE in order to achieve the strategic business objective of upgrading the railway system for its 'core competence' of running a national train service. Within IE's New Works Division, where PMC was developed, the PMC was a 'core competence'. The ESB is also a government-owned utility with traditional responsibility for the national electricity service. Since the mid-1990s, the EU energy sector has become deregulated, which has seen the ESB divesting itself of generating capacity and repositioning its business strategy with the electricity 'networks' as a key component. In the early 2000s in the ESB, the ESB Networks business unit developed a Networks PMC from a near-zero base to renew and upgrade its system networks with a focus on the high-voltage and medium-voltage networks. This was an important 'core supporting competence' for the ESB in order to achieve the strategic business objective of upgrading its system networks for its 'core competence' of electricity generation, transmission, and distribution. Within ESB Networks, where Networks PMC was developed, the Networks PMC was a 'core competence'.

In chapter seven on empirical findings and conceptual elaboration, the initial conceptual development of capability development through organisational CPS from chapter three is elaborated for multi-cycle capability development. This combines the traditional PM approach (contingency) with the guided-evolution approach (emergent) into a teleological approach (means-end) based on the two-stage problem-solving process of differentiation and integration, or disorder and order. Thus, the main process insight of this study is that PMC is seen to be developed in complex PM settings as a dynamic organisational capability through organisational complex problem-solving (CPS). This builds upon and develops the emerging PMC literature in three main areas with implications for traditional PM research and practice. Firstly, PMC is developed as an organisational practice through goal-directed CPS, which extends the work of Popper (1972/1979) by revealing problem-solving as a two-stage process of differentiation-integration, or disorder-order. In contrast to traditional PM which follows a toolkit path from 'order to order', the development of PMC is found to be a process of 'dissipative organising' from 'order to *disorder* to order'.

Secondly, this study supports an integrated knowledge-based view of projects as 'process' and PM/PMC as 'practice'. Thirdly, traditional PM treats complex projects under a general systems approach of centralised 'total planning'. This assumes that project knowledge is pre-given at the outset and little organisational learning is expected beyond the application of prior knowledge. However, under organisational CPS, complex projects seem limited to 'bounded planning', because they cannot be *completely* specified in advance. Thus, a distributed organising approach is proposed by this study for coordinating the formation of 'complex knowledge' under organisational CPS, which is inherently emergent and dynamic. This is based on what this study terms a 'common will of mutual interest' as a distributed tacit dimension (Polanyi, 1967).

Study Conclusions

In the final chapter eight, the findings are summarised and discussed for study perspectives on theory, research, and practice. This revolves around the three finding areas that flow from the main insight of PMC development through organisational CPS: (1) organisational problem-solving as 'learning-organising'; (2) projects as process and PM/PMC as organisational practice; and (3) complex PM as bounded planning.

Firstly, in undertaking the initial conceptual development of capability development through organisational CPS, knowledge creation through problem-solving is viewed as a synonymous duality of learning and organising, or 'learning-organising', where learning is a

form of organising and *vice versa*. Furthermore, the structure of knowledge-creating through differentiation-integration, which is based on the Greek dialectic of antithesis-synthesis, seems to be a learning process that is 'equilogical' at individual level and organisational level. This provides theoretical and empirical support for the idea of an organisation that can learn, i.e., a learning organisation, and for viewing projects as temporary learning organisations. Using 'entropy' for disorder, the two-stage process of problem-solving through differentiation and integration activities constitutes an 'entropy envelope' of learning-organising. Within the entropy envelope, differentiation as divergence causes knowledge entropy to increase (disorder) and integration as convergence causes knowledge entropy to decrease (order). Thus, the knowledge-creating process follows a path from 'order to *disorder* to order' rather than from 'order to order'

Secondly, arising from the central importance of problem-solving as an engine of knowledge creation in this study, together with the *organising* perspective of organisations of Weick (1979, 1995), this study proposes the following tentative reformulations of projects as 'process' and PM/PMC as 'practice' as part of an integrated knowledge-based view. This reflects a synthesis of the data with the literatures on organisations, PM as practice, complex PM, and PMC development.

> A project is a mode of organising to accomplish a temporary undertaking.
>
> Project management is an organisational competence in organising to accomplish temporary undertakings.
>
> Project management capability is a strategic organisational competence in organising to accomplish complex temporary undertakings.

Thirdly, this study finds that PMC is developed as an organisational practice through learning processes based on organisational CPS and equilogical learning processes of differentiation-integration. However, based on the literature review, complex projects can never be *completely* specified in advance, except in outline or in part. Therefore, the most challenging finding is the rediscovery of Hayek's (1945) classic insight of distributed knowledge in complex PM settings, which requires a distributed organising approach for the coordination of project knowledge rather than a centralised approach under traditional PM. This suggests that complex PM is better approached as a domain of 'rational actors', grounded in the rationality of a 'common will of mutual interest' that is akin to the 'invisible hand' of neo-classical economics, rather than as 'rational objects' under traditional PM.

Chapter 2

Literature Review

2.1 INTRODUCTION [4]

Following the introduction to the study in the previous chapter, the main purpose of this chapter is to review the literature and to identify significant research gaps for informing the Research Questions of the study. As part of framing the study within the literature, historical trends in PM research are reviewed under the main theme groups of optimisation (1945+), success factors (1975+), framework process (1985+), and organisation (1995+). The study positions itself within the organisation theme group, which includes a contextual approach to PM by viewing a project as a 'process' rather than an 'object' under traditional PM. Further, as the central research theme of this study is the development of PM as an organisational capability (PMC) through complex learning processes based on problem-solving, insights from the business and PM capability literatures are discussed from three main perspectives - routines, resources, and learning. Based on a synthesis of the literature, this study will propose as a conceptual reformulation that a project is better viewed as 'a mode of organising to accomplish a temporary undertaking'. This view enhances the process perspective of projects with a learning dimension based on 'organising' that supports the central research focus of organisational complex learning processes based on problem-solving. In addition, it supports the practice orientation of the study, which is discussed in Chapter 4 - Research Methodology.

[4] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)

2.2 PM RESEARCH THEMES - HISTORICAL OVERVIEW

Since Gaddis's (1959) original article on PM in the *Harvard Business Review*, there has been over fifty years of research in PM in books and academic journals, including specialist areas within PM, such as IT and construction. From time to time, trends in PM research have been presented that summarise the topic areas that are most frequently researched, including areas of increasing research, declining research, and gaps in research. The foremost PM literature reviews include Betts and Lansley (1995), Kloppenborg and Opfer (2000), Themistocleous and Wearne (2000), Morris (2000), Morris, Patel, and Wearne (2000), Zobel and Wearne (2000), Ulri and Ulri (2000), Crawford, Pollack, and England (2006), and Kolltveit, Karlsen, and Grønhaug (2007).

In addition, several researchers have undertaken reviews of PM research themes, including Jugdev and Müller (2005), who adopt a combined thematic and economic life cycle approach, and Söderlund (2002) and Bredillet (2007a/b/c, 2008a/b/c), who both adopt a thematic schools approach to PM. Drawing on these studies, research in PM can be divided into four main theme groups - optimisation, success factors, framework process, and organisation - that progressively broaden the remit of research themes from an initial narrow focus on the execution phase of projects to a strategic perspective encompassing the broader economic life cycle. The latter encompasses not only the traditional project life cycle to handover stage but also the commercial phase of the project after the handover to operations. Using these main research groups as a reference, the principal research attributes of each theme group are summarised in Table 2.1 for ease of discussion. However, it should be borne in mind that the theme group designations are flexible and sometimes overlap. Moreover, many of the theme group topics continue to be researched down to the present day in parallel with each other.

2.2.1 GROUP 1 THEMES - OPTIMISATION (1945+)

In this theme group, the main focus is on the execution phase of project delivery. This is an era that is confident that an integrated systems approach to projects will deliver the project scope on-time and within budget (von Bertalanffy, 1950; Boulding, 1956). Project managers have faith in 'hard' systems of planning and control (Cleland & King, 1968), which is set against a background in the business literature of 'scientific management' (Taylor, 1911), the early Simon's (1945/1997) decision making, and Fayol's (1916/1988, trans. 1949) management paradigm of planning, leading, organising, commanding, and control. Although

projects are viewed as open systems with feedback mechanisms, their interaction with the immediate environment is limited and, thus, they can be viewed as 'bounded' open systems that are relatively independent of their context (Cleland & King, 1968). This was in keeping with a view of organisations at this time as rational closed systems (Scott, 1998). An appropriate metaphor for projects in this theme group is 'technical system'.

	Group 1 Themes Optimisation 1945+	**Group 2 Themes Success Factors 1975+**	**Group 3 Themes Framework Process 1985+**	**Group 4 Themes Organisation 1995+**
PM Schools (Bredillet, 2007/8)	Optimisation Modelling	Critical Success Factors	Process Decision Contingency	Marketing Governance Behavioural
Business Research Influences	Taylor (1911) Simon (1945) Fayol (1916, trans. 1949) von Bertalanffy (1950) Galbraith (1971, 1977)	Daniel (1961) Rockart (1979)	March & Simon, 1958 Burns & Stalker (1961) Lawrence & Lorsch (1967) Williamson (1975, 1985)	Porter (1980, 1985) Prahalad & Hamel (1990) Barney (1991) Penrose (1995) Nonaka & Takeuchi (1995)
Project Mgmt. Research	Gaddis (1959) Cleland & King (1968) Avots (1969) Kerzner (1979/2006) Baker et al. (1983)	Pinto (1986) Pinto & Slevin (1987/8/9) Morris & Hough (1987) Shenhar et al. (1997)	PMI (1987, 1996); APM (1992) Schultz, Slevin, & Pinto (1987) Turner (1993/2009) Shenhar & Dvir (1996) Lechler (1997/8) Winch (1989, 2002) Turner & Keegan (2001)	Morris (1994/1997) ICE (1995, 1999) Lundin & Söderholm (1995) Thomas, Delisle, & Jugdev (2002) Turner & Müller (2003) Davies & Hobday (2005) Turner, Huemann, & Keegan (2007)
Metaphors	Technical System	Machine	Cybernetics	Flux and transformation Socio-Technical System
Organisational Perspectives	Open systems - bounded Rational Deterministic Context independent	Open systems - bounded Rational and natural Deterministic Context independent	Open systems Pragmatic Contingency Context	Open systems Pragmatic Contingency Embedded context
Goals	Cost, time, scope	Cost, time, scope	Stakeholder satisfaction	Value creation
Enablers	Planning Control 'Hard' systems	Key Perf. Indicators (KPI) Critical Success Factors (CSF) 'Hard' systems	CSF frameworks Stakeholder participation Project Manager & Team Project Management Office	Strategic objectives Temporary Organisation Knowledge - explicit and tacit 'Hard' and 'soft' systems
Ontology Epistemology	Realist Positivist	Realist Positivist	Realist and pragmatist Positivist and interpretivist	Realist and pragmatist Positivist and interpretivist
Research Methods	Questionnaire survey Regression etc.	Quest. survey and case study Regression etc.	Quest. survey and case study Regression etc. Structural Equation Modelling	Survey and case study
Exemplars	Baker et al. (1974/1983), N=646	Pinto (1986), N = 418 Morris & Hough (1987)	Lechler (1997), N = 448	Morris (1994/1997) Davies & Hobday (2005)

(Source: This Study)

Table 2.1 Project Management Research - Theme Groups

In this world of the pre-eminence of the scientific method, reality is 'out there' and detached from the knowing subject, in which PM adopts a mainly Positivist approach to problem-solving and project delivery under the norms of technical rationality. Knowledge is explicit and manifest in documented procedures, policies, scientific formulae, etc. In this academic and practitioner climate, project goals were set at the outset of a project in terms of time, cost, and quality, the so-called "iron triangle" (Atkinson, 1999, p. 337), which were then monitored in order to evaluate performance. At the outset, PM research favoured large-scale questionnaire surveys with accompanying statistical analysis, such as the study of Baker, Murphy, and Fisher (1983) involving a sample size of 646 projects, which was also published earlier in 1974 (see ref.), Table 2.1. One of the surprising results from this early research was the importance of perceptions in relation to project success and failure and the phrase "perceived success" (*ibid*., p. 671) was used to highlight the difficulty associated with attempts to objectively measure success and failure. This was a significant finding that pointed away from the traditional approach to PM, which was grounded in technical rationality, to one that needed to incorporate the social aspects of projects as well, in all their variety. As we shall see, much of the PM research in Group 2 and Group 3 is an attempt to emphasise the rationality of PM against the increasing evidence to the contrary, namely, that PM is a domain that is intrinsically social as well as technical.

2.2.2 GROUP 2 THEMES - SUCCESS FACTORS (1975+)

In this theme group, PM practice and research broadened its remit over the project economic life cycle to include upstream and downstream activities from the focus on project execution in Group 1. In common with research in business studies at this time, PM research in this era focused its attention on the inputs and outputs of the 'black box' of PM and their statistical correlation (R^2), rather than looking inside the 'black box' itself. This was how economic theory worked at the time, which was underpinned by a mechanistic view of rational behaviour and the idea that knowledge was explicit and independent of the knowing subject. A suitable metaphor for this era is the 'machine', with its inputs, outputs, and predetermined internal mechanism that yields predictable outputs for given inputs.

Pinto & Slevin (1988)	Freeman & Beale (1992)	Sanvido et al. (1992)[2]	Shenhar et al. (1997)	Songer & Molenaar (1997)[1]	Lim & Mohamed (1999)	Sadeh et al. (2000)	Chan & Chan (2004)[2]
Project - Time - Cost - Performance Client - Usage - Satisfaction - Effectiveness	Technical performance Time & Cost Managerial and organisational implications Personal growth Project termination Technical innovativeness Manufacturability and business performance	Owner - Schedule - Budget - Function - End result - Quality - Aesthetics - Profitability - Marketable - Disruption Designer - Client satisfaction - Quality - Profitability - Professional development - Project time and cost - Marketable - Design - Reliability - Community - Payment - Scope Contractor - Schedule - Profitability - Savings - Quality - Reliability - Safety - Client satisfaction - Subcontractor satisfaction - Communications - Minimal project changes	Project Efficiency - Time - Budget Impact on the Customer - Performance measures - Functional requirements -Technical specifications - Customer satisfaction Business & Direct Success - Organizational performance Preparing for the Future - Opportunities - Challenges	Budget User expectations Schedule Specifications Workmanship Disruption	Macro - Completion Time - Satisfaction Utility Operation Micro - Completion Time Cost Quality Performance Safety	Meeting Design Goals - Functional - Technical - Schedule - Budget Benefit to the End User - Acquisition goals - Operational need - Entered service - On time - Life cycle - Improvement - Satisfaction Benefit to the Developing Organization - Profitability - New market - New product - New technology - Reputation Benefit to the Defense and National Infrastructure - Critical contribution - Updated products - Self sufficiency - Other projects Overall Success - Combined measure	Objective Measures - Construction time - Construction speed - Time variation - Unit cost - Variations - Net present value - Accident rate - Environmental impact assessment Subjective Measures - Quality - Functionality - End-user satisfaction - Client satisfaction - Design team satisfaction - Construction team satisfaction

Note: 1) Construction projects - government sector; 2) Construction projects - government and private sectors

(Source: This Study)

Table 2.2 Project Success Criteria - Examples from the Literature

The research themes in Group 2 continue the Positivist tradition in PM research from Group 1, with some exceptions (Baker *et al*., 1974/1983; de Wit, 1986, 1988). In this, newly available computer-based tools, such as linear regression, are applied to the challenge of how best to deliver successful projects by identifying critical success criteria, critical success factors, and their correlations. Pinto's (1986) study of critical success factors in projects is representative of this theme group and uses linear regression with a sample size of 418 projects, Table 2.1. The findings from PM research in this theme group were showing both technical and social variables among the project success criteria and project success factors. However, the traditional mechanistic approach to PM was retained with 'bolt-on' adjustments for social factors, rather than any change to the main assumptions underlying the paradigm itself (Pinto, 1986; Pinto & Slevin, 1988; Pinto & Prescott, 1988, 1990). This was

consistent with a view of organisations as rational, as well as natural, closed systems (Scott, 1998) in the manner of Barnard (1938) and Mayo (1945).

Avots (1969)	Baker et al. (1983)	Cleland & King (1983)	Slevin & Pinto (1986)	Morris & Hough (1987)	Songer & Molenaar (1997)[1]	Chan et al. (2001)[1]	Iyer & Jha (2005)[2]
Management commitment to project	Clearly established success criteria	Project summary	Project mission	Attitudes and human qualities	Definition scope	Project team commitment	Project manager's competence
Project manager's qualifications	Goal commitment of project team	Project schedules	Top management support	Project definition	Established budget	Contractor's competencies	Top management's support
Project definition	On-site project manager	Project management	Project schedule / plan	External	Established completion date	Risk and liability assessment	Proj. Mgr's coordinating and leadership skill
Work package sizing	Adequate funding to completion	Market intelligence (competitors)	Client consultation	Finance	Standard design specification	Client's competencies	Monitoring and feedback
Network planning techniques	Adequate project-team capability	Operational concept	Personnel	Schedule	Technologically advanced	End-users' needs	Coordination between project participants
Information flows	Accurate initial cost estimates	Acquisition (development-test-production)	Technical tasks	Organisation and contract strategy	Client experience	Constraints imposed by end-users	Committed project participants
Updating plans	Minimal start-up difficulties	Facility support	Client acceptance	Communications and controls	Adequate client staffing		Owners competence and favourable climatic condition
Linking peformance and rewards	Adequate planning and control techniques	Logistic requirements	Monitoring and feedback	Resources / management	Client's risk aversion		
Employees' personal goals	Task (vs. social) orientation	Manpower and organization	Communications		Client's delegation of design		
Commitment to project management techniques	Absence of bureaucracy	Executive development and personnel training	Troubleshooting		Market conditions		
		Financial support			Contractor availability		
		Project requirements			Project size		
		General information			Contract type		
		Proprietary information			Shared scope understanding		
					Alternative financing options		

Note: 1) Construction projects - government sector; 2) Construction projects - private sector

(Source: This Study)

Table 2.3 Project Success Factors - Examples from the Literature

Examples of project success criteria, or key performance indicators (KPI), from the literature are shown in Table 2.2, which reflects the diversity of views and approaches in this topic area. Despite the variety of approaches to KPIs in Table 2.2, one common feature is the inclusion of measures on time, cost, and quality in almost all the KPI sets, the so-called "iron triangle" (Atkinson, 1999, p. 337). Building on Daniel (1961), Rockart (1979) identified critical success factors (CSFs) as "the few key areas where 'things must go right' for the business to flourish" (p. 85), which may vary over time. In contrast with the project KPIs of Table 2.2, where there was little overlap between criteria, except for time, cost, and quality, there is substantial overlap between the project CSFs in Table 2.3, which represent empirical investigations of general and construction projects in diverse industrial sectors, including the government sector.

2.2.3 GROUP 3 THEMES - FRAMEWORK PROCESS (1985+)

This theme group served as a transition from viewing projects in isolation to viewing projects from a strategic organisational perspective, Table 2.1. This meant that projects were no longer seen as bounded open systems with limited interaction with their immediate environments but as open systems and context-dependent. In terms of methodological perspectives, project reality was not only Positivist and detached from the knowing subject but Pragmatist as well, which informed an approach to epistemology, or theory of knowledge, that was interpretivist as well as empiricist. This change in perspective in PM research was influenced by research in the business literature, which saw firms as open systems but also rational and deterministic (Thompson, 1967). PM research in this theme group reflected the major strands in the wider business literature, such as contingency theory (Shenhar & Dvir, 1996), information processing (Winch, 2002) and transaction cost economics (Winch, 1989; Walker & Wing, 1999; Turner & Keegan, 2001).

PM research was beginning to see more case study research than the traditional questionnaire surveys and, indeed, more case studies were being advocated by leading PM researchers (Morris & Hough, 1987; Morris, 1997). Ironically, the findings of the benchmark PM research that was carried out in the Positivist tradition in Groups 1, 2, and 3, 1940s to 1980s, were pointing away from the traditional normative approach to PM and towards a more balanced socio-technical approach grounded in the social sciences. This was acknowledged explicitly by Baker *et al*. (1974/1983) and Lechler (1997, 1998) but less so by Pinto (1986 *et seq*.). The traditional PM paradigm appeared to be shifting slowly, as glaciers do, and a welcome thaw seemed to be in the air.

As an acknowledgement of the broader strategic perspective of PM and the integration that was needed between project stakeholders at project level, organisation level, and external level, this theme group saw a flowering of a framework process approach to PM. In 1996, the Project Management Institute (PMI) in the USA undertook a major revision of its Project Management Book of Knowledge (PMBoK) from its original format in 1987. The 1996 version has remained broadly in place ever since with ongoing update revisions, which is now comprised of nine knowledge areas and forty four processes (PMI, 2004, 3rd Ed.). Interestingly, in 1987, when it was first issued, the PMBoK aspired to document the full set of PM knowledge but the 1996 revision was issued as a 'Guide' to the PMBoK, an implicit acknowledgement that only the practice of PM represents the full knowledge set of PM and the PMBoK Guide is but a sub-set of this and will always remain so. Five years after the

PMI issued its first edition of PMBoK in the USA, the Association for Project Management (APM) in the UK issued its first edition of its PMBoK in 1992, which is now comprised of seven sections and fifty two knowledge areas (APM, 2006, 5th Ed.).

2.2.4 GROUP 4 THEMES - ORGANISATION (1995+)

In this group of PM research themes, the operative metaphors are flux and transformation within a strategic perspective of organisational relevance and competitiveness that emphasises value creation. By now, organisations are viewed as open systems that are natural as well as rational and, importantly, they are also seen as part of a broader ecological system (Scott, 1998). In effect, organisations have become 'knowing' and interpretation systems that enact their survival in different environments, which vary in complexity and predictability (Daft & Weick, 1984; Tsoukas, 1996; Tsoukas & Chia, 2002). Reality is viewed as both Positivist and Pragmatist, which informs a view of knowledge acquisition that is socially and experimentally constructed with empiricist underpinnings. Organisations enact their knowledgeability through the agency of organising, which can be practical, theoretical, or in combination (Weick, 1979, 1995; Giddens, 1984/2007; Orlikowski, 1996; Tsoukas, 2005).

In PM, the strategic perspective of the wider business literature is reflected in the increasing professionalisation of the discipline through increased membership of the PM professional bodies and the strategic perspective of practitioner and academic textbooks (Cleland & Ireland, 2007; Morris & Pinto, 2007). In PM research, the strategy theme is also reflected in a focus on the 'management of projects' over the entire economic life cycle rather than the truncated version of PM that ends with the handover of the project to operations (Morris, 1997; Davies & Hobday, 2005). Projects are now seen as embedded in their context (Engwall, 2003; Sydow, Lindkvist, & DeFillippi, 2004) as temporary organisations, characterised by time, task, team, and transition (Lundin & Söderholm, 1995; Packendorff, 1995). It is the form of the project as a temporary organisation, rather than its technical content, that gives meaning to a project and the project form derives from a process of social construction between project actors (Engwall, Steinthórsson, & Söderholm, 2003).

By the 1990s, projects have becomes sites of organising, learning, and creating new knowledge, where the 'soft' community model of knowledge is proposed as a contrast to the traditional 'hard' cognitive model (Lindkvist & Söderlund, 2002; Bresnen, Edelman, Newell, Scarbrough, & Swan, 2003). At an organisational level, the development of PM expertise

based on goal-directed learning is manifest as an organisational capability, which contributes to the strategic positioning of the organisation (Lindkvist, Söderlund, & Tell, 1998; Davies & Brady, 2000; Söderlund, 2005).

2.3 PROJECT MANAGEMENT THEORY DEVELOPMENT

As this study is positioned within the 'organisation' theme group of the previous section, this section will discuss the development of PM theory around the core idea of a project as a temporary organisation, or 'actor/becoming', rather than a 'task/being' under traditional PM. This represents a fundamental shift in thinking about projects that facilitates a change in perspective from traditional 'top-down' PM to emergent 'bottom-up' PM. In addition, this supports a practice-oriented approach to PM with implied learning rather than an applied science approach to PM with little learning expected beyond the application of prior knowledge.

Like management in general, PM has evolved over time to incorporate theoretical influences from many sources, as well as practical influences from experienced practitioners, heuristics of 'best practice', professional certification programmes, and government regulation. Also, like management, PM strives to identify a theoretical framework to underpin PM as a separate research domain, as exemplified by Turner's recent editorials in the *International Journal of Project Management* (2006a/b/c/d). In a review of the issue of PM theory, Morris (2002) readily accepts that PM is a discipline but argues that, like management theory, "there will never be an overall theory of project management. Indeed, the very notion is mistaken" (p. 82). Instead, he advocates a pluralistic approach to PM theory, in terms of identifying theory that is useful for aspects of PM rather than a holistic approach. In this, he reminds us that holistic theories do not even exist in the subjects of the natural sciences.

2.3.1 PROJECTS AS TASKS

> A project is a temporary endeavor undertaken to create a unique product, service, or result. (PMI, 2004, p. 5)

> A project is a unique, transient endeavour undertaken to achieve a desired outcome. (APM, 2006, p. xv)

> A 'project' is an organization, which is established for a limited time period to solve a complex (relatively), unique problem. (Gareis, 1989, p. 243)

> A project is a temporary organization to which resources are assigned to do work to bring about beneficial change. (Turner, 2006a, p. 1)

As seen in the above definitions of a project, including the US and UK professional bodies, the traditional approach to PM is grounded in technical rationality, where projects are undertaken to deliver a pre-specified outcome that involves tasks and resources. The outcome is usually a new tangible asset, e.g., building, or product, or service. Within this perspective, projects are seen as "tools" to achieve a planned outcome (Packendorff, 1995), Fig. 2.1.

	Common Assumption	Alternative Assumption
Project management theory	General theory for all kinds of projects, generic concept collecting different theories applicable to projects under one umbrella.	Middle-range theories on different sorts of projects, classified according to different selection criteria.
Aim of research on projects	Prescriptive, normative theory, grounded in ideal models of project planning and control. Research undertaken as survey studies of large samples of projects.	Descriptive theory, grounded in empirical narrative studies on human interaction in projects. Research undertaken as comparative case-studies.
Research metaphor for the project	A tool, a means for achieving higher-level ends.	A temporary organization, an aggregate of individuals temporarily enacting a common cause.

Source: Packendorff (1995)

Fig. 2.1 Project Management Research Approaches

This approach is normative to the extent that it is presumed to be rational and self-evidently correct, where the emphasis is on dividing a project into smaller work packages that can be planned and controlled in a way that is independent of its context (Williams, 2005). The idea is to reduce uncertainty as the project is delivered over its life cycle (Winch, 2002). The definitions also acknowledge the temporary nature of project organisations, which is consistent with an instrumental view of organisations under technical rationality as "special-

purpose collectivities created to achieve goals, to perform work. Their meaning, their legitimacy, and their potency come from *appearing* to be rational systems" (Scott, 1983, p. 160, original italics).

2.3.2 PROJECTS AS TEMPORARY ORGANISATIONS

In a 1995 paper, Packendorff draws attention to the short-comings in PM research on three grounds: (1) a pre-existing normative approach to PM; (2) a lack of empirical PM research; and (3) a lack of alternative representations of projects. In the same paper, he advocates an enactivist approach to projects, in terms of project team actors delivering the project processually as a temporary organisational form, rather than as an object that was constructed using the project as a toolkit, Fig. 2.1. This proposal requires a fundamental change in the way the reality of projects is perceived, a change from the traditional Positivist perspective to an interpretivist approach.

In this alternative view, the uncertainty and ambiguity of projects are acknowledged as inherent characteristics of projects (Engwall, 1992; Kreiner, 1995), which are perceived as temporary organisational forms (Lundin & Söderholm, 1995) in an embedded social context (Engwall, 2003). The key attributes of projects as temporary organisations which differentiate projects from the permanent organisation are "time, task, team and transition" (Lundin & Söderholm, 1995, p. 439) - time (vs. survival), task (vs. goals), team (vs. working organisation), and transition (vs. continual development). This characterisation of projects as temporary organisations is combined with an action perspective of project delivery over the four main phases of its life cycle – (1) action-based entrepreneurialism (concept); (2) fragmentation for commitment-building (development); (3) planned isolation (implementation); and (4) institutionalised termination (termination). This emerging view of projects as temporary organisations draws on earlier research in temporary organisations in education (Miles, 1964), business (Goodman & Goodman, 1976), and in organisation studies (Knight, 1976). In PM research, Kreiner (1992) views projects not as organisations characterised by stability under technical rationality but as 'living organisations' or 'theatres of passions', characterised by innovation and renewal that offer the possibility of constructing a project reality through "coherence, achievement, and identity" (p. 49) over the temporary life cycle of the project. In addition, Söderlund (2000) differentiates between temporary and permanent organisations in terms of 'structure' and 'participation' to shed light on the forms of control that are prevalent in each of four organisational types - bureaucratic-professional, bureaucratic-clan, professional-network, and professional-clan.

In PM research, the theme of projects as temporary organisations is further developed by Engwall (1998), who differentiates between viewing a project as an 'object' and as an 'actor', or between a project as 'being' and 'becoming', respectively (Linehan & Kavanagh, 2006). Mindful that the word 'project' derives from the Latin words *pro* (forward) and *jacere* (to throw), this is analogous to the difference between viewing a javelin throw as the target for the javelin (being/object) or as the act of throwing a javelin at a target (becoming/actor). In a social constructionist approach, Engwall *et al*. (2003) advance the ontological demarcation between viewing projects as 'objects' and 'actors' to view the former as projects due to technical content and latter due to organisational form, Fig. 2.2.

	Project due to technical content	**Project due to organizational form**
Boundaries around projects	Defined by the logic of the technical task	Socially constructed by compromising actors
Uncertainties in projects	An effect of improper project planning	A natural element of every project undertaking
Embeddedness in projects	Low. Projects are solitarian, independent, and closed systems	High. Projects are contextual, dependent, and open (sub-) systems
Patterns of project processes	Management and mission driven	Expectation and mission driven

Source: Engwall et al. (2003, p. 129)

Fig. 2.2 Projects Ontologies - Content and Form

In keeping with the PM 'organisation' themes of Group 4 (1995+), Table 2.1, projects as 'organisational forms' are open systems that are embedded in their context, where uncertainty and ambiguity are natural project characteristics. Indeed, under this view, the prevailing uncertainty and ambiguity in projects gives rise to "ongoing trial-and-error, interactive problem solving, and a frequent cross-functional interaction among the actors throughout the project life cycle" (Engwall *et al*., 2003, p. 121). As an 'organisational form', projects are "temporary, time-limited, and possible to fill with different technical content" (*ibid*., p. 116). In this socio-technical perspective, "a project cannot be defined solely by its technical content. Rather, the project is constructed – defined and established by actors through more or less deliberate acts" (*ibid*., p. 116).

2.3.3 PROJECT MANAGEMENT AS PRACTICE

In new product development, Dougherty (1992) introduces an interpretivist approach that highlights what she calls the "thought worlds" of participants as knowing subjects. This involves interpreting "what people see when they look into the future" (*ibid.*, p. 187), i.e., intimation (Wallas, 1926), abduction, hunch (Peirce, 1931-1958), tacit foreknowledge (Polanyi, 1967). Of course, this runs counter to the norms of technical rationality, where knowledge is pre-given and projects follow a plan that is designed up-front. In a subsequent publication, Dougherty (2001) launches a broadside against technical rationality by arguing that "a mechanistic organization archetype prevents people from seeing in their minds' eyes - from imagining - how to do the work of innovation organizationwide" (p. 612). This process of 'imagining' is harnessed through "thought worlds" in a 'community of practice' approach (Brown & Duguid, 1991; Wenger, 2001), where work is conceived "as *practice,* the exercise of a profession or occupation in an active, hands-on, problem-solving manner" (Dougherty, 2001, p. 629, original italics). However, in contrast to a detached view of knowledge, viewing knowledge as embedded in the practice of new product development raises issues regarding the transfer of knowledge across boundaries between different practices (Carlile, 2002).

In advancing the ontological debate on the representation of projects as actors rather than objects, Engwall (2002) adopts a practice-oriented approach to focus on project goals and the project life cycle as defining features of projects under technical rationality. In an echo of Mintzberg's (1979b, 1987) emergent approach to strategy, Engwall argues that, because it is "impossible to know everything beforehand" (2002, p. 275), project goals are the result of a process of goal formation over the life cycle, rather than the implementation of pre-defined objectives. For Engwall, project goals are better thought of as 'hypotheses', whose precise meaning emerges during the execution process. Furthermore, he maintains that project learning occurs through the tension between the experience of performing concrete actions and abstract knowledge, such as goals, plans, etc. This can be interpreted as an interplay of tacit rationality between 'knowing' knowledge and 'known' knowledge under a dual view of knowledge, which resonates with Kolb's (1984) 'experiential learning' that is based on the "dynamic relation between apprehension and comprehension" (p. 106).

2.3.3.1 PM as Practice – Inter. J. of Project Management (Special Ed.)

In 2006, in response to growing criticism of the divide between PM theory and practice, a Special Edition of the *International Journal of Project Management* summarised a UK government sponsored review of PM entitled *Rethinking Project Management*. In this issue, Winter *et al*. (2006) present the main findings in terms of five directions aimed at developing PM theory and practice. These include project complexity, projects as social processes, value creation, project conceptualisation, and practitioner development, Table 2.4. It should be noted that this two-year research programme included participants from academia, the main PM professional bodies, industry, and government.

The findings represent a move to rebalance the traditional monolithic PM paradigm of technical rationality with insights from the social sciences to yield a socio-technical framework that is malleable to cope with the exigencies of specific project delivery. Indeed, in so far as the format of Table 2.4 is organised around moving 'from' theory 'towards' practice, it parallels the 'being to becoming' re-conceptualisation of projects advocated by Linehan and Kavanagh (2006). In addition, it resonates with the 'object to actor' approach of Scandinavian scholars in relation to viewing projects as temporary organisations (Engwall, 1992, 1998, 2002; Packendorff, 1994, 1995; Lundin & Söderholm, 1995; Söderlund, 2000; Engwall *et al*., 2003).

2.3.3.2 PM as Practice - A Social Construction Approach

In a conceptual review of approaches to PM, Thomas (2000) highlights two main orientations to the function of PM - 'control' associated with traditional PM and 'sense-making' associated with social constructionism. She concludes by advocating a sense-making approach to PM "as a process for making sense of organizational activity" (*ibid*., p. 42) and for negotiating the "meaning" of knowledge structures inter-subjectively and extra-subjectively. Using a social construction perspective, Bellini and Canonico (2008) investigate the impact of HRM practices in project driven organisations using a social interpretivist approach to knowledge, where 'knowing' is conjoined to practice and the process of knowing is regarded as "something that people do" (p. 45), a view echoed by Bragd (2002, p. 144). They view project teams as potential knowing communities and inquire about the impact of socially constructed HRM practices on knowing communities. In their investigation using social constructionism informed by Berger and Luckmann (1967), Jackson and Klobas (2008) investigate how knowledge is created and shared in an information systems development project. Their view of knowledge is based on a process of "continual sense-making" (p. 329), rather than predetermined facts, and the process of

knowledge creation is associated with personal knowledge, or "know-how" (p. 351), a kind of 'knowing' knowledge.

Rethinking Project Management (EPSRC Network 2004-2006)

Directions for Future Research

IMPORTANT NOTE: the word 'Towards' means to enhance the 'from' position rather than to discard it.

Theory ABOUT Practice

Direction 1

The Lifecycle Model of Projects and PM ➡	Theories of the Complexity of Projects and PM
From: the simple lifecycle-based models of projects, as the dominant model of projects and project management. And from: the (often unexamined) assumption that the lifecycle model *is* (assumed to be) the actual 'terrain' (i.e. the actual reality 'out there' in the world).	Towards: the development of new models and theories which recognise and illuminate the *complexity* of projects and project management, at all levels. And towards: new models & theories which are explicitly presented as only *partial* theories of the complex 'terrain'.

Implication

The need for *multiple images* to inform and guide action at all levels in the management of projects, rather than just the classical lifecycle model of project management, as *the* main guide to action, (with all its codified knowledge and techniques). Note: theories ABOUT practice can also be used as theories FOR practice.

⇩

Theory FOR Practice

Direction 2

Projects as Instrumental Processes ➡	Projects as Social Processes
From: the instrumental lifecycle image of projects as a linear sequence of tasks to be performed on an objective entity 'out there', using codified knowledge, procedures and techniques, and based on an image of projects as temporary apolitical production processes.	Towards: concepts and images which focus on social interaction among people, illuminating: the flux of events and human action, and the framing of projects (and the profession) within an array of social agenda, practices, stakeholder relations, politics and power.

Direction 3

Product Creation as the Prime Focus ➡	Value Creation as the Prime Focus
From: concepts and methodologies which focus on: *product creation* - the temporary production, development, or improvement of a physical product, system or facility etc - and monitored and controlled against specification (quality), cost and time.	Towards: concepts and frameworks which focus on: *value creation* as the prime focus of projects, programmes and portfolios. Note however: 'value' and 'benefit' as having multiple meanings linked to different purposes: organisational and individual.

Direction 4

Narrow Conceptualisation of Projects ➡	Broader Conceptualisation of Projects
From: concepts and methodologies which are based on: the narrow conceptualisation that projects start from a well-defined objective 'given' at the start, and are named and framed around single disciplines, eg. IT projects, construction projects, HR projects etc.	Towards: concepts and approaches which facilitate: broader and ongoing conceptualisation of projects as being multidisciplinary, having multiple purposes, not always pre-defined, but permeable, contestable and open to renegotiation throughout.

⇩

Theory IN Practice

Direction 5

Practitioners as Trained Technicians ➡	Practitioners as Reflective Practitioners
From: training and development which produces: practitioners who can follow detailed procedures and techniques, prescribed by project management methods and tools, which embody some or all of the ideas and assumptions of the 'from' parts of 1 to 4.	Towards: learning and development which facilitates: the development of reflective practitioners who can learn, operate and adapt effectively in complex project environments, through experience, intuition and the pragmatic application of theory in practice.

Table 2.4 Rethinking Project Management – Winter *et al*. (2006, p. 642)

2.3.3.3 PM as Practice - Recent Developments

Answering the call from Winter *et al*. (2006) for more practice-oriented PM research, Blomquist, Hällgren, Nilsson, and Söderholm (2010) review PM research trends from a practice view. They present a three-phase typology that ranges from the early traditional approach in PM research, using technical rationality, to a process approach, using a framework approach, to the present practice approach, emphasising processes of local situated actions, Table 2.5. Accordingly, the PM research methods reflect different methodological perspectives: from a top-down/objectivist approach in early PM research committed to explaining PM as an applied science to a more bottom-up/subjectivist approach seeking to enable the construction of situated PM actions as practice.

	Focus	Empirical Approach	Ontological Status of Human Action	Epistemology	Dominating Methodological Commitment	Examples of Research Question
Traditional System	Focuses on rational structures and how they can be best managed	Top-down	Determined	Objectivist	Above all quantitative methods, to enable *Erklaren* (explaining)	What are the success factors of planning?
Andersen (2006); Dvir and Lechler (2004); Pinto and Slevin (1989)						
Process	Focuses on describing the process and how the process relates to the structure	Past, Present, Future	Intersubjective	Objectivist/ subjectivist	Above all qualitative methods such as interviews, documents, etc., to enable *Verstehen* (understanding)	How could the process of planning be understood?
Legris and Collerette (2006); Lindkvist et al. (1998); Lundin and Söderholm (1995); Sutterfield et al. (2006)						
Practice	Focuses on describing the process through the identification of local situated actions	Bottom-up	Intersubjectively situated	Subjectivist	Above all qualitative methods such as ethnography, to enable *Konstruieren* (construction)	What are the actions that are building the activity of planning?
Hällgren and Wilson (2007); Hodgson (2004); Simon (2006)						

Table 1: Three approaches to project management research.

Table 2.5 PM Research Approaches - Blomquist *et al*. (2010, p. 8)

Even though the authors advocate a practice approach to PM research as offering a better alternative to the traditional top-down PM approach based on technical rationality through organisational units, implementing plans, etc., they do not explore in any detail the epistemological implications of a practice approach to projects. This revolves around how we gain knowledge about projects in practice settings and how traditional abstract knowledge relates to 'action' knowledge in a practice scenario. This is inferred from the paper when the authors speculate on the advantages of a project-as-practice approach by

saying "a dynamic setting for action is created on the local arena where *knowledge and action come together* in practice" (Blomquist *et al*., 2010, p. 13, italics added). If 'knowing' knowledge is associated with procedural action (Ryle, 1949), then, this suggests a convergence of 'knowledge' and 'knowing' in practice.

Type 1	Type 2	Type 3	Type 4
Practice as a heuristic	Practice supported by prescriptive models	Practice supported by descriptive models	Reflective practice and situated theorization
Characteristics:	**Characteristics:**	**Characteristics:**	**Characteristics:**
• Practice considered as tacit knowledge • Domain of the "competent" practice • Knowing-in-action • Theories are implicit, inscribed in the practice itself • Intuitive approach to the practice **Theories consider that intuition is neither theorizable nor rationalizable**	• Practice considered as applied science • Domain of the "efficient" practice • Prescriptive knowledge • Prescriptive theoretical models • Mainly positivist epistemology and quantitativist methodology • Instrumental approaches to the practice • Emphasis on developing management tools Theorization stems from main-stream project management: **Prescriptive theories of project management practice**	• Theory considered as an interpretive framework • Domain of the "cultivated" practice • Descriptive knowledge • Descriptive theoretical models • Mainly postmodern epistemologies and qualitativist and interpretativist methodologies • Approaches to the practice through the anthropological and social sciences • Emphasis on actors and their interactions Theorization according to the type of models used **(e.g., sociological theories of project management practice)**	• Epistemology of practice • Domain of the "reflective" practice • Practical and ethical knowledge (knowing-in-action + reflection-in-action) • Descriptive theoretical models • Active and situated qualitativist and interpretativist methodologies • Approach through project management • Emphasis on praxis, the practice, and the act of project management Project-grounded theorization: **Pragmatist theories of project management practice**

Table 1: Characteristics of diverse types of theory-practice relationships.

Table 2.6 PM Practice Types - Lalonde *et al*. (2010, p. 24)

In a their paper, Lalonde, Bourgault, and Findeli (2010) review PM through the lens of practice with the same aim of achieving a better synthesis between PM theory and practice as Winter *et al*. (2006), although not citing the earlier work. They analyse the development of PM practice over time into four phases, or practice types, Table 2.6, ranging from PM practice as a heuristic, as prescriptive models, as descriptive models, and the current phase of PM practice as situated and reflective practice. This typology is broadly in line with the earlier four-group typology of PM themes that is presented by this study in Table 2.1 but with different time horizons - optimisation, success factors, framework process, and organisation.

Although they do not elaborate on the kind of knowledge that is involved in PM practice, they recognise "the *dualism* at the heart of the relationship between theory and practice" (*ibid*., p. 33, italics added). This seems to indicate that traditional PM is about applying theory in practice, whereas reflection-in-action is in the other direction, i.e., creating theory from practice that recursively guides practice (Schön, 1983). This is how practice becomes *praxis*, which is "the process by which a theory or lesson becomes part of lived experience"

(Bredillet, 2006, p. 3). In a subsequent publication using a Pragmatist approach informed by Schön and Dewey, PM practice is viewed as a process of inquiry, which involves a "to-and-fro" movement between "descriptive" practices that reflect what has already happened and "design" practices that signal intentions for the future (Lalonde, Bourgault, & Findeli, 2012, p. 418).

In a practice-oriented approach to projects, Geraldi, Maylor, and Williams (2011) identify complexity as a key contingent variable that impacts on decisions in the "practice of managing projects" (p. 966) and highlight five dimensions of complexity - structural, uncertainty, dynamics, pace, and socio-political. This theme of uncertainty and unpredictability in complex PM settings is echoed by Lenfle and Loch (2010) in reminding us that the original practice of PM in the 1950s was associated with "strategic initiatives, innovation, and change" (p. 33). This involved "parallel trials and experimentation" (*ibid*., p. 37) rather than the "stage gate" approach of mainstream PM that developed later. In a similar vein, recent empirical research in a complex PM setting by Nightingale and Brady (2011) offers a critique of the traditional PM paradigm based on technical rationality and predictability. In their contribution, they propose a "practice-based alternative paradigm" (*ibid*., p. 83) that views project actors "as sources of deterministic behavior in an otherwise often unpredictable world" (*ibid*., p. 83), where projects act as key tools in creating this predictable behaviour.

2.4 PROJECT MANAGEMENT AS AN ORGANISATIONAL CAPABILITY

The previous section discussed the development of PM theory from viewing projects as tasks (object/being) to viewing projects as process (actor/becoming), which is consistent with viewing PM as practice rather than an applied science. This section will build on this approach to discuss the development of organisational capabilities, including PMC, as an enacted 'organisational practice' that is grounded in complex learning processes based on problem-solving, the central research theme of this study, rather than routines or resources. The development of PMC as a 'core competence' in PBOs is discussed through the lens of problem-solving, or knowledge-creating, at project level and organisational level. However, what seems lacking in the empirical literature is research on PMC development as a 'core supporting competence' and as a multi-level construct in organisations that have been subject to radical and rapid external change on a sustained basis, e.g., the PSOs under study.

2.4.1 ORGANISATIONAL CAPABILITY AS ORGANISATIONAL PRACTICE

In the literature on organisational capabilities, Richardson (1972) is generally regarded as an early reference, because of his observation that "organisations will tend to specialise in activities for which their *capabilities* offer some comparative advantage" (p. 888, italics added). Unfortunately, since this publication, the term 'organisational capabilities' has come to mean many things to many people, "like an iceberg in a foggy Arctic sea, one iceberg among many " (Dosi, Nelson, & Winter, 2000, p. 3). Nevertheless, in spite of semantic disparities, organisational capabilities have been identified as 'organisational routines' (Nelson & Winter, 1982; Nelson, 1991), as 'strategic' and 'functional' (Chandler, 1990), as 'a core competence' (Prahalad & Hamel, 1990), as 'architectural and component knowledge' (Henderson & Clark, 1990), as a source of organisational synergy (Chandler, 1992), and as 'a high-level routine' (Winter, 2000).

In both Hayek (1945) and Penrose (1959/1995), the capability of their actors at a point in time, individual and management alike, is based on a holistic knowledgeability that is derived from the goal-driven exercise of their activities. Their capacity to act has developed from their mature experience of enacting their roles, which is an ongoing accomplishment, an ongoing process of learning that involves the creation and utilisation of knowledge to achieve objectives (Brown & Duguid, 1991). In essence, their capabilities have developed from cycles of pursuing objectives through practice and learning, i.e., through cycles of goals, practice, learning, and development. As Bogner and Thomas (1994) observed: "Competencies evolve through an iteration of doing, learning, and doing some more. Each sequence expands knowledge and enriches core competence" (p. 118). However, capability development is not an assured outcome, as enactment that is poorly executed leads to learning that is poor or learning that is forgotten and, without learning, development is unlikely.

2.4.2 ORGANISATIONAL CAPABILITY DEVELOPMENT AS LEARNING TO CHANGE

Nelson and Winter (1982) adopt a knowledge-based view of capabilities by associating organisational capabilities with organisational routines that incorporate organisational knowledge, much of which is tacit. However, under this view, organisational knowledge is embedded in routines, rather than individuals, and the organisation retains its knowledge by

enacting its routines and acquires new knowledge by amending its routines. The idea of routines as the building blocks of organisational capabilities is prevalent in the literature and has given rise to other associated themes, such as routines as hierarchies (Zollo & Winter, 2002; Winter, 2003; Easterby-Smith & Prieto, 2008), the coordination of routines (Levinthal, 2000), and the integration of knowledge that comprises routines (Grant, 1996a/b).

2.4.2.1 Capability Development as Stimulus-Variation-Selection-Retention

The prevalence of the guided-evolutionary cycle of variation, guided-selection, and retention in the strategy literature as a response to environmental change as stimulus is summarised in Table 2.7. For example, in Teece *et al*. (1997), this is manifest as the management processes of coordination, learning, and reconfiguring. This paper takes a resources-learning perspective on capabilities development, which is subsequently repeated in Teece (2007), where the evolutionary cycle takes the form of management interventions of sensing, seizing, and reconfiguring. In contrast, Zollo and Winter (2002) adopt a routines-learning approach to capabilities development under an evolutionary rubric and highlight the learning mechanisms of experience accumulation, knowledge articulation, and knowledge codification.

Similarly, in the PM literature, learning at project level has been identified as a goal-directed, trial-and-error, process that is based on the guided-evolutionary cycle of variation, guided-selection, and retention, where goal pre-selection and error elimination are emphasised (Lindkvist & Söderlund, 2002). This guided-evolutionary perspective at project level is reflected in Söderlund, Vaagaasar, and Andersen (2008) as project learning practices of relating, reflecting, and routinising, Tables 2.7 & 2.8. The goal-directed evolutionary approach is extended further to the development of a project management capability (PMC) at organisation level in response to the the trigger of project/business goals. In Lindkvist (2008), this follows a guided-evolutionary cycle of goals, variation, guided-selection, and retention, which is reflected in Söderlund (2008) as organisational learning modes of shifting, adapting, and leveraging, Tables 2.7 & 2.8. In research on the development of project portfolio management (PPM) as an organisational capability, Killen, Hunt, and Kleinschmidt (2008) adopt the evolutionary learning approach of Zollo and Winter (2002); and Petit and Hobbs (2010) adopt the approach of Teece (2007) based on sensing, seizing, and reconfiguring, Table 2.7.

Evolutionary				
PROBLEM-SOLVING LEARNING→	**STIMULUS**	**VARIATION**	**SELECTION**	**RETENTION**
KNOWLEDGE GROWTH				
Popper (1935,1963,1972)	problem situation	tentative theories	error elimination	problem solution
ORG. CAPABILITY DEVELOPMENT				
Brown & Duguid (1991)	business objectives	work / practice	learning	innovation
Teece & Pisano (1994)	business change	adapting	integrating	reconfiguring
Teece et al. (1997)	business change	co-ordinating	learning	reconfiguring
Zollo & Winter (2002)	business change	experience accumulation	knowledge articulation	knowledge codification
Teece (2007)	business change	sensing	seizing / combining	reconfiguring
PM CAPABILITY DEVELOPMENT				
Lindkvist & Söderlund (2002) - project level	project goals	variation	learning	
Söderlund et al. (2008) - project level	project goals	relating	reflecting	routinising
Lindkvist (2008) - organisation level	business objectives	variation	learning	retention
Söderlund (2008) - organisation level	business objectives	shifting	adapting	leveraging
Problemistic				
PROBLEM-SOLVING LEARNING→	**STIMULUS**	**EXPLORATION**	**EXPLOITATION**	
ORG. CAPABILITY DEVELOPMENT				
March (1991)	business objectives	exploration	exploitation	
PM CAPABILITY DEVELOPMENT				
Brady & Davies (2004) - organisation level	business objectives	exploration	exploitation	

(Source: This Study)

Table 2.7 Organisational Capability Development - Guided-Evolution & Problemistic Learning

This evolutionary perspective of variation, selection, and retention is fundamentally grounded in knowledge growth, or knowledge creation, through the Greek problem-solving dialectic of antithesis as variation and synthesis as guided-selection (Popper, 1972/1979). In addition, the related themes of reflection and reflective practice (selection and retention) as ways of unlocking project learning are echoed by Ayas and Zeniuk (2001), Raelin (2001), and Scarbrough, Bresnen, Edelman, Laurent, Newell, and Swan (2004).

2.4.2.2 Capability Development as Stimulus-Exploration-Exploitation

Using a cognitive approach and a version of the guided-evolutionary cycle of goal-variation-selection-retention, other researchers have identified how knowledge is acquired and utilised at organisation level through 'problemistic' heuristic learning processes, such as exploration

and exploitation (March, 1991). This invites organisations to adopt different business strategies for the exploitation of current knowledge and the exploration of new knowledge. In the PM literature, the theme of exploration-cum-exploitation learning is taken up by Brady and Davies (2004) to advocate a two phase model of project capability building (PCB) based on learning processes that are 'project-led' (exploration) and 'business-led' (exploitation), Tables 2.7 & 2.8. This builds on the seminal paper of Davies and Brady (2000) that conceptualised 'project capability' as a multi-level construct that can develop from a catalyst project (Middleton, 1967) to achieve repeatable solutions, a theme echoed in later research (Ruuska & Brady, 2011). A similar theme of exploration and exploitation is echoed in PM learning through problem-solving and reflection (Raelin, 2001). Again, this version of the evolutionary perspective of variation, selection, and retention is fundamentally grounded in knowledge growth, or knowledge creation, through the Greek problem-solving dialectic of antithesis as exploration and synthesis as exploitation (Popper, 1972/1979).

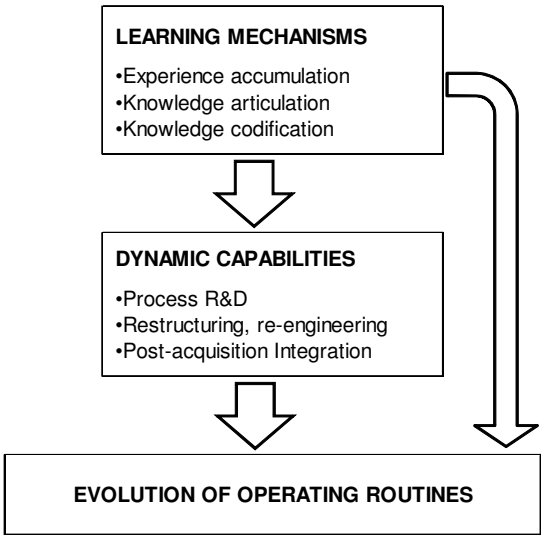
Authors	Title	Antecedents	Unit of Analysis	Research Themes	Research Methods
Keegan & Turner (2001)	Quantity versus quality in project-based learning practices	• Project management • Organisational learning	Learning practices in project-based firms	• Organisational learning as an evolutionary process where the constant recycling of variation, selection, and retention leads to change • Time pressures, centralisation, and deferral are key characteristics of learning in project-based firms, which impede project-based members in learning from and through projects	Semi-structured interviews (N=44)
Prencipe & Tell (2001)	Inter-project learning: Processes and outcomes of knowledge codification in project-based firms	• Organisation capability • Dynamic capability • Organisational learning	Inter-project learning mechanisms	• Three inter-project learning mechanisms based on experience accumulation, knowledge articulation, and knowledge codification (Zollo & Winter, 2002) at different levels of analysis: - individual - project (team) - organisation	Case study (N=6)
Lindkvist & Söderlund (2002)	What goes on in projects? On goal-directed learning processes	• Project management • Organisational learning	Problem-solving learning processes in projects	• Projects as goal-directed learning processes to determine the 'how' of project realisation through trial-and-error learning cycles of: - enactment - selection - retention	Conceptual
Brady & Davies (2004)	Building project capabilities: From exploratory to exploitative learning	• Project capability • Organisation capability • Dynamic capability • Organisational learning	Learning mechanisms for developing project capability	• Project capability-building consisting of two interacting levels of learning – exploration and exploitation • Project-led learning (exploration) - vanguard project - project to project - project to organisation • Business-led learning (exploitation) … create and exploit capabilities to perform routine project activities	Case study (N=2)
Söderlund, Vaagaasar, & Andersen (2008)	Relating, reflecting and routinizing: Developing project competence in cooperation with others	• Project capability • Organisation capability • Dynamic capability • Organisational learning	Learning mechanisms for developing project capability	• Co-evolution of learning processes to build project-level competence: - relating - reflecting - routinising	Case study (N=1)

(Source: This Study)

Table 2.8 Learning in Projects - Examples from the Literature

2.4.2.3 Dynamic Capability & Learning

The concept of dynamic capability within the capability literature is normally associated with the organisation's ability to maintain and increase competitiveness in response to rapid change in the external environment. However, there are parallel debates in the literature revolving around the roles of three underlying drivers of dynamic capabilities - learning, operational routines, and resources (Easterby-Smith & Prieto, 2008). In this, learning often appears as an enabling activity for the organisation to enhance its operating routines or its resource management capability through a guided-evolutionary sequence of variation, guided-selection, and retention, Table 2.7. What is overlooked is that the performance of existing routines involves problem-solving learning, albeit single-loop, where routines are performed for 'another first time' repeatedly (Garfinkel, 1967). Too often, learning in organisations is associated with visible new knowledge, such as new processes or routines, rather than with a distributed tacit dimension of 'tacit foreknowledge' (Polanyi, 1967) that enables organisations to do what organisations do, that is, to organise on a continuous basis.



Source: Zollo & Winter (2002, p. 340)

Fig. 2.3 Learning, Dynamic Capabilities, and Operating Routines

Expanding the learning perspective, Easterby-Smith and Prieto (2008) view learning as a second-order capability that is linked to first-order dynamic capabilities and to zero-order operational capabilities. In an earlier paper, Zollo and Winter (2002) link dynamic capability and the learning mechanisms of experience accumulation, knowledge articulation, and knowledge codification as a means of renewing, or regenerating, operating routines, Fig. 2.3. This is based on an instrumental Positivist view of knowledge as something that is detached

from the knower and can be manipulated to get from A to B. This is consistent with their definition of dynamic capabilities, which revolves around operating routines: "A dynamic capability is a learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness" (*ibid*., p. 340). In Zollo and Winter's (2002) paper, the learning mechanisms associated with dynamic capabilities are not identified as either single-loop or double-loop learning (Argyris, 1977; Argyris & Schön, 1996).

A recent publication defines dynamic capability from a resource perspective as "the capacity of an organization to purposefully create, extend, or modify its resources base" (Helfat, 2007, p. 4). This builds on previous research that incorporated a learning perspective and linked dynamic capability, as a first-order resource capability, with the modification of zero-order, routine, operational capabilities (Teece *et al*., 1997; Zollo & Winter, 2002; Winter, 2003). However, Winter (2003) distinguishes between organisational capabilities in local organisational terms; thus, an R&D business unit in a larger organisation can be a 'first-order' dynamic capability but an R&D lab as an stand-alone business is a 'zero-order' operational capability, i.e., a "how we earn a living" capability (*ibid*., p. 992). In the same paper, he also distinguishes between "*ad hoc* problem solving" (*ibid*., p. 992) for dealing with non-repetitive external business challenges and dynamic capabilities, which he characterises as 'routine', 'highly patterned', and 'repetitious'.

2.4.3 DEVELOPING PROJECT MANAGEMENT CAPABILITY

2.4.3.1 Projects as Arenas of Problem-Solving Learning

Although projects can be characterised in many ways, ranging from their content as specific tasks to their form as temporary organisations (Lundin & Söderholm, 1995; Packendorff, 1995; Engwall *et al*., 2003), few would disagree that problem-solving is an important characteristic of the PM process throughout the project life cycle. Nevertheless, with its "plan-then-execute" (Leybourne & Sadler-Smith, 2006, p. 485) heritage from the engineering disciplines, traditional PM adopts a toolkit, information processing, approach to projects (Winch, 2002; PMI, 2004; APM, 2006; Smyth & Morris, 2007). In this approach, problem-solving as a learning process is subsumed as an element of PM heuristic practices, one among others, rather than as a central aspect of the practices themselves and the overall PM process. In contrast, this study believes that problem-solving in PM needs to be highlighted as a demarcation process that is grounded in knowledge creation, which

differentiates PM, like innovation and entrepreneurship, from operational management disciplines and research.

2.4.3.2 PM Competence and Project Capability as PM Capability (PMC)

The term 'project management competence' was used by Hartman (1998) in the context of PM maturity models, while, in parallel, the capability of organisations to manage multiple projects was investigated by Laufer, Denker, and Shenhar (1996) and by Lindkvist *et al*. (1998). Building on Middleton's (1967) insight that a major new project can initiate a cycle of organisational learning and capability development, Davies and Brady (2000) introduced the term 'project capability' to the PM literature, Table 2.9. In this, they refer to the ability of project-based organisations to deliver 'complex product systems' (CoPS) by managing the organisation, processes, and procedures for bidding and delivering projects to customer specifications. Furthermore, they developed the idea of a multi-level approach to project capability at strategic, project, and functional levels. This includes a phased approach to the development of project capability, in terms of first-off bids, current and succeeding bids, functional reorganisation, and the creation of a new business unit.

In a similar vein, organisational PMC practices have been identified by Winch (2002), Söderlund (2005), Lee and Anderson (2006), Söderlund *et al. (*2008), and Söderlund and Tell (2009). From Winch (2002), defining the project mission, mobilising the resource base, riding the project life cycle, leading the project coalition, and maintaining the resource base; and from Söderlund (2005), project generation, project organising, project leadership, and project teamwork. From a knowledge-based view, Davies and Hobday (2005) include organisational knowledge, along with experience and skills, in their definition of project capability to "perform pre-bid, bid, project and post-project activities" (pp. 62-3). Furthermore, in their formulation of organisational capability, projects play a key role in "capability building and *learning*, organisational structure and design, and *systems integration* (the capability to *combine diverse knowledge bases* and physical components)" (*ibid*., p. 4, italics added).

Authors	Title	Antecedents	Unit of Analysis	Research Themes	Research Methods
Hartmann (1998)	Project management competence	Project management	Organisational project management competence	Project management maturity models	Conceptual
Lindkvist, Söderlund, & Tell (1998)	Managing product development projects: On the significance of fountains and deadlines	Product development	Project co-ordination for new product development - sequential vs. concurrent	• Product development • Concurrent engineering • Organisational learning	Case study (N=1); reflexive interpretation
Davies & Brady (2000)	Organisational capabilities and learning in complex product systems: Towards repeatable solutions	• Organisation capability (Chandler) • Dynamic capability • Organisational learning	Developing project capability	• **Project capability** in bidding and execution • Organisational learning • Economies of repetition	Case study (N=2)
Davies & Hobday (2005)	The business of projects: Managing innovation in complex products and systems (CoPS)	• Organisation capability • Organisational learning	Project business and CoPS • product • project • firm	Ways in which businesses use projects to drive business strategy and innovation	Case studies
Söderlund (2005)	Developing project competence: Empirical regularities in competitive project operations	• Project capability • Organisation capability • Dynamic capability	Developing project capability	• Project competence framework • Building blocks of project competence: - project generation - project organising - project leadership - project teamwork	Case study (N=4)
Söderlund (2008)	Competence dynamics and learning processes in project-based firms: Shifting, adapting, and leveraging	• Project capability • Organisation capability • Dynamic capability • Knowledge-based view • Organisational learning	Developing project capability	Learning processes that contribute to the competence dynamics operating in project-based organisations: - shifts in the project operations of the firm - adapting ... continuous learning - leveraging ... knowledge transfer across projects	Case study (N=6)
Söderlund & Tell (2009)	The P-form organization and the dynamics of project competence: Project epochs in Asea/ABB, 1950–2000	• Project capability • Organisation capability • Dynamic capability • Knowledge-based view • Organisational learning	Evolution of project capability	• Processes of capability building by investigating vanguard projects over a fifty year period • Project epochs - evolution of the firm • Project-form (p-form) organisation	Case study (N=1)

(Source: This Study)

Table 2.9 Development of Project Management Capability (PMC) - Examples from the Literature

As the research themes of project capability and project learning are inextricably linked, these two themes have co-evolved over the last decade. While the unit of analysis, project capability development, remains relatively constant throughout this period, the level of analysis varies between investigations at project level and organisation level, Table 2.9. The latter research is positioned in the wider context of the literature on organisational capabilities and dynamic capabilities (Söderlund, 2005, 2008; Crawford, 2006; Söderlund & Tell, 2009). Using terminology that mirrors confusion over terminology in the organisational capabilities literature, Söderlund (2008) investigates the dynamic nature of developing project competence, which he terms 'competence dynamics', in contrast to 'dynamic capabilities' in the strategy literature (Teece, Pisano, Helfat). At the same time, he advocates that project competence can sometimes be viewed as a dynamic capability and, as such, a strategic organisational capability for project-based organisations.

2.4.3.3 Project Management Capability – Project Level

In a case study that investigated implicit 'project capability' at organisation level - the term was coined two years later by Davies and Brady (2000) - Lindkvist *et al*. (1998) highlight the need for achieving the twin objectives of "promoting creative knowledge generation processes and controlling progress towards global goals and time limits" (p. 931). This research investigated a major product development project in Ericsson, a project-based organisation. In a conceptual paper, Lindkvist and Söderlund (2002) use the evolution metaphor at project level to suggest that projects can be viewed as having evolutionary type properties and, borrowing from Weick (1979, 1996), they further suggest that learning in projects follows a localised evolutionary trial-and-error process. They characterise this evolutionary type learning at project level as self-organising cycles of enactment, selection, and retention, which generate localised structure and give shape to projects.

In a case study of an international project-based R&D organisation (Tetra Pak), Lindkvist (2008) returns to this guided-evolutionary perspective at project level to explore how the introduction of a project organisation promoted localised evolutionary trial-and-error learning and, thus, the adaptive capabilities of the organisation in a changing external environment. Even though Lindkvist (2008) explores the organisation level effects of project organising, these conclusions are conceptual in nature, in comparison to the project level conclusions which are empirically grounded. In a recent paper based on an ethnographic case study of a major technology development project in the Norwegian state-owned railway, the development of PMC is investigated from a Weickian sense-making perspective through evolutionary, project-based, learning processes (Söderlund *et al*., 2008). The capability

development processes involve relating project capability with its context, sharing reflection among the project team and stakeholders over the project life cycle, and the codified routinisation of project management practices.

2.4.3.4 Project Management Capability – Organisation Level

Söderlund (2005) uses data from four case studies of project-based organisations (ABB-Asea Brown Boveri, Ericsson, Skanska, Posten - Swedish state-owned postal service), to present a framework for the development of PMC. This is positioned in the wider literature of organisational capabilities (Chandler, Teece, Pisano, Nelson, Winter, etc.) and a knowledge-based perspective of the firm. Söderlund's (2005) framework seeks to understand how PMC fits "into the larger framework of the strategic or organisational capabilities of the firm" (p. 455). The framework is based on five elements with an emphasis at organisation level: (1) variation of project capability; (2) expansion of project capability; (3) shift of project capability; (4) building blocks of project capability; and (5) fit and dynamics between the building blocks.

In research using data from six in-depth case studies of project-based organisations, Söderlund (2008) builds on Söderlund (2005) to investigate three organisation level learning processes that contribute to the dynamics of building PMC. He also investigates the implications of this for the interplay between operational and dynamic project capabilities, the nested character of learning processes, and the multi-level aspects of project capability dynamics. The three organisation level learning processes are labelled (1) 'shifting' - revolving around the major shifts in the project operations of the firm; (2) 'adapting' - focusing on the continuous learning that takes place within project operations of the firm; and (3) 'leveraging' - emphasising the role of knowledge transfer across projects.

Building on this research, Söderlund and Tell (2009) investigate the dynamics of building PMC within the wider context of the evolution of organisational dynamic capabilities and a knowledge-based perspective of the firm. This uses data from a longitudinal single case study of an international project-based organisation (ABB-Asea Brown Boveri) over a fifty year period from 1950 to 2000. They identify the evolution at organisation level of four 'project epochs' and associated 'vanguard projects' (Brady & Davies, 2004), which represent different types of project capability and these are analysed using the building blocks of project capability from previous research (Söderlund, 2005). These include (a) project generation, (b) project organising, (c) project leadership, and (d) project teamwork, which

are used to explore the interplay between the routine operational character of PMC in project-based organisations and their strategic nature as a dynamic capability.

2.4.3.5 Project Management Capability & Dynamic Capability

As highlighted by Easterby-Smith and Prieto (2008), there are parallel debates in the literature about the roles of three underlying drivers of dynamic capabilities (DC) - learning, operational routines, and resources. Because projects are inherently one-off endeavours and the historical association of organisational capabilities and dynamic capabilities with routine operational activities (Nelson & Winter, 1982), the PM literature is divided on the issue of DC. Moreover, Nelson and Winter's (1982) seminal work cautions that "organizations that are involved in the production or management of economic change as their *principal* function – organizations such as R&D laboratories and consulting firms – do not fit neatly into the routine operation mold" (p. 97, original italics). This seems to apply to project-based organisations (PBO), the locus of much research in PMC development. Nevertheless, viewing DC through the lens of organisational routines, insights from DC have informed research into the dynamic aspects of building project capability without regarding project capability as an example of DC. This research draws attention to the 'economies of repetition' of project capability (Davies & Brady, 2000; Brady & Davies, 2004; Söderlund, 2008; Ruuska & Brady, 2011).

However, Winter (2003) delineates capabilities at organisation level rather than business unit level. He gives the example of an R&D business unit that can be viewed as a 'first-order' dynamic capability in a larger organisation but as a 'zero-order' operational capability in a stand-alone business. This suggests that PMC in project-based organisations is a zero-order operational capability rather than a potential first-order dynamic capability. However, importantly, it leaves open the possibility that PMC is a potential DC in organisations in which PM, like R&D, is an important first-order 'core supporting competence' rather than a zero-order 'core competence', e.g., the PSOs under study.

Elsewhere in the PM literature, Lee and Anderson (2006) view dynamic capabilities through the lens of organisational resources and regard "IT project management as a dynamic capability" (p. 27). In other related literatures, organisational capabilities related to new product development (Iansiti & Clark, 1994; Prieto, Revilla, & Rodríguez-Prado, 2009), project portfolio management (Killen *et al*., 2008; Petit & Hobbs, 2010), and innovation (Lawson & Samson, 2001) are regarded as dynamic capabilities in association with the capability literature.

In a learning perspective on DC in a new product development setting, Iansiti and Clark (1994) highlight "the importance of knowledge as the foundation of capability and the *problem-solving* process as the primary driver for the generation of new capability" (p. 559, italics added). They emphasise the capacity to integrate diverse knowledge bases as a key driver of dynamic performance and problem-solving as the basic unit of knowledge creation. Further, they define dynamic capability from a knowledge-based perspective as "the capacity of an organization to consistently nurture, adapt, and regenerate its knowledge base, and to develop and retain the organizational capabilities that translate that knowledge base into useful actions" (p. 563).

2.4.3.6 Project Management Capability as a Core Supporting Competence

Project-based organisations (PBO) that are based mainly in the private sector are the principle focus of the literature on PMC development. In PBOs, PMC is akin to a routine operational capability and projects form the core business activity of the organisation, such as construction, manufacturing, or consultancy firms (Gareis, 1989; Hobday, 2000; Söderlund, 2005). In this regard, Söderlund (2005) defines a project-based organisation as one that relies "upon projects in developing and sustaining its competitiveness" (p. 457). This means they are mainly commercial organisations for which projects represent a significant proportion of either their internal or external activities. Even when a state-owned enterprise such as Posten is investigated (Söderlund, 2005), the research focus is on its commercial project operations, rather than its public sector, not-for-profit, activities. Research on the development of PMC in PBOs in the private sector essentially investigates the development of the organisation's mainstream organisational capability, its pre-existing 'core competence' (Prahalad & Hamel, 1990). In this, PMC development is researched within the wider business literature perspective of organisational capabilities, where PBOs develop PMC in order to enhance their business performance.

2.5 LITERATURE GAPS AS STUDY THEMES

The purpose of this section is to reflect on significant conceptual gaps in the literature as a background for the study research themes, Fig. 2.4, which inform the Research Questions that are presented in the last sub-section. These research opportunities revolve around problem-solving learning processes within a practice-oriented approach to PMC development, the central research theme of this study. Early analysis of the data with the literature was highlighting two key aspects in the development of PMC, namely, the importance of 'context' and the involvement of learning processes more complex than either single-loop or double-loop learning (Argyris, 1977; Argyris & Schön, 1996). However, learning processes in complex organisational settings are under-developed in the capability literature. This was identifying the need to develop initial concepts of capability development through organisational complex problem-solving (CPS) before presenting the full empirical case studies. In this way, the concepts are inspired by the data, which then illuminate the concepts by illustrating the concepts in the empirical case studies.

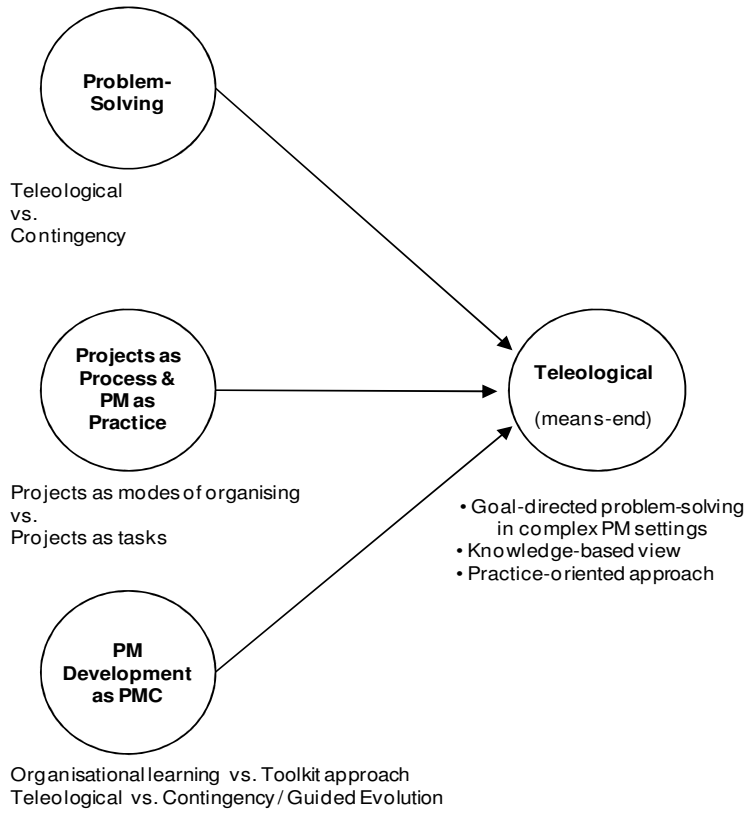


Fig. 2.4 Literature Conceptual Gaps as Study Research Themes

2.5.1 PROBLEM-SOLVING IN PM

What is taken for granted in the PM schools of both Söderlund (2002) and Bredillet (2007a/b/c, 2007a/b/c) is the knowledge-creating dynamic that is inherent in collective problem-solving, which is pervasive in project settings and considered unremarkable. In contrast, this study supports a view that highlights means-end teleological knowledge creation based on problem-solving as a demarcation process in PM rather than an accidental contingent process that is taken for granted and regarded as an inconvenience that reflects on poor design. In other words, what seems lacking in PM research is a knowledge-based PM school that views PM as a knowledge-based process for the construction of goals and solutions through goal-directed problem-solving (Popper, 1999/2006; Engwall, 2002; Lindkvist, 2005, 2008; Enberg, Lindkvist, & Tell, 2006).

In the literature, the links between organisational learning processes and the development of organisational-level PM competence are under-researched. In particular, the creation of new knowledge is problematic for traditional PM research with its Positivist lens, because, under this view, knowledge is objective and detached from the knowing subject and pre-given at the outset of a project as abstract 'known' knowledge (designs, plans, etc.). Accordingly, the role of PM is to apply existing formal knowledge rather than generate new knowledge to resolve problem situations. In effect, traditional PM anticipates little learning beyond the application of prior knowledge. In contrast, using a knowledge-based view, this study proposes that the absence of knowledge characterises projects and it is the role of PM to facilitate the necessary conditions for the creation of 'missing' knowledge through PM as a knowledge-based practice that is grounded in problem-solving.

Under Engwall's (2002) view, PM is an art rather than a science and successful PM involves "creating conditions, meaning, and expectations for the future", in which "project execution is seldom a process of implementation; rather *it is a journey of knowledge creation*" (p. 277, italics added). Even though Engwall does not depict PM as a practice *per se*, the main ingredients of practice are present. These include the application of techniques requiring judgement by a PM professional, the emerging nature of knowledge through practical 'knowing', and goal attainment through problem-solving as the engine of knowledge creation in PM practice settings (Schön, 1983).

2.5.2 PROJECTS AS PROCESS AND PM / PMC AS PRACTICE

2.5.2.1 Projects as Process

The conceptualisation of projects as organisational forms advances the idea of projects as temporary organisations (Lundin & Söderholm, 1995; Packendorff, 1995) but does not harness the key insight of Weick (1977, 1979, 1995) that organisations, even temporary ones, are essentially about *sense-making* and *organising* rather than form. Using an organising lens, the emphasis shifts from the social construction of the form of the project as a temporary organisation to the organising activities that constitute the project as a temporary organising form and the drivers of these organising activities. This study emphasises problem-solving as a key driver of *organising* and *sense-making* activities in project settings. Learning is what organisations do, because the business of organisations is to 'organise' and organising is learning, either single-loop or double-loop. This perspective requires a shift in thinking about knowledge from abstract 'known' knowledge in books and electronic databases to viewing knowledge as a process of knowing that is distributed throughout the organisation's personnel as they continuously *organise* the organisation (Orlikowski, 1996, 2002; Tsoukas, 1996, 2005, 2009).

Using Weick's (1979, 1995) insight, organisations are about *organising* and *sense-making* in a way that is forever dynamic rather than static. This suggests that knowledge-creating and organising forms are interrelated through problem-solving as sense-making, which is under-researched in the literature (Okhuysen & Eisenhardt, 2002). In his approach, Weick (1979) defines organising as a "consensually validated grammar for reducing equivocality by means of sensible interlocked behaviors" (p. 3). In this definition, Weick introduces the association of organising activities with a behavioural grammar, or a set of rules, and, as Wittgenstein (1953/1988, §202) observed: " 'obeying a rule' is a practice", which includes language. Nor is collective meaning required for collective behaviour but, rather, the sharing of the *experience* of collective action (Czarniawska-Joerges, 1992, p. 33). For example, people of the same culture can share the communal experience of its collective enactment but can have different interpretations of its meaning, resulting in either a broad or a narrow church. This perspective allows multiple meanings, or "subuniverses of meaning" (Berger & Luckmann, p. 86), within a collective endeavour such as a project that is focused on delivering a set of goals within specification limits agreed with the customer. Project goals enable the convergence of multiple meanings with centrifugal tendencies to a narrow distribution around an agreed target.

In the spirit of Weick, it seems better to view projects as modes of *organising* over the project life cycle rather than temporary organisational forms that are *organisations* during their temporary life. For projects, this suggests that *sense-making* and the many forms of *organising* over the project life cycle are mutually constituted during the project delivery. In other words, they *become* the project (Linehan & Kavanagh, 2006) and, in projects, sense-making and organising largely revolve around problem-solving, as PM practitioners know only too well in their daily work. When viewed as modes of *organising*, rather than temporary *organisations*, projects can be viewed as processually enacted by actors as 'becoming' rather than as objects in a state of 'being' (Tsoukas & Chia, 2002). Thus, Lundin and Söderholm's (1995) characterisation of projects as temporary organisations by time, task, team, and transition can be reformulated as projects as modes of organising that involve life cycle (time and transition), problem-solving (task), and team.

2.5.2.1.1 Conceptual Reformulation of Projects & PM

Building on the foregoing discussion and inspired by the dataset, this study proposes that projects as modes of *organising* can be characterised by life cycle, project organising (projectising), and team that revolve around accomplishing a temporary undertaking. In effect, *a project is a mode of organising to accomplish a temporary undertaking*. In this view, project management can be seen as an organisational competence in organising to accomplish temporary undertakings, i.e., an *organisational practice*. Taken together, this represents an integrated knowledge-based view of projects as process and PM as organisational practice, which is informed by an engagement between the literature and the dataset. If projectising is a mode of organising for temporary undertakings, this parallels partnering as a mode of organising for collaborative supply-chain activities, temporary and permanent (Bresnen & Marshall, 2000; Brady & Söderlund, 2008).

2.5.2.2 PM / PMC as Practice

Even though few would argue with the broad thrust of the social construction of reality through knowledge, even scientific knowledge (Kuhn, 1962/1996; Knorr-Cetina, 1981), what seems absent in the PM research contributions of Thomas (2000), Bragd (2002), Bellini and Canonico (2008), and Jackson and Klobas (2008) is how practical knowledge, based on 'knowing', relates to theoretical 'known' knowledge and *vice versa*. However, this is not just an issue in PM research, as the relationship between knowledge and 'knowing' in the business literature is also less than clear, especially in the area of practice (Schön, 1983; Cook & Brown, 1999; Nicolini, Gherardi, & Yanow, 2003). In a composite view of

'knowing in practice', Orlikowski (2002, 2006) draws attention to 'knowing' as a verb, that is associated with action, and knowledge as a noun, that is associated with objects and things. This is further complicated by Orlikowski's (2002, 2006) association of 'knowing' with the more holistic term 'knowledgeability' that is used by Giddens (1984/2007) in the sociology literature, where it is used to denote the holistic knowledge of the knowing agent, both discursive and practical.

In the proposed practice-oriented approach of the report on *Rethinking Project Management* (Winter *et al*., 2006), projects are viewed as social processes that are not pre-defined but "permeable, contestable and open to renegotiation throughout" (p. 645). Even though the findings are aimed at achieving a better synthesis between PM theory and practice, the view of knowledge in the practice approach to PM is unclear. For example, while it is acknowledged that PM as an instrumental process involves codified knowledge, techniques, and procedures, Table 2.4 (Direction 2, 'from'), it is not clear what approach to knowledge is proposed in the practice approach to PM, beyond that of a reflective practitioner (Direction 5, 'towards'). However, the paper indicates that the latter approach involves "experience, intuition and the *pragmatic* application of theory" (*ibid*., p. 646, italics added). When allied to an ontological perspective of projects as 'becoming', this allows a constructed view of knowledge, rather than an instrumental view, in the context of knowledge creation and utilisation in projects. Although this view is inferred rather than stated, interpretations using diverse epistemological approaches are encouraged by the authors for the framing of PM research questions and propositions for practitioners (*ibid*., p. 646).

If learning is a central element of PM as organisational practice, a better understanding of learning in projects is needed but, in order "to understand learning, we must understand the nature of knowledge and vice versa" (Kolb, 1984, p. 38). This is a serious impediment for traditional PM with a 'one size fits all' approach to knowledge based on a Positivist perspective that views objective knowledge as detached from the knowing subject. What is needed is a practice-based epistemology to supplement the traditional approach in PM of technical rationality (Schön, 1983) but, in order to effect this change, a shift in ontological perspective is required from viewing projects as 'objects/being' to projects as 'actors/becoming'.

In general, while the debate in PM has accepted the limitations, if not the failure, of the traditional Positivist approach to projects as an applied science grounded in technical rationality, there is no new consensus on the nature of projects and how we can obtain knowledge about them. A 'practice' approach to PM seems to offer good prospects for PM

research on many fronts, because it serves as a meta-theme that can accommodate diverse views of projects, such as those above - projects as tasks, temporary organisations, modes of organising, and arenas of knowledge creation. In addition, it represents an approach for investigating the development of PMC as a multi-level PM ecology that ranges from project level to organisational level, and to external level (Grabher, 2002, 2004).

2.5.3 PM DEVELOPMENT AS PMC

In his work on reflective practice, Schön (1983) emphasises reflection-in-action by practitioners as a meaningful way of engaging with phenomena in the world, which involves situated learning by practitioners, even though learning may not be regarded by practitioners as an intrinsic part of practice. In a constitutional approach, Wenger (2001) suggests that: "One reason they [practitioners] do not think of their job as learning is that what they learn *is* their practice" (p. 95, original italics). However, with few exceptions (Iansiti & Clark, 1994; Zollo & Winter, 2002), capabilities tend to be viewed instrumentally as consisting of separate processes that support a 'problem-then-solution' approach to capability formation. This involves submerged learning rather than viewing organisational capability and learning as mutually constituted processes with learning as the bridge between problem and solution (Brown & Duguid, 1991; Wenger, 2001). In the latter view, organisational capability is constituted as an organisational practice that is inherently a learning process of knowledge creation and utilisation. In the PM literature, viewing PM as an *organisational practice*, as distinct from an aggregate of heuristic practices, is also under-developed.

A knowledge-based view of organisational capability development is adopted by Iansiti and Clark (1994), who highlight "the importance of knowledge as the foundation of capability and the problem-solving process as the primary driver for the generation of new capability" (p. 559). In this approach, which builds on Dosi and Marengo (1993), problem-solving is regarded as "the basic unit of knowledge creation" (Iansiti & Clark, 1994, p. 561), a view also echoed by Leonard-Barton (1992, 1995). Learning acts as a building-bridge between practice and development that guides the evolution of organisational capability (Brown & Duguid, 1991; Eisenhardt & Martin, 2000; Zollo & Winter, 2002). In this approach, practice is viewed as an enacted process and learning is equivalent to a process of innovation (Weick, 1979; Schön, 1983). The knowledge-based approach of (Iansiti & Clark, 1994) to the development of dynamic capabilities is under-appreciated in the literature and represents a synthesis of a top-down perspective with a bottom-up perspective of continuous regeneration of the organisation's knowledge base. In this view, the key challenge for management is to

promote problem-solving as an engine of knowledge creation and translate the resulting knowledge into 'useful actions'. This implies a multi-level approach to dynamic capabilities based on a distributed approach to organisational knowledge and employee engagement (Tsoukas, 1996).

Much of the capabilities literature adopts a guided-evolutionary approach that is grounded in the familiar cycle of stimulus followed by variation, guided-selection, and retention. This resonates with Popper's (1972/1979) work on knowledge growth through dialectic problem-solving, which traces its inheritance from the Greek dialectical method of antithesis and synthesis for resolving contradictions. The business literature largely views organisational capabilities as a combination of resources, routines, and learning but less often as an organisational practice that harnesses the insights of scholars in respect of reflective team practice (Schön, 1983; Weick, 1979, 1995; Wenger, 2001). However, in order to embrace a practice-oriented approach to organisational capability development, learning must play a key role, as learning is the bridge between work and development (Brown & Duguid, 1991). The logic of a practice-oriented approach to organisational capabilities is to adopt a knowledge-based view of capabilities and this in under-represented in the business and PM literatures alike.

2.5.4 STUDY THEMES AS RESEARCH QUESTIONS

From the preceding discussion, the PMC development literature seems under-researched in respect of three interrelated conceptual themes, Fig. 2.4: (1) problem-solving as an engine of knowledge creation in PM/PMC; (2) projects as process and PM/PMC as practice; and (3) PMC development through complex learning processes beyond single-loop and double-loop learning. In order to address these research gaps, two PSOs were chosen to explore the following main Research Question and sub-questions with the aim of gaining insights into the organisational learning processes of PMC development that would enrich the literature on organisational capabilities and enhance management practice.

> How do learning processes underpin the development of project management capability in complex organisational settings?
>
> (i) What role does problem-solving play in learning processes for developing PMC?
> (ii) How does a practice-oriented approach facilitate the development of PMC?
> (iii) How is project knowledge coordinated in complex PM settings?

Certain key authors have influenced the formulation of the Research Questions and these authors will also feature prominently in later chapters on the evaluation of the study empirical findings. The topic areas and authors include three main areas. Firstly, the growth of knowledge through problem-solving (Popper, 1972/1979) and sense-making in organisations (Weick, 1979, 1995), in practice (Schön, 1983), and in projects (Engwall, 2002). Secondly, projects as temporary organisations (Lundin & Söderholm, 1995; Packendorff, 1995), the 'object-actor' and 'content-form' ontological perspectives on projects (Engwall, 1998; Engwall *et al*., 2003), projects as 'being' and 'becoming' (Linehan & Kavanagh, 2006), and PM as practice (Winter *et al*., 2006), Thirdly, the development of PMC through learning processes (Lindkvist *et al*., 1998; Davies & Brady, 2000; Brady & Davies, 2004; Davies & Hobday, 2005; Söderlund, 2005, 2008; Söderlund & Tell, 2009).

In Ireland during the 2000s, PSOs offer a unique empirical opportunity to study in greater relief the organisational complex learning processes that are integral to PMC development, because this was a period of radical and rapid environmental change that is discussed in Chapter 4 - Research Methodology. In this, the two PSOs are regarded as complex organisations, which Thompson (1967) describes as *"*open systems, hence indeterminate and faced with uncertainty, but at the same time as subject to criteria of rationality and hence needing determinateness and certainty" (p. 10). In the two PSO cases in the study, PMC was developed as a 'core supporting competence' in support of their mainstream 'core competence'. This study will also investigate the development of PMC as a multi-level PM ecology at project works staff level, project supervision level, project organisation level, and project external level (Grabher, 2002, 2004).

2.6 CHAPTER SUMMARY

This chapter set out to review the literature within which to frame the study and to identify significant research gaps for informing the Research Questions of the study. The historical trends in PM research and practice were reviewed from the 1940s to date in four main theme groups - Optimisation (1945+), Success Factors (1975+), Framework Process (1985+), and Organisation (1995+). The earlier PM theme groups assume the traditional PM approach of instrumental technical rationality. In contrast, the PM themes in the 'organisation' group, where this study is located, are more accepting of the idea of organisational 'reality' rather than 'rationality', where PM can be viewed as a socio-technical discipline rather than an

applied science. As the view of projects changed from 'objects' to 'actors', this enhanced the view of projects in the literature as temporary organisational forms with technical content that was negotiable rather than pre-given. Building on the literature, projects were reformulated by this study as modes of organising characterised by life cycle, team, and project organising (projectising) physical and social resources. However, the full potential of Weick's (1979, 1995) insight of organisations being about *sense-making* and *organising* does not seem to be harnessed in the PM literature with respect to the pervasive teleological activity in projects of knowledge creation through problem-solving (Thomas, 2000).

In the literature, PM theory is under-developed and, while the debate in PM has accepted the limitations of traditional PM as an applied science, there is no new consensus on the nature of projects and PM and how we can obtain knowledge about them. A 'practice' approach to PM within a knowledge-based view seems to offer good prospects for PM research, because it serves as a meta-theme that can accommodate diverse views of projects, such as projects as tasks, temporary organisations, modes of organising, and arenas of knowledge creation. In addition, it holds out the prospect as an approach for investigating the development of PMC as a multi-level PM ecology that consists of project level, organisational level, and external level. Informed by an engagement between the data and the literature, this study proposes to view *a project as a mode of organising to accomplish a temporary undertaking* and PM as *an organisational competence in organising to accomplish temporary undertakings*. This is an integrated knowledge-based view of projects as process and PM as organisational practice that reflects a synthesis of the data with the literatures on organisations, PM as practice, complex PM, and PMC development.

Much of the capabilities literature adopts a guided-evolutionary approach that is grounded in the familiar cycle of stimulus followed by variation, guided-selection, and retention, which resonates with the Greek dialectical method of antithesis and synthesis for resolving contradictions. The business literature largely views organisational capabilities as a combination of resources, learning, and routines but less often as a reflective organisational practice (Schön, 1983; Weick, 1979, 1995; Wenger, 2001). In PMC research, the development of PMC through learning processes has been largely investigated in PBOs in the private sector, where PMC is a 'core competence' and the stimulus for change is commercial rather than institutional. In this, the research tends to focus on the development of PMC either at project level or at organisation level but seldom on PMC as a multi-level construct that encompasses a PM ecology of project level, organisation level, and external level.

In addition, PMC research is somewhat reluctant to embrace the concept of dynamic capabilities (DC) from the business literature, because of the association of operational capabilities with organisational routines (Nelson & Winter, 1982). This seems to apply to PBOs, where much research on PMC development has taken place and where PMC is a 'core competence', i.e., a routine. However, if PMC is developed as a 'core supporting competence' in organisations other than PBOs, e.g., the PSOs under study, it can be evaluated on its merits as a potential dynamic capability (Winter, 2003).

The study positions itself within the emerging tradition of PMC development through learning processes, the central research theme of this study. The investigation of the main Research Question[5] in the two chosen PSOs addresses three conceptual themes that are under-researched in the PMC development literature that revolve around learning processes - see Sect. 2.5.4, p. 51. In this study, it is conjectured that more rapid learning takes place when PMC is developed from a near-zero base as a 'core supporting competence' in PSOs than in PBOs. In the latter, PMC is an existing 'core competence' that is developed further by incremental learning.

This study offers a unique empirical opportunity to study the complex learning processes involved in PMC development in settings that show these processes in greater relief, in order to contribute to the emerging research tradition of PMC development and its implications for PM practice. However, as learning processes in complex organisational settings are under-developed in the capability literature, this pointed to the need to develop and present initial conceptual development of capability development through complex problem-solving (CPS) before the full presentation of the empirical case studies. This is addressed in the next Chapter 3 - Initial Conceptual Development. Thus, from the outset, the data in the study play a dual interactive role of inspiring conceptual development and illuminating the concepts by illustrating their working in different practical settings (Siggelkow, 2007). This approach to the organisation of the chapters and the role of the data in the thesis is discussed more fully in Chapter 4 - Research Methodology.

[5] How do learning processes underpin the development of PMC in complex organisational settings?

Chapter 3

Initial Conceptual Development - Capability Development as Organisational Complex Problem-Solving

3.1 INTRODUCTION [6]

The preceding chapter on Literature Review identified the main research themes for the study, which revolve around organisational learning processes within a practice-oriented approach to the development of PMC. In addition, it was highlighted that learning processes in the capability literature are under-researched beyond single-loop and double-loop learning. Accordingly, the main purpose of this chapter is to develop initial concepts of capability development through organisational complex problem-solving (CPS) before presenting the two empirical case studies. In this way, the data is inspiring conceptual development and subsequently illuminating it by illustrating its working in the case studies (Siggelkow, 2007).

The initial conceptual development builds on the reformulation of projects in the Literature Review (Sect. 2.5.2.1.1), in which *a project is a mode of organising to accomplish a temporary undertaking*, where PM is an organisational competence in organising to accomplish temporary undertakings. This represents an integrated knowledge-based view of projects as process and PM as organisational practice. This chapter expands on the core idea of projects as modes of organising to view a project as a mode of learning as well, which implies a project is a learning organisation or *a mode of learning-organising* that learns by organising and *vice versa*. In this view, learning is an intrinsic aspect of organising, which involves organising order *and* disorder. It will be shown that learning, or knowledge-creating, involves a path from 'order to *disorder* to order' rather than from 'order to order', like breaking eggshells to make omelettes. After undertaking conceptual development of

[6] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)

organisational CPS, it will be proposed by this study that organisational capability development and complex PM are forms of organisational CPS.

3.2 INITIAL CONCEPTUAL DEVELOPMENT

In contrast to traditional PM, early data analysis was highlighting 'context' and learning processes as key aspects of PMC development. In the two PSOs under study, both organisations were subject to radical external change in the 2000s and PMC was developed as a 'core supporting competence' for the main business of the organisations. Because PMC was developed as a 'core supporting competence' from a near-zero base, this implied that rapid organisational learning processes were central to the development of PMC in a complex PM setting (Thompson, 1967). This contrasts with project-based organisations (PBOs), where PMC is a 'core competence' and PMC development builds on an existing base through incremental learning in a less complex PM setting, in terms of amplitude and pace of change.

Three main reasons support the need to develop a problem-solving framework for complex learning processes before presenting the full empirical case studies rather than after the data (Siggelkow, 2007). Firstly, as discussed in the Literature Review, little analysis is available regarding the type of learning processes that are involved in the development of organisational capabilities, whether single-loop, double-loop, or complex problem-solving (CPS). Secondly, early data analysis was pointing beyond single-loop and double-loop learning processes for PMC development towards organisational CPS, which is under-developed in the capability literature and needed to complement a process framework model for guiding the data collection and analysis.

Thirdly, the capability development literature is largely lacking in an analysis of the characteristics of 'context', when this is changing over time. For example, the amplitude and pace of change are seldom linked to the types of learning processes that are required, e.g., slow-moving change with single-loop or double-loop learning, fast-moving change with CPS, etc.

3.3 ORGANISATIONAL COMPLEX PROBLEM-SOLVING (CPS)

This section is prompted by the need that was identified by initial evaluation of the data with the literature, namely, to develop initial concepts of capability development through complex problem-solving learning processes, the central research theme of this study. This will involve viewing knowledge creation from a problem-solving perspective and the introduction of 'entropy' as a covering concept for 'disorder', where 'order' is proportional to the inverse of disorder (entropy). In this, Popper's (1972/1979) problem-solving dialectic is reformulated in terms of a two-stage process of differentiation (disorder) and integration (order) activities that constitute the logical structure of knowledge-creating. This represents a foundational concept for the remainder of the thesis.

3.3.1 PROBLEM-SOLVING - DISORDER & ORDER

In his work on the growth of knowledge, or learning, Popper's evolutionary approach draws inspiration from the Greek inquiry dialectic of antithesis and synthesis as a means of reconciling contradictions. As discussed in the Literature Review, much of the literature on organisational capabilities, including project management capability (PMC) and dynamic capability (DC), uses a guided-evolutionary approach, which is influenced by the work of Popper, Campbell, and others. In this, the development of organisational capabilities is investigated using different manifestations of the sequence of stimulus, variation, guided-selection, and retention.

However, it was also highlighted that capability development is more akin to means-end teleology than to guided-evolution. In addition, a guided-evolutionary approach to learning does not distinguish easily between different levels of learning, e.g., single-loop, double-loop, and complex problem-solving (CPS). Furthermore, because of its random orientation, the guided-evolutionary approach seems to operate as a semi-isolated system rather than an open system that is purposefully integrated with its environment. Moreover, an evolutionary approach seems more suited to multiple entities, such as populations, than to single entities, such as an organisation or a project. Therefore, it is not considered fully adequate in this study for investigating the development of PMC in public sector organisations (PSO), where goal-directed learning and context are important considerations.

This chapter will view processes of means-end problem-solving, which are pervasive in PM, as engines of knowledge growth that underpin the development of organisational

capabilities. In addition, the covering concept of 'entropy'[7] for disorder is introduced from the natural sciences to develop the idea in this study of an 'entropy envelope' of disorder and order, where order is proportional to the inverse of disorder (entropy). This is constituted by the organising activities of problem-solving knowledge creation, namely, differentiating (disorder) and integrating (order). What this study terms the 'entropy envelope' will be characterised principally by its amplitude and rate of change (pace, tempo, frequency), which derive from the contextual problem space/time in which organisational knowledge is created and organisational capability is developed. Although entropy is a universal quality of physical and social processes that has significant explanatory power, it is little used and understood in the business literature with some exceptions (Beer, 1966/1994; March, 1994; Boisot, 1998). If the market is used as a reference level for entropy (disorder), organisations create value through organising activities that have more order, or less entropy (disorder), than the market. If organisations are essentially about sense-making and organising (Weick, 1979, 1995) and if *sense-making* is about *knowledge-making*, then, a key way organisations create value is by knowledge-making, which is inherently an organising activity that lowers entropy (disorder) by increasing organisational order, i.e., by organising capabilities.

3.3.2 PROBLEM-SOLVING AS LEARNING & ORGANISING

Popper (1972/1979) uses an evolutionary perspective for the growth of 'objective knowledge' through problem-solving learning that follows an evolutionary cycle of variation, selection, and retention, where the selection is guided rather than blind. The process starts from an initial problem situation (PS_1), then progresses to tentative theories (TT), then to error elimination (EE), and, finally, to an improved problem situation (PS_2).

$$PS_1 \rightarrow TT \rightarrow EE \rightarrow PS_2$$

For Popper, the error elimination process, or selection, was critical and meant that the growth of knowledge was based on Darwinian evolution and not on repetition or accumulation (*ibid*., p. 144). This approach to the growth of knowledge mirrors the dialectical method of the ancient Greeks of reconciling contradictions based on antithesis and synthesis, which was a key theme in Popper's work (1935/2007, 1963/2007, 1972/1979, 1999/2006). In his problem-solving dialectic, Popper does not distinguish between the different kinds of knowledgeability that are found in the practice literature, i.e., knowledge and 'knowing'. In Popper's scheme, physical states belong to what he calls world-1. Our mental states belong

[7] If the function 'D' represents disorder, Boltzmann's formulation for entropy 'S' shows S = k log D.

to world-2. What he terms 'objective knowledge' is the contents of our thoughts and belongs to world-3, which is autonomous from the knowing subject and results from the interaction between our mental states and the world.

What is unsatisfactory about this approach to knowledge is that, while the knower is necessary for the growth of knowledge, this knowledge no longer needs the knower after its creation. However, this does not adequately explain the knowledge from the Rosetta Stone[8] that was lost to civilisation without its knowers (Boulding, 1956). In addition, this model of knowledge growth, which is essentially deterministic, does not account for either creativity or the tacit dimension of knowledge (Polanyi, 1967). In particular, it does not account for how we can see the initial problem (PS_1) or can search for a solution that is a hidden reality - the *Meno* paradox. This paradox revolves around an apparent knowledge contradiction - if the solution to a problem is known, there is no need to search for knowledge; and, if the solution is not known, how will it be recognised when encountered? However, even though Popper's underlying theory of knowledge may have limitations, the utility of the dialectical method of problem-solving is beyond question from its use in the ancient world down to the present day.

3.3.2.1 Knowledge Creation as Learning-Organising

What Popper (1972/1979) presents as an evolutionary process of trial-and-error can also be understood as a means-end teleological process that sets out to achieve defined objectives, rather than potentially random guided-evolutionary outcomes. Therefore, it is proposed by this study to represent this as an initial problem situation (PS_1) that leads to a differentiation stage (tentative theories), then to an integration stage (error elimination), and, finally, to an improved problem situation (PS_2), Fig. 3.1. This logical structure of knowledge-creating is more means-end teleology than guided-evolution and more closely reflects the purposeful Greek problem-solving dialectical process of antithesis and synthesis than evolution. This approach to problem-solving knowledge creation in response to change is informed by Lawrence and Lorsch's (1967) differentiation and integration and by Schumpeter's (1942/1976) creative destruction in the strategy literature. It also resonates with March's (1991) exploration and exploitation in organisational learning and with Lewin's (1947/2008) unfreeze and refreeze approach in organisational change, and with Guilford's (1956) divergent and convergent thinking in the creativity and innovation literature.

[8] Discovered by Napoleon's soldiers in Egypt, the stone dates from 200 BC and was carved in Greek and Egyptian hieroglyphs, which provided the key to unlocking the translation of ancient Egyptian hieroglyphs. It is currently in the British Museum.

It is further proposed by this study to view this dialectical problem-solving process in terms of the change in the levels of knowledge disorder (entropy) and knowledge order, Fig. 3.1. During the 'differentiation' mode of problem-solving, knowledge entropy increases as (+). During the 'integration' mode, knowledge entropy decreases as (-) to a lower level than before. Together, they represent an *entropy envelope* of problem-solving knowledge creation that can be characterised by its amplitude and pace of change. In this way, Popper's problem-solving dialectic can be reinterpreted to become a two-stage problem-solving process of disordering differentiation (knowledge entropy increase) and ordering integration (entropy decrease). This follows a path from 'order to *disorder* to order' rather than from 'order to order'. Importantly, the transition point '*B*' in Fig. 3.1 between differentiation and integration activities can be viewed as a 'bifurcation point' with implications for judgment, timing, and transition capability.

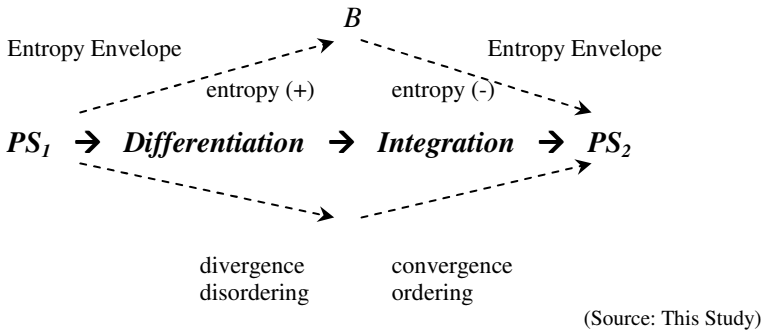


Fig. 3.1 Logical Structure of Knowledge-Creating

The implication of this view of the logical structure of knowledge-creating is that a two-stage process of differentiation and integration, as knowledge entropy increase and decrease, respectively, is *indispensable* for knowledge growth. Because differentiating and integrating are 'organising' activities, then, *organising forms* are also indispensable for knowledge growth. In effect, as a process of knowledge creation, problem-solving is a mode of learning and organising within its constituent entropy envelope that is manifest as a mutually constituted duality of knowledge-creating and organising forms through the activities of differentiation and integration. In this way, problem-solving can be viewed more holistically as *a mode of learning-organising* that is a synonymous duality of learning and organising at the same time. As a knowledge creation duality, 'learning-organising' parallels the synonymous duality of 'agency-structure' in the sociology literature (Giddens, 1984/2007) and, taken together, complement one another as a combined knowledge formation perspective. If a project is a mode of organising to accomplish a temporary undertaking, as proposed by this study, then, it follows that a project is synonymously a mode of learning

and an organising form, or a 'learning organisation' as *a mode of learning-organising* that learns by organising and *vice versa*. Furthermore, as a mode of organising that is manifest as a temporary organisation (Lundin & Söderholm, 1995; Packendorff, 1995), a project can be viewed as a 'temporary learning organisation' or a mode of temporary 'learning-organising'.

Problem Space

Even though the logical structure of knowledge-creating in Fig. 3.1 is shown in a linear sequence from problem situation (PS_1) to a differentiation stage, then to an integration stage, and, finally, to an improved problem situation (PS_2), the process is iterative with multiple feedback loops and permeable boundaries between stages. This approach can also be correlated with the problem space of Newell and Simon (1972) in the case of search heuristics, Fig. 3.2, where their problem set (P) corresponds with PS_1, their goal set (G) with PS_2, and their search space with the entropy envelope of this study. Even though Newell and Simon (1972) regard human problem-solving as though "the human operates as an information processing system" (p. 19) rather than as a knowledge creator, nevertheless, the divergence-convergence of the heuristic search process is similar to the differentiation-integration approach of this study. However, unlike Popper's (1972/1979) problem-solving dialectic on which this study is based, Newell and Simon (1972) do not highlight different stages of their heuristic search process.

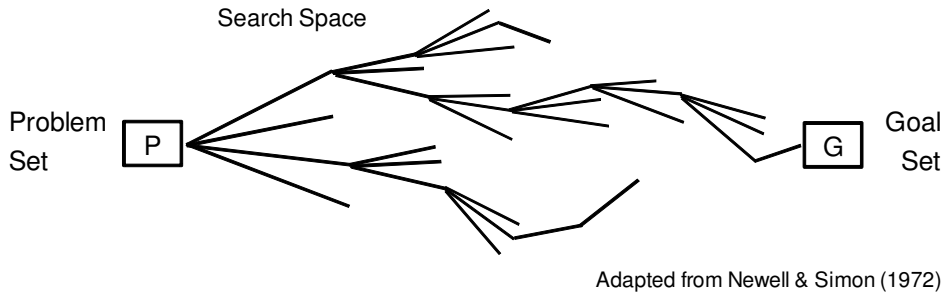


Fig. 3.2 Problem Space – Search Space, Problem Set, Heuristic Search, Goal Set

The concept of an 'entropy envelope' signals that problems (entropy/disorder) remain unsolved until they are solved through activities that involve a two-stage process of disorder (differentiation) and order (integration). Also, because of the way knowledge is created through differentiation and integration activities, it signals that for organisations to progress from 'order to order', the path lies from 'order to *disorder* to order', which represents an overall net increase in order through a net reduction in disorder (entropy). Moreover, even

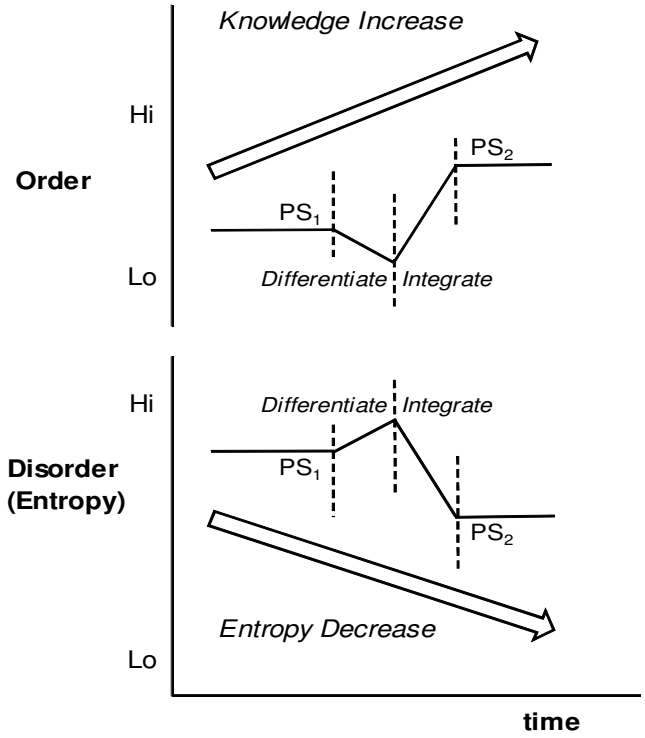
when organisations are in a state of order, the risk is always potential disorder rather than greater order. In keeping with the law of entropy increase, it is increasing entropy (disorder) that relentlessly gnaws away at the order of organisations, which can only be overcome by countervailing organising.[9] For increased competitiveness, the key management challenge is to harness the organisation's organising potential beyond its latent tendencies towards increasing entropy (disorder).

3.3.2.2 Capability Building as Problem-Solving

What may not be clear from the depiction of the entropy envelope is that the knowledge entropy level of disorder of a problem after it is solved (PS_2) is always *less* than the entropy level of the same problem before it was solved (PS_1), otherwise, the problem remains unsolved, Fig. 3.3. Accordingly, the level of knowledge order of a resolved problem (PS_2) is always *greater* than that of the same unresolved problem (PS_1).

When problem-solving is done in groups in organisations, management needs to facilitate the increase in local levels of knowledge entropy, e.g., brain-storming (differentiation), before coordinating a reduction in knowledge entropy through integration activities. This exploits an overall net reduction in knowledge entropy and an increase in organisational order, or capability. As a control mechanism, management needs to facilitate the increase and decrease of the levels of knowledge entropy for the necessary problem-solving activities of differentiation and integration, respectively. Repeated cycles of organisational problem-solving through differentiation-integration activities, then, can lead to an overall increase in order over time, or a net reduction in entropy (disorder), Fig. 3.3. Elaborating this empirical process will be a key aspect of the discussion in the later Chapter 7 on Empirical Findings. Conversely, a steady state condition (PS_1) without capability increase corresponds to a net zero rate of entropy production rather than a minimum entropy level (Prigogine, 1980).

[9] All organisations, including sentient life, appear to defy *The Second Law of Thermodynamics* of increasing entropy in closed systems (Schrödinger, 1944/1980). In the closed system of the universe, it is conjectured by this study that the reduction in entropy represented by the order of organisations is offset, in part, by a greater increase in the entropy of the external environment. This occurs through an increase in the *degrees of freedom* that organisations imply for the environment. Thus, the organisation of a new start-up company provides more degrees of freedom for the overall economy - more opportunity, more uncertainty, more market entropy - which can be a combination of realised entropy and potential entropy.



(Source: This Study)

Fig. 3.3 Knowledge-Creating as Net Entropy Decrease

This study views problem-solving as a form of 'dissipative organising' where order and disorder are intrinsic aspects of both learning and organising as a synonymous duality that is manifest in the knowledge-creating dialectical activities of antithesis and synthesis. In this, the two-stage problem-solving process of differentiation (disorder) and integration (order) mutually constitutes 'learning-organising' as an overall net ordering process whose path lies from 'order to *disorder* to order'. There are three interrelated aspects involved in 'dissipative organising' - stimulus, inquiry, and form (Prigogine, 1980). The problem to be solved represents the stimulus. The two-stage problem-solving activities of differentiation (disorder) and integration (order) represent inquiry, which is a synonymous duality with its own organising forms.

3.3.3 PROBLEM-SOLVING ENTROPY ENVELOPE

3.3.3.1 Entropy Envelope - Engine Room of Knowledge-Based Change

It has been highlighted in the PM literature that projects as temporary organisational forms revolve around collective trial and error problem-solving from problem identification to

problem solution. This has tended to follow the guided-evolutionary sequence of variation-(guided) selection-retention rather than the key *organising* activities of differentiation and integration (Packendorff, 1994; von Hippel & Tyre, 1996; Söderlund, 2000; Lindkvist & Söderlund, 2002; Dosi, Hobday, & Marengo, 2003; Lindkvist, 2008). Using the latter approach shifts the change process perspective from evolution based on blind or guided-selection, with underlying randomness, to means-end teleology based on active selection, which seems to better reflect PM practice (Van de Ven, 1992). Reinterpreting the literature, PM change process can be better viewed as teleological, rather than evolutionary, and one that is based on cycles of goals, differentiation (disorder), integration (order), and normalisation. Moreover, this teleological approach is reflected in the PMI's (2004) process groups of initiating, planning (differentiation), executing (integration), and closing with monitoring and controlling throughout, which are presented without a theoretical underpinning. Like compressing a fuel-gas mixture in a hypothetical organisational combustion engine, it is when knowledge entropy levels are compressed, or reduced, that organisational knowledge acquires the ability to do gainful work. However, doing knowledge work requires allowing the fuel-gas to expand, after which it must be compressed again to do further work and so on.

3.3.3.2 Entropy Envelope - Amplitude Change & Amplitude Rate of Change

Using the conventional designation 'S' for entropy, the entropy envelope can be likened to an irregular waveform of variable amplitude over time. Using Fourier analysis in mathematics (Kreyszig, 1972), it can be shown that a complex waveform can be approximated as a Fourier series of regular waveforms consisting of a primary waveform with a fundamental frequency (ω) and supplementary waveforms with harmonic frequencies.[10] The waveforms in the series share the characteristics of a common underlying functional waveform, such as a sinusoid, but differ with regard to their amplitudes and frequencies (pace, tempo). This suggests that key differences between entropy envelopes are amplitude change (ΔS) from a previous level and the time rate of change of the amplitude (dS/dt) rather than the underlying functional waveforms, which may be similar. Moreover, in complex organisational settings, it may not be possible to quantify with precision the entropy envelope beyond estimating comparative differences between environmental disturbances, in terms of the amplitude change and the pace of change.

In the literature on innovation, Brown and Eisenhardt (1997) investigate multi-product innovation in competitive business environments with a high pace of change, which they

[10] Fourier series of an irregular function $S(t) = a_0 + a_1\sin(\omega t) + a_2\sin(2\omega t) + a_3\sin(3\omega t) + ... + a_n\sin(n\omega t) + ...$

characterise as "high-velocity" (*ibid*., p. 1). In this, they acknowledge the earlier work of Burns and Stalker (1961) on 'organic' organisational structures for dealing with business environments that are experiencing radical and rapid change. The importance of the 'pace of change' (velocity) of the business environment is one that is repeatedly emphasised by Eisenhardt in other studies on strategy and dynamic capabilities but is generally under-researched in the capability literature (Eisenhardt, 1989b; Eisenhardt & Tabrizi, 1995; Eisenhardt & Martin, 2000). Nevertheless, this offers support for the approach being adopted in this study of characterising the problem space, or entropy envelope, in which organisational capabilities are developed by the entropy amplitude change (ΔS) and the pace of entropy change (dS/dt).

3.3.3.3 Knowledge Creation as Emergent Knowledge through Interplay

Within the problem-solving entropy envelope, the constitution of knowledge-creating and organising forms through the two-stage entropy processes of differentiation-integration is not a 'chicken and egg' situation, where knowledge-creating is the starting point and organising forms the corollary, or *vice versa*. Once the process gets started, each needs the other and begets the other in a "generative dance" (Cook & Brown, 1999) until we are unable to distinguish "the dancer from the dance".[11] If we accept the existence of two kinds of knowledge, 'knowing' and 'known' (Ryle, 1949; Dewey & Bentley, 1949), there is some evidence in the literature regarding the directionality between knowledge-creating and organising forms depending on the weighting between the two kinds of knowledge. For example, Weick (1996) suggests that the absence of structure promotes trial-and-error learning that "imposes structure on larger and looser situations" (p. 44). If trial-and-error learning is weighted towards contextual 'knowing' knowledge (know-how, etc.), then, this suggests that the ignition spark is provided by the exigency of survival learning and organising forms follow thereafter. This is in line with an 'emergent' view of strategy formation (Mintzberg, 1987, 1990).

In the same paper, Weick (1996) goes on to say that "When large organizations are surprised, smaller groups organize for improvisation and experimentation ... [that] essentially replace organization with *organizing*" (pp. 54-5, italics added). This suggests two things. Firstly, when surprised, organisations resort to trial-and-error learning, or knowledge that is weighted towards contextual 'knowing' knowledge, or organising knowledge. Secondly, in stable situations, organisational knowledge seems weighted towards formal 'known' knowledge (designs, plans, etc.) and organising forms lead the process of routine knowledge-

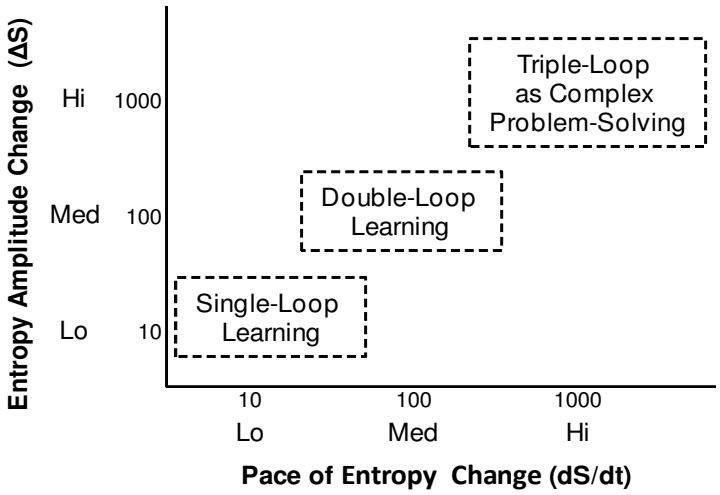
[11] Last line of the poem '*Among School Children*' by W.B. Yeats

creating of organised knowledge. This is the traditional Positivist view of organisations of strategy-then-structure followed by the application of knowledge that is 'given', 'out there', and detached from the knowing subject (Chandler, 1977, 1990; Ansoff, 1991). This is also the traditional 'plan-then-execute' view in PM of project organisation followed by project planning, followed by project execution, etc.

Whether knowledge is viewed as contextual 'knowing' or formal 'known' knowledge, what seems clear is that knowledge-creating and organising forms are synonymous and inseparable. Therefore, it seems appropriate to conjecture knowledge-creating and organising forms as a mutually constituted duality of 'learning-organising', or agency-structure, that are "always both at once" (Wenger, 2001, p. 68; Giddens, 1984/2007). This is easier to conceptualise by viewing knowledge as a process of 'knowing' and organisation as a process of 'organising' (Polanyi, 1967; Weick, 1995). In this view, knowledge-creating derives from an interplay between 'knowing' temporal knowledge as a form of organising (agency) and 'known' temporised knowledge that has been organised (structure).

3.4 ORGANISATIONAL PROBLEM-SOLVING MODES

The previous section elaborated problem-solving knowledge creation as a synonymous duality process of 'learning-organising', whereby we learn by organising and *vice versa*. Even at an abstract level, someone studying pure mathematics needs to learn by organising their understanding through an intermediate level of misunderstanding, a process of order from disorder. The main purpose of this section is to discuss different modes of organisational learning that vary in complexity - single-loop learning, double-loop learning, and complex problem-solving (CPS). This supports the central research theme of the study, which is the development of PMC through organisational complex learning processes based on problem-solving.



(Source: This Study)

Fig. 3.4 Problem Space/Time -
Entropy Amplitude Change (ΔS) & Pace of Entropy Change (dS/dt)

The level of complexity of the problem space has long been used to distinguish between different levels of learning, or knowledge creation. In the learning literature, Argyris (1977) and Argyris and Schön (1996) have distinguished between single-loop and double-loop learning in terms of inputs, action process, outputs, and feedback. This basic typology is mirrored in Weinberg's (2001) systems spectrum of simple systems (single-loop), machine systems (double-loop), and organised complexity. This is further extended by Snowden (2002) in a problem-solving typology of problems that are known, knowable, complex, and chaotic. In a recent publication, Cleden (2009, p. 13) adopts an analogous 'four quadrants' approach to project uncertainty - 'known knowns' (knowledge), 'known unknowns' (risks),

'unknown knowns' (untapped knowledge), and 'unknown unknowns' (uncertainty). In so far as complexity is often a function of the pace of change, this study will use the term 'problem space/time' to include the time dimension in all levels of problem-solving, whether single-loop, double-loop, or complex problem-solving (CPS). The following discussion will review these modes of learning with respect to the problem-solving entropy envelope that was outlined above. It is proposed by this study that dialectical problem-solving is integral to all modes of problem-solving with varying entropy envelopes that reflect different dynamics of the problem space/time in respect of entropy change (ΔS) from a previous level and the pace of entropy change (dS/dt), Fig. 3.4. The scales are indicatively logarithmic rather than linear, in order to reflect significant changes in problem space/time between the different learning modes.

Single-Loop Learning

In the case of single-loop learning, the inputs and outputs are pre-given and the overall system is kept on course by feedback, which compares the actual output with the desired output. If there is a deviation, the feedback error signal adjusts the inputs to the action process, which adjusts the output to the desired pre-given level. This is the basis for how servo-mechanisms work in machinery and is the reason why production operations in organisations are often regarded as organisational servo-mechanisms under a Positivist methodological perspective. Accordingly, it is little wonder that the metaphor of 'machine' is most often associated with Positivism.

Double-Loop Learning

With double-loop learning, problem space/time is more complex than single-loop learning but the increased complexity derives largely from within the system than from without. While the output requirements of the system are pre-given as before, the action process does not respond to the feedback error signal to maintain the output in line with the desired pre-given level. This scenario requires an intervention to review the overall system and make changes to the inputs, action process, and feedback aspects of the system, in order to achieve the desired output levels. Importantly, this includes the action process, the heart of the servo-mechanism.

3.4.1 TRIPLE-LOOP LEARNING AS COMPLEX PROBLEM-SOLVING

In the capabilities literature, single-loop learning underpins the concept of 'routines' at organisational level, where organisations '*remember* by *doing*' (Nelson & Winter, 1982, p. 99, original italics). At this relatively low level of complexity in problem space/time, the problem is usually invariant with respect to time and is more static than dynamic, which facilitates a view of knowledge that is detached from the knowing subject. But as Hayek (1945) reminds us, change is the key issue and, at higher levels of complexity, this gives rise to a requirement for dynamic problem-solving, at individual, organisational, and societal levels. He argues that economic organising can only be achieved efficaciously as a distributed system based on localised mutual control, because knowledgeability is distributed and synonymous with the knower, rather than detached, and can never be "given" to anyone in its totality. In this, Hayek was reinforcing Adam Smith's (1776/1981) idea in *The Wealth of Nations* of economic organising based on the 'invisible hand' of self-interest but with a knowledge-based perspective.

In triple-loop learning, or complex problem-solving (CPS), problem space/time is unstructured, non-linear, with little pre-given inputs, outputs, action process, or feedback. In this, CPS represents the most unstable representation of the entropy envelope, which is constituted by the synonymous duality of knowledge-creating and organising forms as a mode of 'learning-organising'. In effect, the third loop is the 'entropy envelope', or problem-solving context, which is largely quiescent for single- and double-loop learning. The characteristics of complex problems and their solutions are profiled at organisational level in a conceptual paper by Swinth (1971, pp. B68-9, italics added), which are echoed in Weinberg (2001), Snowden (2002), and Cleden (2009):

> (1) Usually the solution must serve a variety of organizational objectives, and satisfy the goals of a number of participants.
>
> (2) *There is typically a high degree of interdependence between parts*. The decisions of any one center frequently have consequence for other centers in the system.
>
> (3) *Such tasks are too complex to be readily understood and solved by one person or group*. It is necessary to put together knowledge, information, and action from several sources.
>
> (4) The cause of the novelty is typically a changing world: change in external environment, or change in the goals of the system. *Or the novelty is in the unknowns at the frontier of knowledge* or at the interface arising from combining existing ideas and techniques in a new way.

This profile draws attention to the difference between the terms 'complicated' and 'complex'. An aircraft is a complicated machine that relies on a large number of servo-mechanisms (single-loop) and crew members (double-loop) to operate the machine system within normal parameters. In aviation history, aircraft design progressed from being a complex problem, when the technology was poorly understood, to being a complicated machine, when detailed designs could be documented for production assembly and, therefore, comprehensible to a single mind. However, like an emerging proto-type that is only partially understood, a one-off complex project may not transition from complex to complicated until *after* it is delivered and *retrospectively* comprehended in its entirety like Lego blocks (Snowden, 2002). Although not depicted in Fig. 3.4, beyond complex problems are so-called 'wicked problems', which are chaotic and unsolvable problems that usually require crisis management and are not considered relevant for this study of PMC development as a complex problem (Snowden, 2002). In Cleden's (2009) typology, complex problems correspond to 'unknown knowns' and wicked problems to 'unknown unknowns'.

Swinth's (1971) profile of complex problems will now be discussed and expanded as characteristics of the CPS entropy envelope.

CPS - Organisational Objectives

In CPS problem space/time, neither the problem state nor the goal state, nor the search space, is well defined (Newell & Simon, 1972). At societal level, complex problems such as the illegal drug trade are highly profitable, dynamic, with multi-facetted resource impacts for governments (Mumford, 1998). This emphasises that a key aspect of CPS, like dynamic capabilities, is defining the problem space/time and this is normally reserved for senior management, because of the organisation-wide resource implications of CPS (Eisenhardt & Martin, 2000; Pisano, 2000; Helfat, 2007).

Unfortunately, PM often places less importance on the process that is involved in selecting the project to be undertaken, a strategic decision that is normally the preserve of senior management, than on the project delivery phases. As Morris (1997) points out, this is the difference between project management and the 'management of projects', the latter being a more holistic approach that encompasses the economic life cycle, rather than just the project life cycle (Munns & Bjeirmi, 1996; Jugdev & Müller, 2005). As an 'embedded' (Yin, 2003), or distributed, multi-level organisational capability, this study of PMC development reflects Morris's (1997) holistic approach to PM in supplementing the engineering focus of traditional PM with a business perspective.

CPS - Systems Perspective

The integrated systems aspect of Swinth's (1971) profile of CPS under items (2) and (3) is one that is emphasised in the canons of PM literature and derives from PM's inheritance from the engineering sciences (Cleland & King, 1968). This sees non-equilibrium, or potential chaos, as the norm and systems equilibrium as a 'cure for chaos' (Ramo, 1969). This is less appreciated in the dynamic capabilities (DC) literature with its influence from neo-classical economics, which sees equilibrium as the norm and non-equilibrium as an aberration from the norm. This is reflected in the DC literature, which often sees DC in terms of moving an organisation's capability from one level of routines to a higher level of routines (Teece *et al*., 1997; Zollo & Winter, 2002). This view in DC is strongly influenced by the seminal work of Nelson and Winter (1982) in the economics literature, which takes a dynamic evolutionary approach to developing organisational capability. This is based on the evolution of routines, where "routines play the role that *genes* play in biological evolutionary theory" (p. 14, italics added). In this evolutionary equilibrium perspective, change is neither volatile nor chaotic but a guided-evolutionary transition between equilibrium states of routines. However, the disadvantage of the evolutionary approach in DC is the random nature of all forms of evolution in contrast to a teleological, means-end, systems approach that is available to PM.

CPS - External Environment

As a key driver of the entropy envelope, the external environment can be viewed in terms of unstable entropy amplitude change (ΔS) and pace of entropy change (dS/dt), the latter emphasising the time dimension of problem space/time in CPS. In single-loop and double-loop learning, the time dimension largely emanates from within the organisation and is more stable and controllable, whereas in CPS, it emanates from without the organisation and is more unstable and independent. Moreover, like the bounce of an oval football, the volatility of the environment is largely unknowable *ex ante* as a dynamic phenomenon, except in outline or in part, even though it can be known *ex post* as a sequence of static phenomena or "comparative statics" rather than "true dynamics" (Boulding, 1956, p. 202).

CPS - Requisite Entropy & Requisite Order

In dealing with problem space/time that is complex, Mumford (1998) recalls Ashby's (1956) principle of 'requisite variety' that is based on the idea of a control mechanism having a level of 'variety' that is equal to, or greater than, the 'variety' of the system being controlled.

If 'variety' is equivalent to the number of possible states of a system as entropy (Beer, 1988), this suggests that the control mechanism needs to have a 'requisite entropy' that is equal to, or greater than, the entropy level of the system being controlled. However, this study suggests that the key function of the control mechanism is order rather than variety (entropy). Accordingly, a thermostat needs to have the 'requisite order' to raise room temperature above ambient in a heater (entropy increase) and to lower room temperature below ambient in air-conditioning (entropy decrease). Under this view, a control mechanism acts like an Archimedean fulcrum point with 'requisite order' to control the entropy balance above and below a reference level.

Although there are many similarities between problem-solving and entropy in terms of order and disorder, the entropy of sentient knowledge differs from the statistical entropy of physics, because human beings can exercise choice and mutual cooperation over the 'variety' that is available to them (Beer, 1966/1994, 1988; Snowden, 2002). Thus, in a physical system of stable gas molecules in a container, high variety is associated with high entropy (disorder) but, in contrast, high knowledge variety facilitates a high potential capacity for ordering, or low entropy potential (disorder), which the actors can choose to exercise, or not. If not exercised, high knowledge variety is equivalent to high entropy (disorder), e.g., indecision. In effect, high knowledge variety gives rise to a range of potential levels of order, which is not available to stable gas molecules in a container or billiard balls on a table. Thus, a football team with less physical variety due to a missing player can still beat a full team, if it has more order than the full team. It is conjectured by this study that the smaller winning team has more knowledge variety than the full team, which is a greater ordering capacity.

CPS - A Common Will of Mutual Interest

Organisational complex problems are often strategic, unstructured, non-linear, and positioned towards the 'unanalysable' end of the known-unknown environmental spectrum (Daft & Weick, 1984), where a key role of senior management is framing the problem to be resolved (Iansiti & Clark, 1984; Teece *et al*., 1997; Morris, 1997). However, organisational CPS also includes a multitude of sub-routines that are based on single-loop and double-loop learning, which are based on routines that are largely 'analysable' (Argyris & Schön, 1996). In addition to the instability of its constituent entropy envelope, organisational CPS contrasts with single-loop and double-loop learning through the processes of systems integration and distributed organising that are required to coordinate a solution to the problem, which, because of its complexity, cannot be understood in its totality by any one individual. Thus, a

crucial ingredient for organisational CPS is what this study terms a 'common will of mutual interest', comprised of distributed tacit presuppositions, which works in concert with the methodologies of formal coordination to achieve a joint solution. In this way, a common will of mutual interest can be viewed as a distributed tacit dimension (Polanyi, 1967).

3.4.1.1 CPS as Distributed Organising

Swinth (1971) regards an organisation as "a system for solving complex problems" (p. B78) and reviews traditional approaches of organisations for solving complex problems. The 'authority approach' is top-down and fails because of the inability of one individual to grasp the overall complexity of the system in its totality, which is an inadequacy of *differentiation*. The 'incremental approach' is bottom-up but it too fails because of the lack of coordination capability above the level of the incremental change, which is an inadequacy of *integration*. To overcome the difficulties with these traditional approaches, Swinth (1971) proposes 'organizational joint problem-solving' (OJPS), which is based on a cluster approach of coordinating between 'centres' of problem-solving, where each centre is responsible for an important part of the overall system. The organising form for the centres is compared to the 'organic' approach for innovation of Burns and Stalker (1961) and is described as "low centralization, low formalization, and low stratification" (Swinth, 1971, p. B72). In the innovation literature, the same 'organic' approach is used by Brown and Eisenhardt (1997) for "high-velocity" (p. 1) environments of radical and rapid change, which is analogous to a CPS environment with high entropy pace of change (dS/dt), or high-acceleration change, or jerking change.

The 'organic' approach of Burns and Stalker (1961) is conceptualised by this study as one based on a 'common will of mutual interest', a distributed tacit dimension (Polanyi, 1967; Kreiner, 2002; Enberg *et al*., 2006), where the actor participates in the overall goals to be achieved. This is akin to Adam Smith's (1776/1981) 'invisible hand' of uncoordinated self-interest, where the actor is focused on personal goals rather than mutual goals. Overall, in order for the centralised coordination of abstract 'known' knowledge to function (designs, plans, etc.), it needs to be complemented by the distributed organising of contextual 'knowing' knowledge (know-how, etc.) within and between centres (Kolb, 1984). This is based on tacit pre-suppositions, like following the rules of a practice (Wittgenstein, 1953/1988). It is the self-organising property of distributed contextual 'knowing' knowledge (know-how, etc.), which is beyond centralised planning control (Hayek, 1945), that provides the 'requisite order' for dealing with complex problems that are " too complex to be readily understood and solved by one person or group" (Swinth, 1971, p. B69). In effect, contextual

dynamic knowledge over time is substituted for the limitations of static knowledge that endeavours to plan for complex problems that cannot be *completely* specified or comprehended in advance by a single individual, except in outline or in part. In this way, contextual dynamic knowledge coalesces any gaps in pre-given static knowledge that emerge over time as untapped knowledge, or 'unknown knowns' (Cleden, 2009), which are unknowable in advance under traditional PM because of the contextual specificity of 'knowing' knowledge.

This study proposes that complex projects, too, cannot be *completely* specified, or comprehended in detail by a single individual. In this, they can be better approached by a distributed organising approach based on a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967). This coordinates the interplay of tacit rationality between centralised 'known' knowledge from bounded planning and contextual 'knowing' knowledge that is local (Kolb, 1984).

3.4.1.2 CPS as Emergent Knowledge & Emergent Strategy

Notwithstanding their different approaches to knowledge, both Hayek (1945) and Swinth (1971) identified knowledge constraints that were overcome by adopting a distributed organising approach to the management of contextual 'knowing' knowledge (know-how, etc.) in complex problem situations. However, it needs to be highlighted that Swinth's (1971) human bandwidth constraint largely disappears at lower levels of complexity in problem space/time and might be resolved at higher levels with a super-computer, whereas Hayek's (1945) specification constraint persists at all levels of problem complexity. Even at individual level, we are largely unaware of our local contextual knowledge before 'knowing' it but our informational 'known' knowledge can often be documented in advance. For firms, this can lead to what Tsoukas (1996) calls "radical uncertainty" (p. 21), where firms cannot know in advance what they need to know, because distributed contextual knowledge is a kind of 'live' knowledge that makes the idea of a control room approach to knowledge management problematic, if not redundant. This is a knowledge issue that not only affects firms with permanent organisations but also projects as temporary organisations as well. In this study, this conundrum is termed Hayek's 'specification problem'[12] and implies that complex problems cannot be *completely* specified or comprehended in advance by a single individual, except in outline or in part (Smith, 1776/1981; Hayek, 1945). The total complexity is not 'given' to a single individual nor can it be, because it is like an emergent prototype with incomplete Lego blocks of knowledge.

[12] See Hume's 'induction problem' and Kant's 'demarcation problem' in Popper (1972/1979, p. 4, n. 7)

If business strategy is an exercise in organisational CPS, this suggests that strategy is emergent to a lesser or greater degree, whether 'planned' (low-entropy emergent) or 'organic' (high-entropy emergent) (Burns & Stalker, 1961; Mintzberg, 1987, 1990; Ansoff, 1991; Chandler, 1992). In this, complex problem-solving (CPS) is more like a painting that emerges over time than a jigsaw whose picture is known in advance. Using problem space/time as a reference, Fig. 3.4, if strategy can be 'planned' to the n^{th} degree, it suggests single/double-loop problem-solving rather than emergent strategy as CPS, i.e., a planned jigsaw rather than an emergent painting.

3.5 CAPABILITY DEVELOPMENT AS ORGANISATIONAL CPS

The previous section discussed different problem-solving modes in terms of a characterisation of problem space/time by the amplitude of entropy change (ΔS) from a previous level and the pace of entropy of change (dS/dt). In this, problem-solving was presented as a synonymous duality process of 'learning-organising' that is grounded in the two-stage process of differentiation (disorder) and integration (order). This section will discuss the development of organisational capabilities and suggest that it can be viewed as a learning process based on organisational CPS. This is based on knowledge creation as a sequence from 'order to *disorder* to order' rather than from 'order to order'.

Among the key organising activities in projects, as in organisations generally, are differentiation and integration (Lawrence & Lorsch, 1967; Thompson, 1967; Mintzberg, 1979a), where differentiation can be viewed as problem-solving that is disaggregating and integration as problem-solving that aggregates. This resonates with the 'fragmentation' and 'implementation' phases of the action-oriented perspective of projects as temporary organisations (Lundin & Söderholm, 1995). In delivering a project, the project plans and designs have to be disaggregated to component level before the components can be integrated to form the project whole. In Materials Requirement Planning (MRP), the bill of material (BOM) is 'exploded' out to component level before the 'netting' process of integration takes place and so on. This is also how food is prepared: ingredients are disaggregated from their packages before being integrated into meals. Viewed in terms of the direction of disorder and order, capability development follows a path from 'order to *disorder* to order' rather than from 'order to order'.

We can reinterpret Schumpeter (1942/1976) and Lewin (1947/2008) in terms of the correspondence between organisational structures and knowledge disorder-order. For example, an increase in the entropy of organisational structures through differentiation / destruction / unfreeze corresponds to an increase in knowledge entropy through disaggregating problem-solving. If the dynamic balance is right, this is followed by a reduction in the entropy of organisational structures through integration / reorganisation /refreeze corresponding to a reduction in knowledge entropy through creativity, or aggregating problem-solving. Therefore, the two key variables of organisational structures and knowledge creation through problem-solving appear to be correlated by the common attribute of disorder-order. This relationship seems to be positively correlated to the extent that organisational entropy and knowledge entropy increase and decrease in tandem and, again, the path is from 'order to *disorder* to order' rather than from 'order to order'. As a conceptual reformulation, this study views organisational capability development as a form of organisational CPS.

CPS as Complex Learning-Organising

Recognising that research in organisational knowledge and structures is under-developed, Okhuysen and Eisenhardt (2002) call for research "to more closely examine the relationship between structure, adaptation, and knowledge", because "Without structures, knowledge is too disorganized. Without knowledge, structure is not useful" (p. 384). This study contributes to this topic area by investigating the development of PM as an organisational capability (PMC) and proposes that this is best understood as organisational CPS that is grounded in the synonymous duality of knowledge-creating and organising forms as a mode of complex 'learning-organising'. In terms of structure and agency, it is not a question of linear cause and effect but *mutual* cause and effect, that is, it is not a dualism of 'either-or' but a synonymous duality of 'both-and' (Giddens, 1984/2007).

Temporary organisational complexity has been investigated in the literature in different settings that reflect the activities of organisational CPS as a synonymous duality of 'learning-organising', i.e., differentiation, integration, and distributed organising based on a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967). Thus, Meyerson, Weick, and Kramer (1996) identify 'swift trust' as a self-organising coordinating mechanism in temporary groups, Weick and Roberts (1993) identify 'heedful interrelating' for coordinating on flight decks, and Weick (1993) investigates the breakdown of a common understanding, or a common will of mutual interest, in a situation of novel high-entropy

complexity – the Mann Gulch tragedy. In the strategy literature, Eisenhardt (1999) identifies 'collective intuition' as an ingredient for successful strategy building. In the PM literature, Parkin (1996) indentifies 'team mind' in relation to local decision-making among project team members based on "taken-for-granted protocols" (p. 261) that is often the result of good project leadership.

3.6 COMPLEX PROJECT MANAGEMENT

The previous section discussed the development of organisational capabilities through learning processes based on organisational CPS. This section will discuss complex PM and suggest that it can also be viewed as a complex learning process and a form of organisational CPS. This supports the central research theme of the study, which is the development of PMC through organisational learning processes based on organisational CPS.

In early work on the complexity of project settings, Shenhar, Dvir, and Shulman (1995) distinguish two dimensions of project complexity - 'technological uncertainty' and 'system scope'. Technological uncertainty is differentiated between 'low-tech': existing technology, repeat products etc.; 'medium-tech': existing technology plus innovation, new model cars etc.; 'high-tech': radical innovation, defence technology etc.; and 'super-high-tech': vanguard innovation, space technology etc. On the second dimension, system scope is differentiated between 'assembly' (consumer appliances), 'system' (aircraft), and 'array' (missiles, public transport). This typology is used in later work in advocating a contingency approach to PM (Shenhar & Dvir, 1996; Shenhar, 1998, 2001), rather than the "one size fits all" (Shenhar, 2001, p. 394) approach of traditional PM. This builds on the idea from contingency studies of distinguishing between incremental and radical innovation (Burns & Stalker, 1961; Lawrence & Lorsch, 1967) and advocates a project-specific approach to PM rather than the traditional approach to PM that is well summed-up as "a project is a project is a project" (Pinto & Covin, 1989, p. 49).

In a conference paper, Shenhar, Dvir, Lechler, and Poli (2002) elaborate a "universal, context-free framework for all project types" (p. 101) based on the three dimensions of 'uncertainty', 'pace', and 'complexity' (UPC Model). In this scheme, which underpins a contingent approach to PM, the two dimensions of 'technological uncertainty' and 'system scope' from earlier research are revised as 'uncertainty' and 'complexity', respectively. In addition, 'pace' is added to the model as a third dimension to reflect the "speed and

criticality of time goals" (*ibid*., p. 101). While this line of research by Shenhar *et al*. on the complexity of project settings sheds valuable light on the contingent, or contextual, nature of PM, nevertheless, it holds to a traditional systems view of PM, where increased project complexity requires increased systems complexity (Ashby, 1956). Of course, implicit in this research is the assumption that knowledge relating to project complexity can be analysed and integrated as 'technical' complexity under the norms of technical rationality, rather than as 'social' complexity that requires a socio-technical approach (Sapolsky, 1972; Cooke-Davies, Cicmil, Crawford, & Richardson, 2007). Under the former approach, knowledge is detached from the knowing subject, while, under the latter, knowledge is integrated with the knower.

In recent PM literature, researchers have sought to incorporate insights from research in complexity, chaos, self-organising, and evolution with traditional PM, where the latter is viewed as an applied science that is grounded in technical rationality. This emerging area in PM is termed 'complex project management' (Whitty & Maylor, 2009). Although the earlier work of Shenhar *et al*. is not cited, Saynisch (2010a/b) analyses complexity using the two dimensions of 'project complexity' and 'environmental complexity' and calls for an integrated approach to the two cybernetic cycles of traditional PM and the management of complexity (evolution, self-organisation, edge of chaos). Project complexity is further analysed into four types - structural (scope), technical (design), directional (unclear goals), and temporal (new legislation) (Saynisch, 2010b). In contrast, environmental complexity reflects the economy and society. Interestingly, in a move away from the traditional PM paradigm, he maintains that getting the balance right between these two "will be the future *management art*" (Saynisch, 2010b, p. 8, italics added), which suggests that, in order to deal with situations of project complexity, PM may have to reposition its self-image as a craft rather than an applied science. However, Saynisch (2010a/b) does not elaborate on the methodological implications of this tentative shift in PM perspectives from PM as an applied science to PM as a practice.

Overall, what Saynisch (2010a/b) describes as 'project management second order' (PM-2) integrates four worlds, namely, world-1 as traditional PM (PM-1), world-2 as the management of complexity, world-3 as human behaviour, and world-4 as ways of thinking. The latter two worlds appear to be addendums to the fundamental cybernetic systems approach of traditional PM (world-1) and complexity theory (world-2), which are in a direct line of succession to traditional PM systems thinking but with a higher level of complexity (von Bertalanffy, 1950; Cleland & King, 1968; Beer, 1966/1994, 1988). As with traditional PM, the approach is normative and grounded in technical rationality, in the sense that complexity is analysable and can and should be integrated within an overall equilibrium

systems approach to PM (Saynisch, 2010a). Using Saynisch's (2010b) two dimensions of 'complexity' and 'project and environment', the Positivist assumption is that the knowledge set of the complexity of these dimensions is 'out there' and knowable, because it is detached from the knowing subject. Moreover, the integration of the knowledge set relating to complexity can be 'managed' in the traditional top-down way of centralised organising without the need for 'bottom-up' distributed organising. In this approach, the 'visible hand' of management (Chandler, 1977) is privileged for coordinating abstract 'known' knowledge.

Complex PM as Complex Organisational Practice

As discussed in Chapter 2 - Literature Review, the traditional PM paradigm of predictability and control is increasingly being called into question in favour of a practice-oriented approach to PM (Lenfle & Loch, 2010; Geraldi *et al*., 2011; Nightingale & Brady, 2011). In a paper that recognises the limitations of the 'planned approaches' of traditional PM in complex project settings, Berggren, Järkvik, and Söderlund (2008) advocate a practice-oriented approach, termed 'neo-realistic', which involves three key managerial practices. These include "reducing complexity by transforming expectations", understanding of interdependencies for better "systems integration", and, importantly, "public arenas for handling the *unknown amount of errors*" in complex PM settings (*ibid*., p. S112, italics added). This analysis implicitly acknowledges Hayek's 'specification problem' by recommending 'organic integration' for coordinating distributed contextual knowledge, which resonates with the distributed organising that is proposed by this study. In a recent paper on knowledge integration in a complex PM setting, Enberg, Lindkvist, and Tell (2010) also encounter Hayek's 'specification problem' in terms of "unforeseeable and unimaginable multiplying effects of small changes" (p. 762). Informed by Weick's (1995) sense-making and Polanyi's (1967) tacit dimension of knowledge, they adopt a 'segregated team' approach to knowledge integration that relies in part on the 'gut feelings' of senior project team members, which this study views as a distributed tacit dimension (Polanyi, 1967).

In both these papers (Berggren *et al*., 2008; Enberg *et al*., 2010), complex PM appears limited to 'bounded planning' in contrast to the assumption of 'total planning' under traditional PM. Consequently, a distributed organising approach evolved for coordinating project knowledge as a complex organisational practice rather than using a centralised PM approach. In both cases, this seems grounded in a common will of mutual interest for coordinating the interplay of tacit rationality between contextual 'knowing' knowledge (know-how, etc.) and abstract 'known' knowledge (design, plans, etc.) from centralised bounded planning (Kolb, 1984). In addition, a common will was fostered and paced by goal-

setting over the project life cycle (Lindkvist *et al*., 1998; Kreiner, 2002; Enberg *et al*., 2006; Söderlund, 2010). As a conceptual reformulation, this PM in complex settings is viewed by this study as 'complex organisational practice' based on organisational CPS.

3.7 CHAPTER SUMMARY

Prompted by an initial engagement between the data and the literature, which highlighted context and learning, this chapter set out to undertake conceptual development of capability development through organisational CPS before presenting the full empirical case studies. Capability development, including PMC, is viewed by this study as a form of organisational CPS, which requires a distributed organising approach for the integration of knowledge that is both static (designs, plans, etc.) and dynamic (know-how, etc). As a mechanism for coordinating project knowledge, this study proposes the agency of a 'common will of mutual interest' as a distributed tacit dimension (Polanyi, 1967), which is fostered around project goals and paced by the project life cycle. The distributed organising approach will be illuminated by the empirical case studies as illustrations of different practical settings and will be further developed in Chapter 7 - Empirical Findings after the case studies.

The logical structure of knowledge-creating through problem-solving was discussed as a mode of learning and organising that creates an entropy envelope wherein knowledge-creating and organising forms are mutually constituted. In effect, knowledge-creating and organising are a synonymous duality process of 'learning-organising' that is a net ordering process whose path lies from 'order to *disorder* to order'. This is a process of 'dissipative organising' that involves stimulus (problem), function (differentiation-integration), and form (organising), where function and form are a synonymous duality of 'learning-organising' (Prigogine, 1980). What this study terms the 'entropy envelope' reflects the problem space/time in terms of the amplitude of entropy change (ΔS) and the pace of entropy change (dS/dt).

Under this approach, projects as modes of organising are viewed as modes of 'learning-organising' that create knowledge as project solutions, which follow a teleological process of goals-differentiation-integration-normalisation. This provides a theoretical underpinning of the PMI's (2004) process groups of initiating (goals), planning (differentiation), executing (integration), and closing (normalisation). With the central research theme of organisational

complex learning processes based on problem-solving as an underpinning, three tentative PM definitions can now be formulated in support of the main Research Question,[13] which are informed by the discussion so far and will be illuminated by the two case study chapters:

> A project is a mode of organising to accomplish a temporary undertaking.
>
> Project management is an organisational competence in organising to accomplish temporary undertakings.
>
> Project management capability is a strategic organisational competence in organising to accomplish complex temporary undertakings.

These tentative PM definitions share the common theme of 'learning-organising' and represent an integrated knowledge-based view of projects as process and PM as organisational practice. They can be viewed like concentric circles around the inner circle of a project as a mode of organising to accomplish a temporary undertaking. As the second circle, PM is an organisational competence in organising projects. As the next circle out, PMC is a strategic organisational competence in organising the project management of complex projects and so on.

3.8 SUMMARY OF THEMES, CONCEPTS, & TERMINOLOGY IN THE STUDY

At this point, it may be useful to gather together the main themes, concepts, and terminology that inform the study before commencing the next Chapter 4 - Methodology, which is a prelude to the presentation of the empirical case studies in the subsequent chapters.

Overall, the thesis is attempting to extend the PM/PMC literature by addressing a number of interrelated themes that are under-researched in the literature, namely, (1) problem-solving as an engine of knowledge creation in PM/PMC; (2) projects as process and PM/PMC as practice; and (3) PMC development through complex learning processes.

Firstly, when grounded in problem-solving, knowledge creation is viewed as a synonymous duality of learning and organising, or 'learning-organising', where learning is a form of organising and *vice versa*. Building upon and extending the work of Popper (1972/1979), the

[13] How do learning processes underpin the development of PMC in complex organisational settings?

two-stage process of problem-solving through the knowledge activities of differentiation and integration constitutes an 'entropy envelope' of learning-organising. Within the entropy envelope, the organising activities of differentiation/divergence cause knowledge entropy to increase (disorder) and the organising activities of integration/convergence cause knowledge entropy to decrease (order). Thus, the knowledge-creating process follows a path from 'order to *disorder* to order' rather than from 'order to order' Furthermore, based on the Greek dialectic of antithesis and synthesis, the structure of knowledge-creating through differentiation-integration is found to be an 'equilogical' learning process that is the same at individual level and organisational level, although multi-path and multi-outcome. This provides theoretical and empirical support for the idea of a learning organisation, i.e., an organisation that can learn, and for viewing projects as temporary learning organisations.

Secondly, stemming from the central importance of problem-solving as an engine of knowledge creation in this study together with the *organising* perspective of organisations (Weick, 1979, 1995), this study has proposed tentative definitions of projects as 'process' and PM/PMC as 'practice' - see previous Sect. 3.7. This is part of an integrated knowledge-based view of PM, which reflects a synthesis of the data with the literatures on organisations, PM as practice, complex PM, and PMC development.

Thirdly, this study proposes that PMC is developed as an organisational practice through learning processes based on organisational CPS that is grounded in equilogical learning processes of differentiation-integration. Based on a synthesis of the literature, complex projects can never be *completely* specified in advance, except in outline or in part. Using Hayek's (1945) classic insight of distributed knowledge in complex PM settings, this suggests that a distributed organising approach is required for the coordination of project knowledge rather than a centralised approach under traditional PM. In this, complex PM is better approached as a domain of 'rational actors', grounded in the rationality of a 'common will of mutual interest' that is akin to the 'invisible hand' of neo-classical economics, rather than as 'rational objects' under traditional PM. This study proposes a common will of mutual interest as a distributed tacit dimension of knowledge (Polanyi, 1967), which is fostered and paced around the challenge of project goals.

3.8.1 NEW RESEARCH TERMINOLOGY

This study has introduced new terms which are now summarised in a thematic sequence.

Learning-Organising

'Learning-organising' is the synonymous two-stage process of learning and organising through the problem-solving activities of differentiation and integration, where, like two sides of the same coin, learning implies organising and organising implies learning. This is based on the Greek dialectic of antithesis and synthesis for resolving contradictions.

Equilogical

The logical structure of knowledge-creating is based on the two-stage process of differentiation and integration, which is a synonymous process of 'learning-organising'. In so far as this same structure is observed at individual and organisational level, it is said to be equilogical, which is implicitly multi-path and multi-outcome.

Knowledge Entropy

Knowledge entropy is the relative level of disorder, or incoherence, in 'knowing' and 'known' knowledge components before they are ordered by the knower into a coherent set of 'knowing' and 'known' knowledge.

Entropy Envelope

The entropy envelope is the problem space/time of disorder-order that is constituted by the two-stage process of problem-solving through the knowledge activities of differentiation and integration. The entropy envelope is characterised in terms of the amplitude of entropy change (ΔS) and the pace of entropy change (dS/dt). Because of its divergent-convergent depiction in Fig. 3.1, it may also be viewed as an 'entropy diamond'.

Dissipative Organising

Problem-solving is a form of 'dissipative organising', where order and disorder are intrinsic aspects of both learning and organising as a synonymous duality that is manifest in the knowledge activities of differentiation and integration - the Greek dialectic of antithesis and synthesis. There are three interrelated aspects involved in 'dissipative organising' - stimulus, inquiry, and form. The problem to be solved represents the stimulus. The two-stage problem-

solving activities of differentiation (disorder) and integration (order) represent inquiry, which is a synonymous duality with its own organising forms.

Projectising

Projectising, or project organising, is a means-end mode of organising physical and social resources for delivering projects as temporary undertakings. In this, it is viewed as an organisational practice that implies learning. As a practice, it is analogous to partnering in supply-chain studies.

Bounded Planning

Complex projects are limited to 'bounded planning', because they cannot be *completely* specified in advance by a single individual, except in outline or in part. This contrasts with total planning under traditional PM.

A Common Will of Mutual Interest

A common will of mutual interest is a distributed tacit dimension of tacit foreknowledge that is fostered and paced around the challenge of mutual goals. This is a mechanism of distributed organising for coordinating the integration of knowledge components through the interplay of tacit rationality between contextual 'knowing' knowledge (know-how, etc.) and abstract 'known' knowledge (designs, plans, etc.).

Chapter 4

Research Methodology

4.1 INTRODUCTION [14]

The previous two chapters reviewed the literature and presented conceptual development of organisational CPS, in order to frame the study within the emerging tradition of PMC development based on organisational learning processes, the central research theme of this study. The main purpose of this chapter is to explore different PM research perspectives for conducting the study. The discussion is based on Pepper's (1942) root metaphors for delineating different perspectives about how we view the world - Mechanism, Contextualism, Formism, and Organicism. It will be shown that the metaphor of Mechanism (Positivism) can act as an underpinning for traditional PM and the metaphor of Contextualism (Pragmatism) as an underpinning for a contextual approach to PM.

As the chosen research perspective for this study, Contextualism and the case study research method represent an integrated system of research perspectives for investigating PMC development using a practice-oriented approach within a knowledge-based view. This approach for the study emphasises 'context', which, together with learning processes, were highlighted in early data analysis as key aspects of developing PMC.

[14] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)

4.2 THE IMPORTANCE OF CONTEXT

The initial analysis of the data was highlighting 'context' as an important aspect for developing PMC in PSOs. However, this ran counter to traditional PM and associated Positivism, which is context independent, and signalled very clearly that a traditional PM approach was not going to be fully adequate for conducting the study. Traditional PM adopts a toolkit approach to delivering projects that is independent of context, where project knowledge is a commodity that is detached from the PM professional and is available before the project commences. In this view, the role of the PM professional is to apply project knowledge to deliver the project - the Lego block knowledge approach to PM. In contrast, early analysis of the data was suggesting a social science perspective to PM that emphasised 'context' and a socio-technical approach to delivering capital projects. This finding implied the contextual specificity of knowledge integration, which was pointing towards the creation of knowledge over the project life cycle (know-how, etc.) rather than pre-given at the outset (designs, plans, etc.) (Engwall, 2002).

From a methodological perspective, traditional PM research adopts a Positivist approach based on technical rationality, which is reflected in the 'plan-then-execute' approach of the PMBoKs of the professional bodies (PMI, 2004; APM, 2006). This has consequences that limit the investigating of PMC development in organisations using traditional PM. Firstly, by viewing PM as an applied science rather than an organisational practice, the emphasis is on abstract 'known' knowledge (plans, designs, etc.) that are pre-given at the outset and assembled like Lego blocks. In contrast, a practice-oriented approach assumes that learning '*is*' the practice, which acknowledges 'knowing' knowledge as well as 'known' knowledge, even though these are not reconciled in the practice literature. Secondly, by viewing PM as an applied science, problem-solving is subsumed as a decision-making heuristic rather than highlighted as generative innovation that arises from organisational practice, which demarcates PM from operational management disciplines. Thirdly, by assuming that knowledge is pre-given rather than emergent, traditional PM implicitly assumes that PMC development is a reversible process that is timeless, whereas this study views PMC development as an irreversible organisational practice through time.

Even though the importance of 'context' in the early analysis of data ran counter to traditional PM, a close reading of the canonical PM research was supporting a social science perspective of PM to address the limitations of traditional PM and the need to develop alternative perspectives (Baker *et al*., 1974/1983; Pinto, 1986; Lechler, 1997, 1998). Thus, in order to investigate the longitudinal process of the development of PMC as an organisational

capability, 'context' was going to play an important role and it was decided to adopt a practice-oriented approach based on Contextualism (Pragmatism) for the study (Pepper, 1942). A practice lens allows PMC development to be explored as an emergent phenomenon, either organic or planned, where problem-solving learning processes play a crucial role in fostering knowledge creation. Adopting a practice-oriented approach to the study represents a change in perspective about the nature of projects from traditional 'top-down' planned PM under Positivism to 'bottom-up' emergent PM under Contextualism. Stated differently, this is a change from viewing projects as tasks to projects as processes as modes of organising. This also represents a change in how we can obtain knowledge about projects from technical rationality to practice, or from *pre-given* plans (being) to plans that are always about *planning* (becoming) (Engwall, 1998; Linehan & Kavanagh, 2006).

4.3 PM RESEARCH - MECHANISM & CONTEXTUALISM

The main purpose of this section is to outline methodological perspectives to underpin the practice-oriented approach of this study to PMC development as a contrast with traditional PM. To this end, Pepper (1942) outlines four root-metaphor perspectives as criteria for truth in his influential book, *World Hypotheses*, based on a critical refinement of common sense knowledge about the world - Mechanism, Contextualism, Formism, and Organicism. Using the PM typology of Engwall *et al*. (2003), this implies a correspondence between Mechanism and the traditional PM approach of normative-content and a correspondence between Contextualism and the Scandinavian descriptive-form approach, based on projects as temporary organisations.

Paraphrasing Pepper (1942), Mechanism is associated with Realism / Positivism (Descartes, Berkeley, Hume), causal-adjustment as a validation of truth, and can be described by the metaphor of 'machine'. Contextualism is associated with Pragmatism (Peirce, James, Dewey, Mead), pragmatic operationalism as a validation of truth, and can be described by the metaphor of 'live historic event'. Formism is associated with Realism and Platonic idealism (Plato, Aristotle), correspondence as a validation of truth, and can be described by the metaphor of 'similarity'. Finally, Organicism is associated with objective idealism (Schelling, Hegel, Royce), coherence as a validation of truth, and can be described by the metaphor of 'organism'.

4.3.1 APPLIED SCIENCE PM - MECHANISM AS TECHNICAL RATIONALITY

Using Pepper's (1942) root metaphor of Mechanism as a reference, traditional PM revolves around projects as plans and associated activities, which are implemented in a methodical efficient way by competent project team members to achieve predetermined targets, such as cost, time, and scope. This is the traditional Positivist, mechanistic, normative way of delivering projects as tasks based on technical rationality (Cooke-Davies, 2002; Leybourne & Sadler-Smith, 2006; Smyth & Morris, 2007). In this approach, project knowledge is available up-front and, then, assembled like Lego blocks, i.e., projects as 'being', or objects, or commodities, Fig. 4.1. Under a Positivist view, reality, knowledge, problems, and solutions are 'out there', waiting to be encountered by the detached knowing subject and processed under the norms of technical rationality. This kind of knowledge is context-independent and can be documented and possessed by knowers, transferred without difficulty between knowers, and derives from our empirical experience of the world (Popper, 1963/2007, 1972/1979).

Perspective	**Contextualism / Pragmatism**	**Mechanism / Positivism**
Ontology	Subjective/Objective Becoming Actor Process	Objective Being Object Commodity
Epistemology	Subjective/Objective Knowing/Known Problem-Solving Enacting Organising Here (Context)	Objective Known Solution Application Organisation Anywhere

(Source: This Study)

Fig. 4.1 Project Perspectives - Ontology and Epistemology

In traditional PM terms, the project team (subject) endeavours to manage a project plan (object) as documented knowledge that can and should be fully specified in advance, in order to successfully deliver the project. However, as courts of law bear witness, no complex plan, or rule, can ever be fully specified in advance, because all contracts, plans, laws, etc. are inherently incomplete and rely on tacit presuppositions for their understanding and implementation (Wittgenstein, 1922/2010; Polanyi, 1962/1974, 1967). Moreover, the failure of the traditional PM approach based on technical rationality is well documented, in respect

of not delivering on its own terms the key success parameters of scope, budget, and timescale for capital projects in both the private and government sectors (Hall, 1980; Morris & Hough, 1987; Standish Group, 2003; Flyvbjerg *et al*., 2003).

If a different approach is not advanced in PM theory and practice, this discipline, which takes pride in its scientific heritage, will suffer the inglorious fate predicted by Einstein, namely, the insanity of doing the same thing over and over again and expecting different results! In so far as "a way of seeing is also a way of not seeing" (Poggi, 1965, p. 284), PM research needs to be open to other methodological perspectives that enrich the PM domain by demonstrating their relevance to theory and practice. This requires openness to new conceptualisations of projects and, also, the way knowledge can be obtained about projects, rather than merely changing the PM research methods while retaining the traditional Positivist perspective.

4.3.2 SOCIAL SCIENCE PM - CONTEXTUALISM AS PRACTICE

Using Pepper's (1942) root metaphor of Contextualism (Pragmatism) as a reference, projects can be viewed as temporary processual undertakings in a specific context involving project stakeholders as actors. The latter project organise (projectise) physical and social resources to deliver projects over the economic life cycle, i.e., projects as 'becoming', or actors (Engwall, 1998; Linehan & Kavanagh, 2006). Under this view, project knowledge is not 'out there' and pre-given at the start of the project in project plans but is an emergent knowledge solution to the challenge of delivering the project as a hidden reality through its plans and associated artefacts, which can never be fully specified in advance. In effect, knowledge is both 'out there' and 'in here' with the knowing subject as the crucial interface between the two kinds of knowledge, 'known' knowledge that is 'out there' and 'knowing' knowledge that is 'in here', Fig. 4.1.

Viewing projects as phenomena that are 'actors/becoming' suggests an interpretivist approach to epistemology, which emphasises dwelling in the world through 'knowing', problem-solving, enacting, and organising (Polanyi, 1962/1974; Weick, 1979, 1995; Schön, 1983; Tsoukas, 1996; Orlikowski, 1996, 2002). Under an interpretivist view such as Contextualism, knowledge emerges through a process of 'knowing' as the knower engages with the world through awareness, which can be practical, intellectual, or in combination (Dewey, 1916/1966; Polanyi, 1962/1974, 1967). Under this approach, project knowledge emerges from the enactment of the project through the engagement of project actors with the

organising activities of delivering the project (Dougherty, 1992; Bragd, 2002; Engwall, 2002, 2003; Koskinen, 2000, 2004; Lindkvist, 2005; Newell, Bresnen, Edelman, Scarbrough, & Swan, 2006; Bellini & Canonico, 2008). In the business literature, the Pragmatist approach is an older tradition and a broad church that includes a practice-oriented approach to epistemology (Schön, 1983; Daft & Weick, 1984; Orlikowski, 1996, 2002; Nicolini *et al*., 2003; Gherardi, 2006; Tsoukas, 2005, 2009).

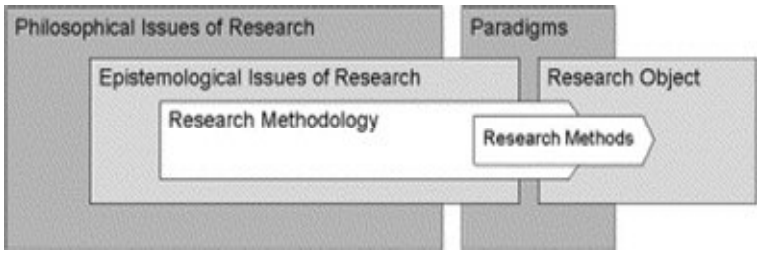
Informed by the phenomenological and ethno-methodological traditions, Gherardi (2006) defines practice as "a mode, relatively stable in time and socially recognized, of ordering heterogeneous items into a coherent set" (p. 34). This is grounded in a view of knowledge that rejects technical rationality and, instead, associates knowledge with 'knowing' and the latter with practical enactment (Gherardi, 2006, p. 2):

> Knowledge is not what resides in a person's head or in books or in data banks. To know is to be capable of participating with the requisite competence in the complex web of relationships among people, material artefacts and activities.

Gherardi (2006) advocates a practice approach to research, because it is a socio-technical perspective with the capacity to go beyond "problematic dualisms like mind/body, actor/structure, human/non-human" (p. 39). A practice-oriented approach to PM research, then, is processual in nature and draws its strength from following actors in the exercise of living and working in organisations, both permanent and temporary (Pettigrew, 1990, 1997). Crucially, in a practice approach, learning is an intrinsic part of practice and as Wenger (2001) insightfully observed: "One reason they [practitioners] do not think of their job as learning is that what they learn *is* their practice" (p. 95, original italics). Paraphrasing this insight for project settings, one reason PM practitioners do not think of problem-solving as learning is that solving problems '*is*' their job, i.e., their practice.

4.4 RESEARCH METHODOLOGY IN THIS STUDY

Smyth & Morris (2007) describe research methodology as a *system* of research perspectives, which is informed by perspectives of the research domain and philosophical issues. As part of the research methodology, research methods are the techniques and tools that are used to undertake specific research, Fig. 4.2.



(Source: Smyth & Morris, 2007, p. 424)

Fig. 4.2 Research Methodology - System of Research Perspectives

A practice-oriented approach is consistent with Contextualism (Pragmatism), which is being adopted in this study (Pepper, 1942). As discussed in the Literature Review, Winter *et al.* (2006) advocate a practice approach to PM research in a special edition of the *International Journal of Project Management*, in order to achieve a better synthesis between PM theory and PM practice. In addition, recent papers have also called for a practice approach to PM research to achieve the same objectives of PM research that is relevant to practice (Blomquist *et al*., 2010; Lalonde *et al*., 2010, 2012). In the area of the development of PM as an organisational capability (PMC), Söderlund (2005) advocates a processual approach that is also broadly in line with Pepper's (1942) Contextualism.

4.4.1 RESEARCH PROCESS MODEL

Using a Contextualist approach, the researcher needs to follow the actors under investigation and allow them to speak for themselves as they recount the story of how PM developed as an organisational capability (PMC) in their organisation in response to the environmental stimulus of the 2000s (Pettigrew, 1990, 1997). As a kind of company historian, the researcher requires only general headings to prompt the conversation around the development of PMC over time, the main dimensions of PMC, the enabling conditions for PMC, and the complex learning processes for PMC.

As Yin (2003) makes clear, adopting a case study approach as a research method requires an initial conceptual framework that guides the data collection process and is iteratively modified throughout the data collection process. As the topic area of this study is under-developed in the literature, it was considered appropriate to generate a process model to guide the data collection process and analysis, Fig. 4.3. This includes six aspects in support of the Research Questions, which are repeated from the Literature Review:

> How do learning processes underpin the development of project management capability in complex organisational settings?
>
> (i) What role does problem-solving play in learning processes for developing PMC?
> (ii) How does a practice-oriented approach facilitate the development of PMC?
> (iii) How is project knowledge coordinated in complex PM settings?

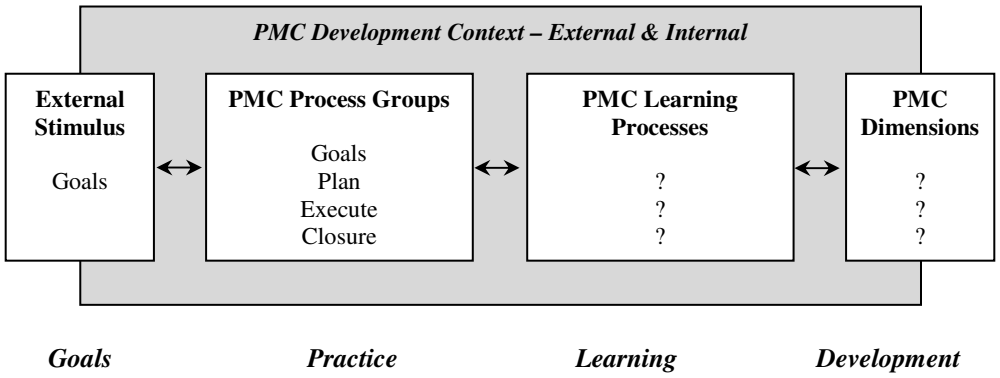


Fig. 4.3 Study Process Model – PMC Development

Firstly, the model assumes very broadly that PMC was developed through multiple recursive cycles of goals, practice, and learning during the 2000s. Secondly, the model emphasises the external and internal context in which PM developed as an organisational capability (PMC). Thirdly, it recognises that the development of PMC was triggered by a major stimulus in the external environments of the two representative PSOs that are the focus of this study. Fourthly, it takes as a starting point for PM practice the well-known espoused PM process group of goals-plan-execute-closure, with monitoring and control throughout the project life cycle (PMI, 2004). This PMI heuristic is commonly used to underpin the 'top-down' planning approach of traditional PM but may reveal an emergent nature when viewed processually as an active heuristic (verb) rather than a passive one (noun), i.e., goal forming-planning-executing-closing. From this starting point, the investigation will seek to explore how PMC developed at different levels in the two case study organisations as a PM ecology

at project works-staff level, project supervisory level, organisational level, project governance level, and project external level.

Fifthly, the model assumes that, as yet, indeterminate complex learning processes of knowledge creation and utilisation are integral to the development of PMC in conjunction with goal-driven practices that are oriented around problem-solving. Sixthly and lastly, the investigation seeks to explore the structural dimensions of PMC as it developed over time as a multi-level construct that encompasses a PM ecology at project works-staff level, project supervisory level, organisational level, project governance level, and project external level. It is broadly assumed that the development of PMC is the result of organisational complex learning processes, which revolves around goal-driven practices that are grounded in project problem-solving. This study seeks to elucidate the organisational complex learning processes that contributed to the development of PM as an organisational capability (PMC).

The process model is dynamic rather than static. Even though the main aspects of the model are shown in a linear fashion from right to left, the reader's attention is drawn to the double-end arrows that interconnect each of the main elements. This signifies bidirectional and multi-directional interactions between the model elements with multiple feedback loops and permeable boundaries between elements. Moreover, all the elements of the model share a common organisational context in which PM developed as an organisational capability (PMC) during the 2000s, in response to a radical change in the external environment of the two organisations under investigation.

4.4.2 RESEARCH UNIT OF ANALYSIS

In this study, the unit of analysis is the development of PM as an organisational capability (PMC) in complex organisations. Because PMC is under-developed in the literature in respect of both theoretical and practitioner perspectives, this study is exploratory in nature. Overall, the development of PMC is a multi-level construct at different interrelated levels in a PM ecology (Grabher, 2002, 2004), e.g., project level, organisation level, and external level. In effect, each of the two cases of PMC development in this study reflects an "embedded case study design" (Yin, 2003, p. 43). The key dimensions of this study topic are the *longitudinal development* of PMC and the *context* in which it was developed. Mintzberg (1979b) uses the analogy of a 'marble cake' to describe the complexity of organisations and the difficulty of analysing a slice of the 'marble cake' at a point in time and relating that cross-sectional slice to the whole organisation at the same, or previous, points in time. When

the object of study is the development of an organisational capability over time, the task is more challenging when the organisation needs to be viewed cross-sectionally as well as longitudinally.

The unit of analysis in this study is broadly similar to that of Söderlund (2005), namely, the development of PM as an organisational capability (PMC), or competence. In his view, researching this phenomenon "must rest upon an analysis of both specific projects and the development and change of the focal firm" and, furthermore, "such an understanding must be based on in-depth studies of firms over time, not on broad surveys and comparisons of projects in different sectors and industries" (Söderlund, 2005, p. 454). Although Söderlund (2005) does not reference Pettigrew's (1990, 1997) methodology of 'processual analysis', which uses longitudinal case studies informed by Pepper's (1942) Contextualism, their methodological perspectives and methods are broadly similar. The lack of research in the continuous development of PM as an organisational capability (PMC) has been echoed in recent research (Berggren *et al*., 2008) and, in earlier research, the detrimental effect of out-sourcing PMC development rather than in-house development (Berggren, Söderlund, & Anderson, 2001).

4.4.3 RESEARCH METHOD - CASE STUDY

4.4.3.1 Case Study - General

The case study research method is being adopted in this exploratory research investigation and a key strength of this method is its ability to empirically investigate phenomena in their own contexts over time, especially when context is an important dimension of the object of study (Pettigrew, 1990, 1997; Yin, 2003). In addition, the case study approach can cope with, and is enriched by, multiple sources of data, such as documents, interviews, and observations. Findings from a case study can be corroborated easily by several sources of evidence in a triangulation fashion, thereby strengthening its construct validity and reliability.

4.4.3.2 Case Study - Context

The ability of case study research to empirically investigate phenomena in their own contexts over time is a key strength of the case study research design. The level of analysis for a case study can be an individual, an organisation, a team, etc. but each phenomenon is investigated in its holistic context, where its actions are embedded in the context of its environment to

constitute meaning. In doing case study research, qualitative and anecdotal 'soft' data often facilitate an understanding of the meaning that case study actors ascribe to events, which provides insight into the causal relationships identified by quantitative 'hard' data (Mintzberg, 1979b).

4.4.3.3 Case Study - Corroboration

The case study research method is often criticised for its ability to generate hypotheses but not to test them, that is, its lack of statistical validity to generalise beyond the case study (Yin, 2003; Flyvbjerg, 2004). Much of the criticism is based on the confusion of equating a single case study with a sample size of one. A case study is not a sampling unit but an experimental unit that, if carefully chosen, contains all the necessary ingredients to build, test, and validate theory to generate analytic/theoretical generalisation (Pepper, 1942; Eisenhardt, 1989a; Pettigrew, 1990, 1997; Yin, 2003). In contrast, a survey sample is selected to represent a target population and the data from the survey sample are used to infer results to the target population by statistical, or literal, generalisations. As with a laboratory experiment, the results of a case study can be replicable, repeatable, and transferable to other similar settings. If two or more case studies support the same theory, replication is claimed; if two, or more, case studies support the same theory but do not support a rival theory, more robust replication is claimed (Yin, 2003).

4.4.4 RESEARCH METHOD DESIGN

As the overall unit of analysis in this study is the development of PM as an organisational capability (PMC) in complex organisations at several interrelated levels, this recommends itself as a multi-level construct using an embedded design (Yin, 2003). In addition, it was decided to pursue a two-case design, rather than a single-case, because of the advantages of comparative case studies for a research topic area that is under-developed in terms of theoretical and practitioner perspectives. Furthermore, by not putting "all your eggs in one basket" (Yin, 2003, p. 53), the testability of the study findings from each case are mutually enhanced by a two-case design, in terms of construct validity, internal validity, and external validity (Flyvbjerg, 2004).

For research purposes, Yin (2003) outlines three main types of case study: (1) descriptive, or historical; (2) exploratory; and (3) explanatory, or causal. The two case studies in this exploratory research investigation are mainly descriptive, or historical, case studies that trace

the development of PMC in two PSOs in the 2000s. However, the case studies are also partly exploratory and explanatory, where necessary, in order to provide support for the main descriptive narrative.

4.4.4.1 Case Study Organisations

The two cases in this study are (1) Iarnród Éireann - Irish Rail (IE) and (2) Electricity Supply Board (ESB), both of which are government-owned organisations, or PSOs. This researcher is an employee of IE and is grateful for their permission to conduct this study in a private capacity and for partial funding of the study. This researcher is also grateful to ESB for generously allowing access to personnel, in order to conduct the ESB case study in a private capacity. The IE case is the main case study and the ESB case is a supporting case study. Overall, the cases were chosen for a combination of their intrinsic interest, access potential, and for their instrumental applicability (Stake, 2000).

While each is a separate organisation, they have similarities that influenced their selection for investigating the development of PM as an organisational capability (PMC) in PSOs in the 2000s. Firstly, both IE and ESB are PSOs. Secondly, both are organisations for which PMC is a 'core supporting competence' rather than a 'core competence', which implies more rapid organisational learning. Thirdly, both organisations were subject to a radical change in their external environment in the 2000s. IE was subject to the stimulus of the government's National Development Plans in the 2000s and the ESB was subject to EU deregulation of the electricity market in the 1990s/2000s.

4.4.5 DATA COLLECTION & ANALYSIS

As case studies are investigated in context, it is common for the researcher to have access to multiple sources of data, including interviews, observations, anecdotes, organisational records, public records, etc., which are often rich and highly descriptive (Eisenhardt, 1989a; Yin, 2003; Pettigrew, 1990, 1997). Intrinsically, the case study approach can cope with and thrives on multiple sources of data. This means that findings from a case study can often be corroborated by several sources of evidence in a triangulation fashion, which strengthens its construct validity.

The case studies are based on two government-owned utility companies during the ten-year period of the 2000s. A case study protocol was developed for the study to guide the overall approach to the investigation of the Research Questions (Yin, 2003), Appendix I. The data

used in the two case studies were obtained from a variety of sources, including company annual reports, company procedures, organisation charts, interviews with key participants, newsletters, government publications, and direct observation in the main IE case study, Table 4.1.

Source of Evidence	Strengths	Weaknesses
Documentation	• stable - can be reviewed repeatedly • unobtrusive - not created as a result of the case study • exact - contains exact names references, and details of an event • broad coverage - long span of time, many events, and many settings	• retrievability - can be low • biased selectivity, if collection is incomplete • reporting bias - reflects (unknown) bias of author • access - may be deliberately blocked
Archival Records	• *[Same as above for documentation]* • precise and quantitative	• *[Same as above for documentation]* • accessability due to privacy reasons
Interviews	• targeted - focuses directly on case study topic • insightful - provides perceived causal inferences	• bias due to poorly constructed questions • response bias • inaccuracies due to poor recall • reflexivity - interviewee gives what interviewer wants to hear
Direct Observations	• reality - covers events in real time • contextual - covers context of event	• time-consuming • selectivity - unless broad coverage • reflexivity - event may proceed differently because it is being observed • cost - hours needed by human observers
Participant Observation	• *[Same as above for direct observations]* • insightful into interpersonal behaviour and motives	• *[Same as above for direct observations]* • bias due to investigator's manipulation of events
Physical Artefacts	• insightful into cultural features • insightful into technical operations	• selectivity • availability

(Source: Yin, 2003, p. 86)

Table 4.1 Sources of Evidence - Strengths & Weaknesses

As the interviews were semi-structured to allow participants the freedom to wander freely over areas they considered relevant to the topic, this meant that the questions posed to each participant were not identical and varied to suit the flow of the interview conversation around the themes of the main Research Question.[15] The nature of the questions related to the development of PMC as a strategic organisational capability and revolved around the six aspects of the process model, Fig. 4.3, p. 92, namely, external context, internal context,

[15] How do learning processes underpin the development of PMC in complex organisational settings?

external stimulus, PMC process groups, PMC learning processes, and PMC dimensions. Sample questions are indicated in Appendix I - Case Study Protocol. In total, fifty one semi-structured interviews were conducted with informants at project level, organisational level, and external level, Table 4.2. The external informants included consultants that were on secondment contract with IE during the 2000s, as well as informants at government level. The interviews were conducted over a four year period, 2008 to 2011, and varied in time from three quarters of an hour to an hour and a half, usually lasting about an hour.

	IE		ESB	Total
Interviews - IE		**Interviews - ESB**		
External				
Department of Finance	2			
Project Management Consultant	3			
Organisation		**Organisation**		
Executive Director	3	Executive Director	2	
Strategic Planning	1	Contracting Partners Manager	1	
Chief Safety & Security Officer	1			
Chief Signalling Engineer	1	Contracts Manager	1	
Programme Manager	4	Programme Manager	1	
Asst. Programme Manager	3	Network Manager	1	
Project Controls	2	Project Controls	2	
Liaison - Operations	1			
Project		**Project**		
Project Manager - Construction	2	Project Manager - Construction	2	
Project Manager - Signalling	1	Project Manager - Contracts Planning	1	
Project Manager - Track Installation	3	Project Manager - Networks	5	
Project Manager - Track Protection	1			
Project Planner	1			
Asst. Project Mgr. - Track Installation	1			
Project Task Leader	3			
Coordinator - Track Installation	1			
Inspector - Track Installation	1			
Totals - IE	**35**	**Totals - ESB**	**16**	**51**
Interview Transcripts - IE		**Interview Transcripts - ESB**		
Recorded Transcripts	33	Recorded Transcripts	13	46
Other Transcripts	2	Other Transcripts	3	5
Totals - IE	**35**	**Totals - ESB**	**16**	**51**
Transcript Wordcount (k) - IE	**216**	**Transcript Wordcount (k) - ESB**	**131**	**347**

Table 4.2 Study Interviews - Personnel & Data

Before conducting interviews, permission was obtained from informants regarding the use of interview data in the study under the ethical guidelines of Dublin City University for data confidentiality in conducting social science research. Where possible and with the consent of the participants, the interviews were electronically recorded and transcripts prepared for subsequent analysis for major themes and supporting themes. If this was not possible, notes were taken during the interviews. According as each interview transcript became available, a copy was sent to the informant for their review. In addition, both IE and the ESB were sent a draft copy of their respective case in this study for review and comment.

When conducting inductive case study research, the empirical data collection continues until a saturation level is reached in respect of major themes and supporting themes, when the data begins to reinforce itself by repetition (Strauss, 1987; Yin, 2003). In order to facilitate thematic analysis of the study data, the contents of the transcripts were transferred from MS Word to MS Excel[16] files, where labelling was done by rows. Using the study process model as a reference, Fig. 4.3, p. 92, and a coding approach informed by grounded theory (Strauss & Corbin, 1998), different labelling columns were established for major themes (level-1), supporting themes (level-2), and supplementary themes (level-3, level-4). A summary of the coding scheme is shown in Table 10.1, Appendix II. The use of MS Excel spreadsheets facilitated the use of multiple filters for ease of access to themes and the use of pivot tables for frequency analysis. Taken together, the approach outlined above enhances the validity of the data analysis and the credibility of the research findings.

4.4.6 CASE STUDY - THEORY DEVELOPMENT APPROACHES

A case study research design embraces inductive proposition-building and the deductive generation of preliminary hypotheses before data collection (Eisenhardt, 1989a; Yin, 2003). During the case study itself, there is an ongoing iteration between hypotheses and data during the data collection process, in order to refine preliminary hypotheses and build theory from the case study. This reflects the general nature of all research inquiry from grounded theory in social science to the scientific method in natural science. This revolves around inferences and verification, where inferences can be abductive, inductive, deductive, or a combination of these types and verification must be acceptable to an open community of scholars that is committed to universal standards of knowledge (Peirce, 1931-1958; Polanyi, 1967; Strauss, 1987).

[16] Computer applications by MS - Microsoft Corporation (USA)

Siggelkow (2007) offers different perspectives on how case study data might be used for developing theory. He highlights the constant iteration between data and theory and also draws attention to using cases for theory development in two different ways - "inspiration versus illustration" (*ibid.*, p. 22). In the first scenario, Fig. 4.4 Method I, the case is used as inspiration and positioned before the theory development, which builds on the findings. In the second scenario, Fig. 4.4 Method II, the case is an illustration and the theory development is presented before the case and draws its inspiration from the same case, or a previous case, or other sources. In the second scenario, the theory can be developed yet further based on the findings.

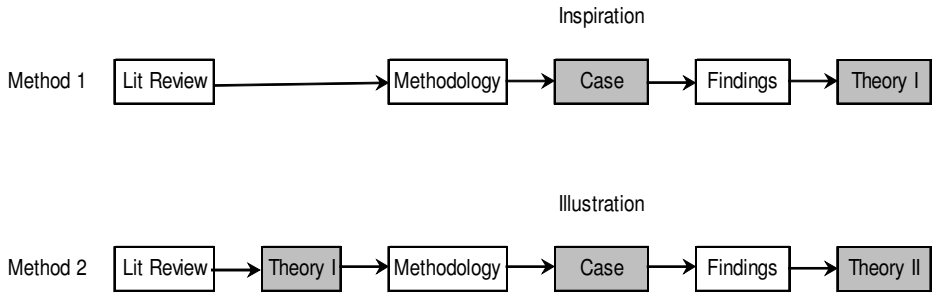


Fig. 4.4 Theory Development - Case Data as Inspiration vs. Illustration

In early analysis of the data, 'context' emerged as a key theme for PMC development and its inherent organisational learning processes. Therefore, because key aspects of the PMC development context were intrinsically linked to the types of learning processes that were integral to the development of PM as an organisational capability (PMC), this was likely to emerge early in the investigation and be a pervasive theme throughout the remaining study. Indeed, the initial data analysis was pointing to complex learning processes beyond single-loop and double-loop learning, which is under-developed in the capabilities literature. This was suggesting a dual interactive role for the data from the outset of the study, namely, inspiring conceptual development and illuminating the concepts by illustrating their working in different practical settings, which could be further developed with the findings. The integrated role being played by the data in this inductive study influenced the organisation of the thesis, in terms of presenting initial conceptual development that was inspired by early engagement between the data and literature before presenting the full empirical case studies.

As Siggelkow (2007) points out, using a case as inspiration or illustration is a matter of sequencing. By adopting a dual approach, as this study is proposing, the case data inspires

and illuminates the conceptual development and together they inform the findings, which can develop the concepts yet further. In this, the conceptual development can be viewed as a preliminary formalisation of the ongoing interaction between data and theory that is an intrinsic part of inductive case study research (Strauss, 1987; Eisenhardt, 1989a; Yin, 2003; Siggelkow, 2007).

4.5 CHAPTER SUMMARY

This chapter set out to explore different PM research perspectives for conducting this study, which were outlined in terms of Pepper's (1942) four root-metaphor theories - Mechanism, Contextualism, Formism, and Organicism. In this, it provides a theoretical underpinning for the traditional PM approach of technical rationality under Mechanism (PMI, 2004; APM, 2006) and for alternative approaches. A practice-oriented approach based on Contextualist (Pragmatism) was proposed for the study, which allows for multiple perspectives when dealing with complex PM settings for the development of PM as an organisational capability (PMC) using complex learning processes based on problem-solving, the central research theme of this study.

A process model for guiding the data collection and analysis was presented for the study, in which the unit of analysis is the development of PM as an organisational capability (PMC) in complex organisations. As this topic area is under-developed in the literature, the research approach is exploratory, longitudinal, and comparative. The case study method was presented as an appropriate research method for this study, which is also consistent with the methodological perspective of Contextualism (Pragmatism). The two case study organisations have three aspects of 'context' in common for comparison purposes that facilitate the empirical investigation of the main Research Question[17] - (1) PMC development in public sector organisations (PSO), (2) PMC development as a 'core supporting competence', and (3) PMC development in an external environment that is subject to dynamic and sustained change. Lastly and importantly, it was highlighted that in this inductive study, the data plays a dual interactive role from the outset, namely, inspiring conceptual development and illuminating the concepts by illustrating their working in different practical settings.

[17] How do learning processes underpin the development of PMC in complex organisational settings?

Chapter 5

Case Study No. 1: Iarnród Éireann - Irish Rail (IE)

5.1 INTRODUCTION [18]

After decades of under-investment, the government-led National Development Plans (NDP, 2000, 2007) afforded IE an unprecedented opportunity to upgrade the railway system as part of a strategic integrated approach to transport across the economy. In response to the NDPs, IE developed a project management capability (PMC) during the 2000s that became an acknowledged organisational competence that contributed to the achievement of key organisational objectives. This was achieved by following an incremental development approach rather than following a pre-determined path of unproven suitability for a large, long-standing, public sector organisation (PSO) for which the NDPs represented a radical change in its external environment. It was not just that IE needed to adapt quickly to the NDP environment as a single event but that IE needed to continue to adapt to an uncertain and dynamic external environment under the NDPs over the next ten years and more. As remarked: "There wasn't a grand strategy ... but we evolved into a grand strategy."[19]

The development of a robust PMC in IE in response to the NDPs was not an assured outcome, due to unsatisfactory experiences with the out-sourcing of capital projects in the early 2000s. Nevertheless, over a decade and more, IE developed and refined its PMC to successfully deliver hundreds of projects during the 2000s - small, medium, large, and major projects –achieving key performance targets of scope, budget, and timescale for project stakeholders. However, the timeline of the development of IE's PMC did not coincide neatly with the start of the NDPs in 2000. In particular, the root stock from which the PMC would develop during the 2000s was germinated in organisational experiences before the 2000s. Therefore, in order to profile the development of a PMC in IE during the 2000s, it is

[18] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)
[19] IE interview No. 18, Aug 2010

necessary to appreciate the relevant organisational history of IE before the 2000s and the catalyst events that contributed to the development of a PMC during the 2000s.[20]

The case study that follows is based on thirty five semi-structured interviews, which together represent a longitudinal and cross-sectional perspective on the development of a PMC in IE as a response to the ongoing stimulus of the NDPs during the 2000s. In addition, data have been collated from secondary and other sources, such as IE documents, reports, books, periodicals, electronic media, etc. The case study presentation is broadly organised around the PMC process model that was introduced in Chapter 4 - Methodology as a guide for data collection and analysis, Fig. 4.3, p. 92.

5.2 PMC DEVELOPMENT - CONTEXT & STIMULUS

This section outlines the context and stimulus for PMC development in IE as a case study organisation.

5.2.1 RAILWAYS IN IRELAND - OVERVIEW[21]

The railway boom, which started in England in the early 1800s, quickly spread to Ireland and about 180 one-time separate railway concerns form part of Irish railway history. When other abortive railway schemes are included, this number may well have reached around 200. The first public railway in Ireland was the Dublin & Kingstown Railway (D&KR), which was incorporated in 1831 and opened in 1834. At the time of its opening, it was one of the earliest public railways in the world, the first being the celebrated Stockton & Darlington Railway of 1825 in England. In 1925, some twenty six railways in Ireland were amalgamated to form Great Southern Railways and, in 1945, this company was amalgamated with the Dublin United Transport Company, which operated trams and buses, to form Córas Iompair Éireann (CIE), a statutory corporation with the State as sole shareholder.[22] In addition to rail transport, CIE also operated bus services in and between the large towns and cities. Between 1925 and 1945, the railway experienced increased competition from road transport, which was exacerbated during World War II by the shortage of good quality coal

[20] IE interview No. 18, Aug 2010
[21] Main source is Casserley, H. (1974). *Outline of Irish railway history*. London: David & Charles.
[22] CIE. The history of transport in Ireland. www.cie.ie/about_us/schools_and_enthusiasts.asp (accessed Aug-2008)

to power the steam locomotives of the trains. During the 1950s and early 1960s, a complete conversion to diesel locomotives took place. From its inception in 1945, the commercial viability of CIE became an ongoing political conundrum, as the country became industrialised and alternative more cost-effective modes of transport became available for both passengers and freight.

5.2.2 PMC EXTERNAL CONTEXT PRE-2000

5.2.2.1 Demographic & Passenger Trends

In 2004, it was reported by the International Union of Railways (UIC) that passenger volumes in IE had grown at the highest percentage level (+41.8%) in Europe over the previous decade.[23] Annual railway passenger journeys increased dramatically in IE from 25.8m in 1994 to 45.5m in 2007, an increase of +76%, or +4.5% p.a.[24,25] Among the reasons advanced for the increased use of train services above levels suggested by demographic indices alone include: increased economic activity and affluence; higher employment participation rates among both genders; longer commuting distances; road gridlock; improved timetable service; modernised rolling stock and stations; value for money *vis-à-vis* alternatives; increased life expectancy of older passengers with government-subsidised free travel; and quality of life choice.

5.2.2.2 EU Strategic Plans

In the formulation of the first NDP in 2000, the EU was an important influence[26] on the government's policy to pursue a balanced regional development strategy across the economy and within sectors of the economy, such as transportation, rather than concentrating on specific sub-sectors within the economy, such as roads.[27] This approach by the EU to the formulation of the NDPs in the mid 1990s was fortuitous from IE's perspective, as it facilitated a favourable political environment for the acceptance and integration of IE's own proposal under the NDPs, dating from 1993, to develop the railway with EU funding.

[23] Cited in IE Annual Report and Financial Statements 2005, p. 5. Dublin: Iarnród Éireann.
[24] IE Annual Report and Financial Statements 2004. Dublin: Iarnród Éireann.
[25] IE Annual Report and Financial Statements 2007. Dublin: Iarnród Éireann.
[26] The first NDP (2000) was co-funded by the EU
[27] IE interview No. 18, Aug 2010

5.2.2.3 Government Strategic Plans

At the turn of the new millennium, the government launched an ambitious seven-year National Development Plan (NDP, 2000),[28] lasting from 2000 to 2006 with a budget of €52bn, to upgrade infrastructure in key sectors of the economy, including public transport (€2.8bn). The first NDP was followed by a successor seven-year plan (NDP, 2007),[29] lasting from 2007 to 2013, with a budget of €184bn, of which public transport was allocated €13bn. The multi-annual strategic NDPs were supported by the EU. The first NDP (2000) was part-funded at approximately 10% by the EU and the current NDP (2007) is funded entirely from Irish exchequer resources. Thus, starting with the first NDP in 2000 and continuing to 2013, the government committed itself to an ambitious fourteen-year programme whose key objective was the continual upgrading of national infrastructure, including public transport (€15.8bn). In addition to the NDPs, the Euro was launched in 1999 by fixing the exchange rates - notes and coins followed three years later in 2002. The single currency consolidated the EU single market and meant access to credit at low interest rates, which represented a stimulus for investment in both the private and public sectors. Taken together, the Euro and the NDPs provided a framework for economic buoyancy in the Irish economy in the years ahead that represented a major external stimulus for private and public sector organisations (PSO) alike.

5.2.2.4 IE Strategic Plans

In 1984, the government's policy for the future development of transport services was contained in the report 'Building on Reality 1985-1987'.[30] This report accepted the McKinsey Report recommendation of restructuring CIE into three separate operating companies (Iarnród Éireann, Bus Átha Cliath, Bus Éireann), all of which came into being in January 1987 as CIE subsidiaries. The report also signalled that there would be "no substantial investment in the railways"[31] after the completion of current projects.

In 1993, IE was invited to submit proposals to government on the future of the railway that were consistent with government policy of 'no substantial investment'. In addition to proposals on railway rationalisation, IE also submitted an additional proposal to develop the railway with EU funding, which, if accepted, would break "the psyche of 'no investment' "[32] and develop the railway to EU standards. The upgrading of the Dublin to Belfast railway

[28] NDP (2000). National Development Plan 2000 – 2006. Dublin: The Stationery Office
[29] NDP (2007). National Development Plan 2007 – 2013. Dublin: The Stationery Office. Revised in 2011.
[30] CIE (2008). The history of transport in Ireland, www.cie.ie/about_us/schools_and_enthusiasts.asp (accessed Aug-2008)
[31] CIE (2008). The history of transport in Ireland, www.cie.ie/about_us/schools_and_enthusiasts.asp (accessed Aug-2008)
[32] IE interview No. 18, Aug 2010

line, 1993 to 1997, was a good example of the type of railway infrastructure projects that IE could undertake with joint funding from the Irish exchequer and the EU. Nevertheless, in spite of such development proposals and the availability of EU funding, the ongoing under-investment and related obsolescence of railway rolling stock and operational assets continued until the late 1990s. At this time, both public and private transport became integrated elements of the government's national transportation strategy for the first time, as reflected in the NDPs (2000, 2007) and 'Transport 21'[33] programmes.

5.2.3 PMC INTERNAL CONTEXT PRE-2000

5.2.3.1 Stakeholder Groups

For the purposes of NDP capital projects, IE had three main groups of stakeholders: (1) central government departments and EU equivalents; (2) non-government external stakeholders (residents, land owners, passengers); and (3) internal stakeholders (operating and maintenance divisions, staff, trade unions). Firstly, for capital investment projects in PSOs, central government, as guardian of the public interest, is a key player in deciding which projects are undertaken and how they will be funded. Fortunately for IE, it enjoyed a good rapport with key central government departments during the period of continuous NDPs and this ensured the alignment of NDP goals between both parties.[34,35]

During the period of continuous NDPs, 2000 to 2013, the second group of external stakeholders, such as residents, land owners, and passengers, was affected in different ways by sponsoring bodies such as IE and similar public sector bodies delivering capital projects. Moreover, this stakeholder group was conjoined to the first stakeholder group, central government, through the political process, at both local and national levels, which highlights the unique social context in which capital projects are delivered in the public sector compared to the private sector.

With regard to IE's third group of internal stakeholders, the commitment of IE's Board to developing the railway during the 2000s ensured the full support of IE's senior management to delivering capital projects to meet IE's objectives within the overall NDP framework.[36] At the beginning of 2000s, IE was a large public sector body with 5,000+ employees that

[33] Transport 21, www.transport21.ie/What_Is_Transport_21/Transport_21/What_is_Transport_21.html (accessed 19-Aug-2008)
[34] IE interview No. 14, Mar 2010
[35] IE interview No. 12, Feb 2010
[36] IE interview No. 12, Feb 2010

operated in a relatively stable commercial environment, which was reflected in an organisational design based on functional lines.[37] This is the permanent organisation surrounding IE's core business activity of running a national train service, its 'core competence'. Even though developing PMC as a 'core supporting competence' was a strategic business objective for IE, projects are temporary organisations and this made the task of managing internal stakeholders more challenging for project managers. This required the continual involvement of IE's internal client customers during the delivery of capital projects[38] for whom projects did not represent their primary focus.

5.2.3.2 Professional Groups

Professional and cultural issues also contributed to the development of a PMC in IE, such as the technical challenge[39] that the NDP projects posed for a company with a deep-rooted pride in the railway and a strong engineering self-image.[40] However, initially, this engineering self-image may have been a double-edged sword for the development of a PMC in the early 2000s. On one hand, it represented an inherited engineering competence that was marshalled to deliver the original DART project[41] in the early 1980s and the Dublin-Belfast upgrade in the mid-1990s, which was built upon to develop a PMC in the early 2000s. On the other hand, it may have led the delivery of capital projects in the early phase of the NDPs as 'project engineering' tasks, centred on engineering processes, rather than as projects requiring a full-scale 'project management' approach, centred on management processes. The latter approach predominated as PMC developed in IE during the 2000s.

5.2.4 PMC PROJECT DELIVERY CONTEXT PRE-2000

5.2.4.1 Organising Maintenance Projects

Before the NDP era, the approach to maintenance projects in IE centred around two project management offices (PMO), a Mechanical PMO (rolling stock) and an Infrastructure PMO (Trackwork, Signalling, General Works). The PMOs were separate from the operational divisions of IE and were dedicated to delivering maintenance projects and intermittent capital projects. This PMO organisational arrangement had co-developed to perform routine maintenance projects in support of IE's operational capability of running a nationwide train service - its 'core competence'.

[37] IE interview No. 15, Mar 2010
[38] IE interview No. 30, Jul 2011
[39] IE interview No. 12, Feb 2010
[40] IE interview No. 13, Mar 2010
[41] DART - Dublin Area Rapid Transport, the over-ground commuter rail network serving Dublin and surrounding areas.

5.2.4.2 Organising Capital Projects

The DART project in the early 1980s was the largest infrastructure project in IE's history at that time with a budget of IR£87m/€110m, or approximately €450m in 2010 prices.[42] The project management of the DART project was undertaken by IE staff and the project team members were drawn from IE staff who worked either part-time or full-time on each of the different modules comprising the project. This approach was "the nearest thing you get to a project team"[43], rather than an integrated PMO, and consisted of a distributed project team with two layers, an inner full-time core with an outer part-time periphery. More recently, in the mid 1990s, the Dublin to Belfast line was upgraded (c. €20m) through a joint collaboration between IE and Northern Ireland Railways (NIR), with each company responsible for the work on their own side of the border. This project was important in building confidence among IE management to deliver capital projects on this scale, as remarked: "we knew, once we could do that [project], we could do anything"[44].

Therefore, before the start of the NDPs in 2000, IE had developed a pre-existing organisational capability for the ongoing maintenance of its locomotives and track network, in addition to episodic experiences of delivering major capital infrastructure projects. After the completion of these intermittent capital projects, the IE project team members were redeployed within the company, including IE's diverse Maintenance function, where the newly acquired PM expertise could be utilised.[45]

5.2.5 PMC CATALYST EVENTS

Knockcroghery Derailment

In late 1997, a train derailment occurred at Knockcroghery, Co. Roscommon, and, although there were no fatalities, subsequent investigations into the circumstances of the derailment identified that much of IE's rail network needed upgrading to meet modern operating standards. Therefore, arising out of this derailment incident and related inquiries, the government committed itself to three 5-year plans[46] to renew the rail network to meet safety standards for normal operating conditions. This represented a substantial investment

[42] CSO, Consumer Price Index annual % changes 1980 – 2010
www.cso.ie/statistics/conpriceindex.htm (accessed 24-Oct-2011)
[43] IE interview No. 16, Jul 2010
[44] IE interview No. 12, Feb 2010
[45] IE interview No. 16, Jul 2010
[46] IE Track Safety & Renewal Programmes (5-year): 1999-2003; 2004-2008; 2009-2013

commitment by the government[47] of approximately €100m annually, or €1.5bn over three 5-year plans, around which IE could develop an organisational competence to deliver capital projects related to the renewal of the track network.

Mini-CTC Project

In the mid-1990s, the Mini-CTC (Central Traffic Control) project was initiated to upgrade the signalling system on certain intercity rail lines. Because of the scale of the project (c. €19m)[48] and the demanding timescales, IE decided on a strategy of out-sourcing the project to an external contractor on a 'design and build' basis. The out-sourcing experience with this large capital project was considered unsatisfactory, due partly to interface issues between the new and existing signalling systems, and, eventually, the project was taken in-house and delivered by internal resources. In effect, the out-sourcing experience acted as a "catalyst"[49] for IE to reconfigure its internal resource base to develop a PMC for the delivery of capital projects that was based on the experience of existing staff.

Heuston Redevelopment Project

Between 2001 and 2004, IE undertook the Heuston Redevelopment Project (HRP)[50] with a budget of €117m, which was the largest NDP project undertaken by IE at that time. Although the project scope was delivered on time and under budget, the genesis of the project was fragmented. The IE Board approval process that underpinned the project scope consisted of five separate Board approvals over three years, 1999 to 2001, rather than a single Board approval consistent with a finalised project scope from the outset of a project.

Both the Mini-CTC (c. €19m) and the HRP (€117m) projects seemed to highlight the need for improvements in key front-end PM activities, such as project scope definition and planning,[51] in addition to interface issues between external contractors and the 'live' railway. Prior to the 2000s, when railway works were delivered using IE's internal resources over longer timescales, interface issues did not arise to the same extent, because projects were designed and built concurrently, design-cum-build, rather than sequentially, design-then-build. In this way, the localised expertise of project stakeholders, which is normally not fully documented, could be accessed more easily during the concurrent design and delivery of the projects.

[47] Initially with EU funding support
[48] Circa £15m pre-euro
[49] IE interview No. 12, Feb 2010
[50] Hueston Station is one of Dublin's largest train stations serving commuter and inter-city routes.
[51] IE interview No. 18, Aug 2010

5.3 PMC DEVELOPMENT - PRACTICE & LEARNING

This section outlines the practice and learning involved in PMC development in IE as a case study organisation.

5.3.1 THEORY & PRACTICE

In IE, PM expertise is considered to be related to project team members practising their existing expertise, and gaining new expertise, in specific project situations supported by PM procedures, rather than the other way around.[52,53] In other words, PM is regarded as an experience-led team practice that revolves around problem-solving, which is supported by documented procedures and rooted in shared project delivery experiences, rather than a procedure-led activity. In this practice domain, project delivery revolves around problem-solving, or creating and utilising knowledge, which involves searching for solutions, sharing ideas, synthesising solutions, and disseminating expertise to other projects. While documented procedures inform practice, the experienced practitioner often refines and embellishes the practice of the procedure beyond the basic requirements of the procedure.

5.3.2 GOAL-DIRECTED PROBLEM-SOLVING

5.3.2.1 Problem-Solving in Projects

Delivering projects involves the integration of dispersed knowledge that is embodied in the extended project team, including direct team members, indirect team members, contractors, and other stakeholders. The project problem-solving process typically involves several phases, such as searching for potential problem solutions, sharing ideas, integrating new ideas and solutions, and disseminating newly acquired expertise to where it is needed. Nor is it a linear sequential process but a dynamic and iterative process that is grounded in a team practice that is being enacted as the project is delivered, as remarked:

> And having, then, the ability to articulate that clearly, produce a few sketches, come back to the design team and, you know, the option for the design is there - 'Would it also work there? I think it would. Fine, that's what we'll do!'[54]

[52] IE interview No. 15, Mar 2010
[53] IE interview No. 12, Feb 2010
[54] IE interview No. 13, Mar 2010

5.3.2.2 Organisational Forms for Projects

The knowledge creation and utilisation process on projects draws on the prior knowledge of the project team members but, because PMOs in IE were temporary organisations, gaining access to and harnessing the prior knowledge of team members was more challenging than in stable organisational settings. During the 2000s, capital projects in IE were delivered through PMOs, which were comprised of an inner core of semi-permanent project team members and a periphery of transient team members, like concentric circles.[55] These PMOs embodied a localised approach to team practice, learning, and innovation, where the creativity of project team members was harnessed to successfully deliver capital projects and, in the process, advanced the development of IE's PMC. Without a project team environment that promoted mutual support and trust, it is difficult to imagine this kind of problem-solving-led process of knowledge creation and utilisation being sustained over a multi-annual project life cycle.

5.3.2.3 Human Resources for Projects

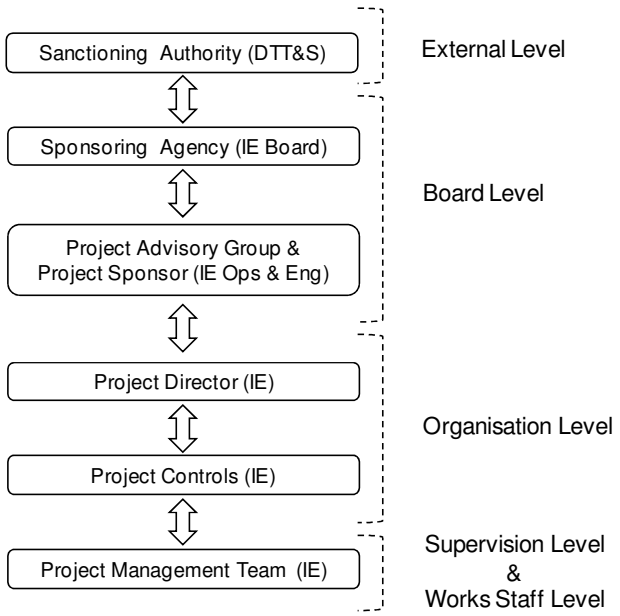
Projects are not for everyone! Because of their one-off nature, they represent a journey of exploration and discovery that requires dynamic problem-solving involving multiple stakeholders over the project life cycle, where no two days on the project may be the same. It is not an environment of repeatable routines, even though specific routines are often deployed to deliver the goals of the project. Above all, project environments are hotbeds of problem-solving that create and utilise new knowledge by solving old problems in new ways and new problems in novel ways, which are not always documented in procedures. This requires project team members with a willingness to learn and to continuously learn in a supportive teamwork environment.[56,57] In a nutshell, PM involves innovation and this is facilitated by project team members with a disposition for innovating.[58]

5.3.3 PMC DEVELOPMENT LEVELS - PMC ECOLOGY

The development of a PMC in IE during the 2000s occurred at four interrelated levels in the organisation - at project board level, at project organisation level, at project supervision level, and at project works staff level, Fig. 5.1. Externally, a PMC also developed during the

[55] IE interview No. 7, Jul 2008
[56] IE interview No. 24, Apr 2011
[57] IE interview No. 13, Mar 2010
[58] IE interview No. 31, Jul 2011

2000s in the government's Department of Finance (DoF), which was influenced by EU and international developments in the way capital projects are delivered in the public sector arena. In turn, the DoF influenced all organisations across the public sector. Overall, this represented a PMC ecology of five interrelated levels of PMC development.



(Source: This Study)

Fig. 5.1 IE Project Governance & PMC Ecology

Generically, the development of a PMC in IE revolved around the over-riding goal of successfully delivering capital projects and, thus, the cumulative development of PMC resulted from recursive cycles of goals, practice, and learning. This goal-directed development process took place over the life cycle of hundreds of capital projects that were successfully delivered during the 2000s, which involved setting project goals, formulating plans, implementation, and the normalisation of PM processes.

5.3.3.1 PMC External Level

At external level, the development of IE's PMC was linked to the development of an over-arching PMC at public sector policy level in the Department of Finance (DoF). Because of its position at the heart of government and the backing it received from government, the DoF's PMC would influence the methodology for delivering capital projects in all other government departments, government agencies, local authorities, and semi-state organisations such as IE. The DoF's PMC was developed through a combination of goal

alignment with government and EU objectives, drafting a framework for delivering capital projects, publishing a capital works framework with associated guidance notes, and monitoring for compliance through parliamentary committees and other means.

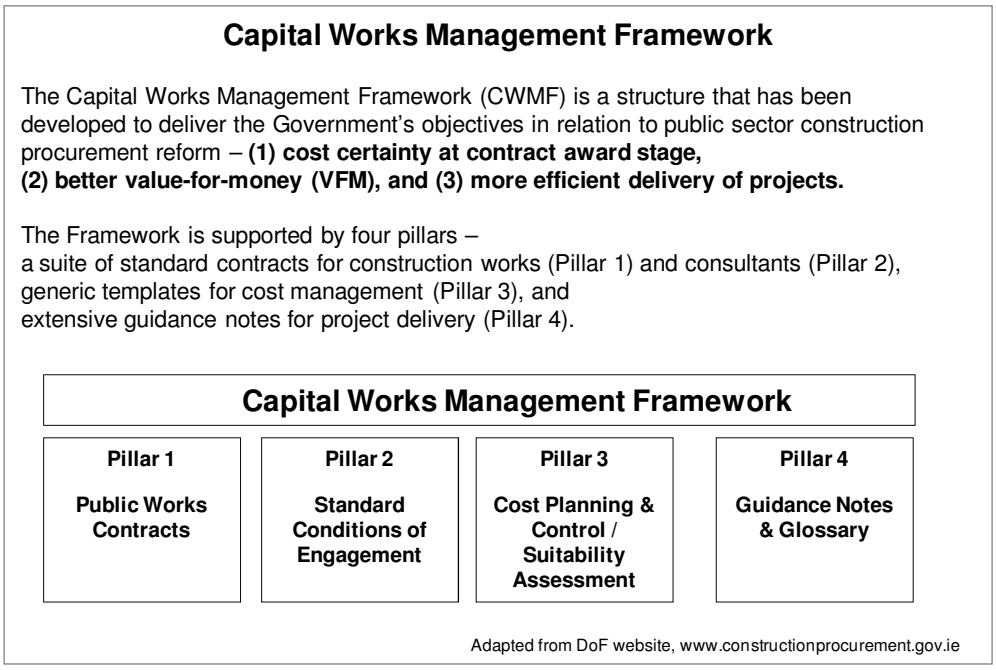


Fig. 5.2 Dept. of Finance - Capital Works Management Framework (CWMF)

In 2004,[59] the government focused the reform process for the procurement of public sector capital projects around the principles of efficiency and effectiveness, which included the three main objectives of (1) cost certainty at contract award stage, (2) better value-for-money (VFM), and (3) more efficient delivery of projects. This was a key government decision that would lead on to the publication by the DoF in 2009 of a 'Capital Works Management Framework' (CWMF) for the delivery of capital projects, which included 'fixed-price lump-sum' contract templates (GCCC)[60] for consultancy services and construction works, Fig. 5.2. In addition, the CWMF included a comprehensive suite of Guidance Notes (GN) for the implementation of the various elements of the CWMF. The CWMF was a new departure at public sector policy level, because the DoF was now focused in considerable detail on the process of project delivery itself in addition to the traditional financial appraisal of capital projects.

[59] Government cabinet decision S29837, 04-May-2004
[60] Government Construction Contracts Committee (GCCC)

5.3.3.2 PMC Board Level

At project board level, IE's PMC was evident in the pursuit of project goals through the different levels of the governance structure in alignment with the NDP objectives of the Dept. of Transport, Tourism, and Sport (DTT&S), Fig. 5.1. The positive contribution of the Advisory Groups was widely recognised in IE and this contribution grew during the 2000s, as the Advisory Groups devised, reviewed, and regularised enhanced reporting information for capital projects during the 2000s to achieve IE's overall goals for capital projects. In 2003, the relevant Advisory Group decided to bring the DART Upgrade project (€175m) in-house and complete the delivery using an internal IE project management team. This bias for action at a high level in the project governance structure permeated all levels of the extended project team and provided a process dynamic for the ongoing development of IE's PMC. This was reflected in the additional levels of information on the progress of the project over its remaining project life cycle that were devised and implemented by the Advisory Group. The revised reporting requirements then became regularised for subsequent capital projects.

The experience of the DART Upgrade project enhanced the role of the Advisory Groups and project governance in general. Through the agency of several Advisory Groups, external managerial experience was brought to bear on the execution of IE's major capital projects to validate and, where necessary, enhance the development of IE's PMC.[61] The Advisory Groups, as a crucial part of IE's project governance structure for major capital projects, also served as conduits for the dissemination of expertise from external organisations to IE and from the private sector to the public sector, depending on the composition of the Advisory Group. Project management expertise at this level was largely based on the opinion and judgement of senior figures from respected organisations in both the public and private sectors against which the Board of IE sought to benchmark the delivery performance of its capital projects. In effect, this dissemination of expertise took place from the external level to IE and, at the same time, from the external level to the project, the latter facilitated by the participation of the project managers of the major capital projects at the meetings of their respective Advisory Group.

[61] IE interview No. 13, Mar 2010

5.3.3.3 PMC Organisational Level

At project organisational level, the development of IE's PMC was greatly facilitated by the multi-annual funding horizon of the NDPs,[62] because the PMC development process at this level needed to follow a more continuous trajectory than the punctuated trajectory at the levels of project governance and the project external level. At organisational level, IE's PMC was manifest in defining and delivering the '3-pillar' project goals of scope, budget, and timescale for all capital projects during the 2000s.[63] This was achieved by configuring the PMOs on an ongoing basis to support the delivery of projects, by combining projects into programmes of projects, and by transferring the newly acquired PMC expertise to other projects where it was needed. In effect, developing a PMC in IE revolved around the management of the dimensions and processes that supported the achievement of IE's set of generic project goals, as remarked: "it all came down to those 3-pillars [scope, budget, timescale] … if you got those three right, you were delivering!"[64]

Throughout the 2000s, IE espoused an organisational learning approach that was based on conventional techniques that focused on codified information, such as documented procedures, 'lessons learned' workshops, etc. In tandem with this and in order to keep pace with the demands of the NDPs, it also pursued an organisational design approach to develop its PMC that was based on the undocumented experience-based knowledge of key PM personnel that was manifest in their methodology for delivering capital projects. This may be called an 'experience-led approach' to project management organisation design and involved changing the organisation "in line with the expertise that is available to us"[65], usually project managers with proven ability, rather than recruiting personnel to fill a pre-designed organisational chart. This 'experience-led approach' offered IE an alternative approach to the traditional 'function-led approach' to organisational design that is frequently found in mainstream textbooks. Thus, from 2000 to date, the PMOs were continuously reconfigured around a mixture of 'function' and 'experience', externally and internally, in order to develop its PMC to deliver ever larger projects and higher volumes of projects during the 2000s – small, medium, large, and major projects. Externally, the two PMOs that existed in IE in 2000 had metamorphosed into five 'function-cum-experience' PMOs by 2006 and, within each PMO, internal organisational arrangements also revolved around a mixture of 'function' and 'experience'.

[62] IE interview No. 15, Mar 2010
[63] IE interview No. 14, Mar 2010
[64] IE interview No. 19, Aug 2010
[65] IE interview No. 14, Mar 2010

PMC Knowledge Aspects

There was an ongoing desire to utilise the PMC expertise on other projects but a sanguine recognition that the dissemination of PMC expertise was problematic, because the PMC expertise was gained from experience supported by documented procedures and was embodied in those who had participated in specific project delivery experiences. Without an organisational learning approach that took account of the experience-based nature of PMC expertise, IE would find itself "reinventing the wheel"[66] for ongoing projects.[67] This problem of accessing and documenting organisational knowledge based on experience was also observed in relation to maintaining IE's engineering infrastructure by an informant after a conversation with colleagues about a proposed technical change, as remarked:

> [I]t occurred to me that the conversation we had was based mainly on our experiences. /.../ And we discussed the implications of doing something and I realised, afterwards, [that] I don't think there's a manual in the country that it would be written in.[68]

Internally, after the completion of major projects, IE undertook 'lessons learned' workshops in order to capture and disseminate PMC expertise that would be useful on other projects. However, the circulation of the reports arising from these workshops and the dissemination of the newly acquired organisational information was informal.[69,70,71,72] Interestingly, there was also recognition by some management that part of the difficulty in disseminating organisational expertise relating to PMC was due to the limitations of the 'lessons learned' process in documenting techniques that were learned in a practice setting and acquired by experience supported by documented procedures, rather than *vice versa*. It seemed that IE's PMC was practice-led rather than theory-led, although each needed the other. Both informational knowledge from procedures and practice knowledge from experience seemed to be integral to IE's new PMC expertise but part of this new expertise resided in "people's heads"[73] beyond the reach of the documented 'lessons learned' workshops.

After the successful delivery of the DART Upgrade project (€175m), IE documented the lessons learned from the civil construction works and incorporated these lessons into the executed legal contracts that were negotiated for civil works on the subsequent Kildare Route Project (€357m).[74,75] What used to be a single volume legal contract now became two

[66] IE interview No. 24, Apr 2011
[67] IE interview No. 14, Mar 2010
[68] IE interview No. 31, Jul 2011
[69] IE interview No. 9, Jul 2008
[70] IE interview No. 13, Mar 2010
[71] IE interview No. 3, May 2008
[72] IE interview No. 4, May 2008
[73] IE interview No. 13, Mar 2010
[74] IE interview No. 25, May 2011
[75] IE interview No. 27, Jun 2011

volumes and the new Volume-2 covered contract administration areas, including safety, environment, handover documentation, communications, change control, track possessions, construction strategy, planning, temporary works, quality assurance, industrial relations, and railway order commitments. Previously, these contract administration processes were largely undocumented and often gave rise to disagreements with external contractors, as IE staff sought to follow them on a 'taken for granted' basis.

5.3.3.4 PMC Project Level (Supervision)

At project level, the development of IE's PMC took place within and between IE's PMOs over the project life cycles of hundreds of capital projects that were successfully delivered during the 2000s, Fig. 5.3. While projects under €50m accounted for 98% of all projects undertaken by number, they only represented 44% of the overall expenditure on projects. Projects over €50m, while small numerically at twelve (2%), accounted for 56% of the overall spend on capital projects in IE. Thus, IE's PMC spans a budget hierarchy from small projects (< €2m) to medium projects (€2m to €50m) to large projects (€50m to €100m) to major projects (>€100m). Although not included in Fig. 5.3, IE has developed a detailed feasibility proposal for the DART Underground Interconnector Project, circa €2.5bn.

Proj. Scale	Budget	Qty.	%	Cum %	€'m	%	Cum %
Small	under €2m	403	76.3%		€204	8.5%	
Medium	€2m to €50m	113	21.4%	98%	€847	35.4%	44%
Large	€50m to €100m	7	1.3%		€428	17.9%	
Major	over €100m	5	0.9%	2%	€915	38.2%	56%
		528	**100%**	**100%**	**€2,395**	**100%**	**100%**

(Source: This Study)

Fig. 5.3 IE Capital Projects 1999 to 2008 - Quantity & Budget (copy Fig. 1.1)

Delivering capital projects on such a scale during the 2000s involved the essential PM process activities of goal-setting, planning, execution, and closure and handover. These processes were enacted by the project team over the project life cycle as a whole and within each phase of the project life cycle. Therefore, almost every aspect of PM over the project life cycle involves mini-cycles of goals, plans, execution, and closure and every such mini-cycle is referenced to the priority at hand and that of the phase of the project life cycle, e.g., feasibility, design, execution, handover. Of course, at project level, this project-based

heuristic of goals, plan, execute, and closure appears in many forms and is often abbreviated as 'plan-then-execute'. In the case of trackwork projects, the informant who was responsible for delivering these projects described his methodology around "survey, design, plan, and implement".[76] In this scenario, the process activities of goal-setting and handover were implicit and the process activity of planning was expanded to include surveying and designing as precursors to the planning process proper.

In the Construction Unit (CU) PMO, the process of project planning using up-to-date planning software[77] was a key aspect of the way project goals were delivered, which was driven by the CU Programme Manager and embraced by other core CU team members over time, who realised its benefits for achieving project goals. Once adopted by the project team as an essential piece of the architecture of PM, the project plan becomes the reference, both seen and unseen, for guiding the delivery of the project over its life cycle for the benefit of its stakeholders. Moreover, the successful adoption of a planning process approach requires its collective adoption by the project team members, because of its pervasive effects on all aspects of project delivery, especially during the project execution phase.[78,79,80]

PMC Knowledge Aspects

At project level as well as at organisation level, IE's PMC was implicitly recognised as a team practice that needed to exercise collective judgement in applying design standards, or changing such standards, all of which were difficult to capture in documented procedures, as remarked:[81]

> [W]hen standards were pretty new in the system, you just referred to the people who originally developed the standards, because they had the reasoning and thought process 'why things were done'. What we lose out, or what's not being captured, is the reasoning why things are done in certain ways, because you need that reasoning to be able to make decisions to change standards.

If this resonates with the age-old difficulty of 'specifying a rule to follow a rule',[82] the same informant had found a practical solution to this problem from his long experience as a project manager. He understood that expertise is embodied in the wider project team and that a single team member's expertise was part of this collective body of knowledge, theory and practice, to which all team members had access. According to this view, the newly acquired PMC during the 2000s was embodied in people *as well as* codified in documented procedures, rather than in one *or* the other. In other words, it was a case of knowledgeability involving 'both-and' rather than 'either-or'. Unsurprisingly, when the PMOs in IE were

[76] IE interview No. 28, Jun 2011
[77] MS Project etc.
[78] IE interview No. 9, Jul 2008
[79] IE interview No. 27, Jun 2011
[80] IE interview No. 34, Jul 2011
[81] IE interview No. 17, Aug 2010
[82] Aristotle, Kant, Wittgenstein

reconfigured during the 2000s and project managers moved to another PMO, or project, it was common practice for project managers to try to bring their core team with them.[83]

5.3.3.5 PMC Project Level (Works Staff)

For delivering capital projects in IE, the project supervisory staff and the internal and external works staff form an extended team during the execution phase of the project life cycle. The approach to project tasks is similar within this extended team and is one based on goal-setting, planning tasks, executing tasks, and closing-out the task. As previously mentioned, this heuristic comes in many guises, e.g., "survey, design, plan, and implement"[84], which assumes the project goals and close-out elements as taken-for-granted. Within the extended team, the time horizon of project tasks may be shorter for works staff and longer for supervisory staff, because of different planning perspectives.

PMC Knowledge Aspects

Before the 2000s, the approach to training works staff in IE was based around 'on-the-job' training, where new personnel were given initial basic training in IE's Training Centre and, "learned then from his fellow workmates"[85]. This was an improvement on the 1970s, when there was little off-line basic training and, as a new recruit, "[y]ou went straight out, you were probably in with a gang and you learned from them".[86] With this experience-led approach, the works ganger played a key role in the training of new recruits and the development of all the works personnel under his supervision. Before and during the 2000s, the works gang and ganger has remained a constant organisational unit in IE,[87] much like a close-knit community but one that transcends the workplace, e.g., attending family social events of group members.[88] This close-knit network of works gangs and gangers facilitates the timely dissemination of information regarding new tools and techniques that are developed in IE.[89]

During the 2000s, the training of works staff changed to an approach based on certified competencies, which combines theory and practice.[90,91] For long-service works staff with little previous off-line training, the catch-up phase of the certification process involved, in part, reviewing documentation relating to processes in respect of which they were already

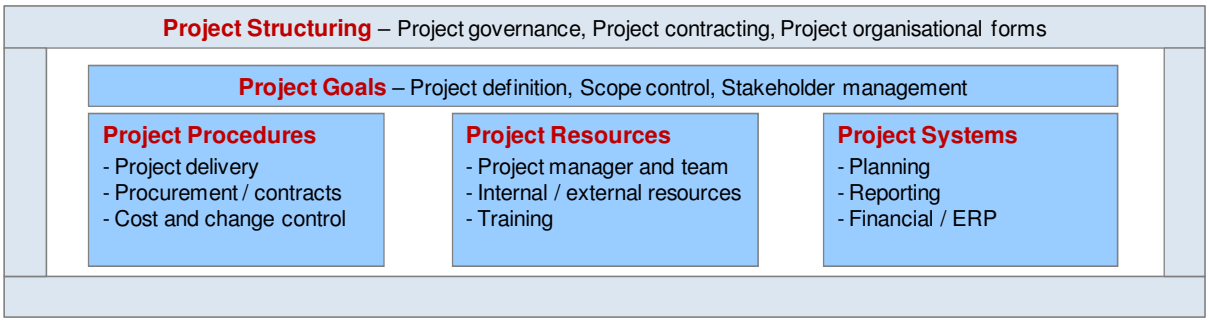
[83] IE interview No. 13, Mar 2010
[84] IE interview No. 28, Jun 2011
[85] IE interview No. 33, Jul 2011
[86] IE interview No. 33, Jul 2011
[87] IE interview No. 29, Jul 2011
[88] IE interview No. 33, Jul 2011
[89] IE interview No. 33, Jul 2011
[90] IE interview No. 28, Jun 2011
[91] IE interview No. 29, Jul 2011

proficient, if not expert.[92] Within this current framework, training in safety techniques is paramount. Despite the welcome emphasis on formal training methods, experienced personnel from the 1970s still appreciate that a balanced combination between off-line training and experience is essential[93]

5.4 PMC DIMENSIONS

This section outlines the dimensions of PMC development in IE as a case study organisation. Even though IE's PMC was an emergent organisational capability during the 2000s, nevertheless, there was a high-level roadmap which informed the development trajectory that was followed during the 2000s. In essence, this focused on developing an architecture for PMC to support the '3-pillar' project goals of scope, budget, and timescale with PMC dimensions consisting of organisational structures, procedures, resources, and systems, Fig. 5.4, as remarked:

> So, at the centre you had the 3-pillars [project goals - scope, budget, and timescale] and, then, it was how we brought about improvements to those and it was based on the procedures, systems, people, and, then, the organisational structure ... [as] the surrounding envelope.[94]



(Source: This Study)

Fig. 5.4 IE PMC Dimensions - Goals, Structures, Procedures, Resources, & Systems

[92] IE interview No. 29, Jul 2011
[93] IE interview No. 33, Jul 2011
[94] IE interview No. 19, Aug 2010

5.4.1 PROJECT GOALS

5.4.1.1 Project Definition

The period of continuous NDPs, 2000 to 2013, with its commitment to multi-annual funding, provided the backdrop for IE to plan the implementation of capital projects to upgrade the railway. Before projects were undertaken, it was essential to establish the goals and objectives for projects and, after projects were commenced, it was important to ensure that the original goals and objectives were implemented and not subject to 'scope creep' (additions) or 'scope drift' (substitutions and deletions)[95,96,97] that was better deferred for incorporation in follow-on projects.[98] The main project goals that were measureable revolved around the "3-pillars of scope, budget, and timescale"[99]. There was an additional fourth pillar of quality,[100] which transcended the fundamental '3-pillar' project goals as an intrinsic dimension of scope, budget, and timescale, Fig. 5.5. Although quality was less amenable to direct quantification than scope, cost, and timescale, nevertheless, it was very significant over the economic life of the project and a key deliverable for IE's internal clients, who were focused on the project's fitness-for-purpose in commercial operation after project handover.[101,102]

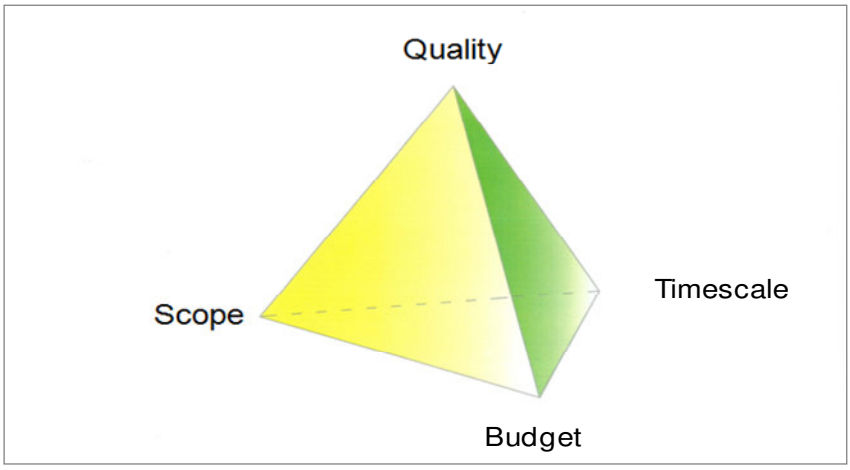


Fig. 5.5 3-Pillar Project Goals - Scope, Budget, and Timescale

[95] IE interview No. 16, Jul 2010
[96] IE interview No. 19, Aug 2010
[97] IE interview No. 18, Aug 2010
[98] IE interview No. 14, Mar 2010
[99] IE interview No. 19, Aug 2010
[100] IE interview No. 19, Aug 2010
[101] IE interview No. 19, Aug 2010
[102] IE interview No. 3, May 2008

Establishing deliverable objectives with client customers is a well-known problem in many professions, not least in PM, where large projects can be technically complex with multi-annual project life cycles. In many cases, client customers seek solutions to problems but are unable to specify in detail either the problem or the solution - like going to a doctor with a malady but only being able to offer a vague description of the symptoms. Therefore, a key role of the project manager at the beginning of a project is to generate a project scope in consultation with the client customer that elucidates problems and solutions that were, up to then, partly hidden from view. As remarked by a project manager: "As project manager ... you have to extract from the client in the company 'what they want' ".[103] In addition, clarifying the project specification for contractors serves to mitigate potential legal disputes.[104]

5.4.1.2 Scope Control

Recognising the need for formal scope setting and control throughout the project life cycle, IE adopted a process based on a documented Customer Requirements Specifications (CRS), which was periodically reviewed within an overall multi-level review process at project level, organisation level, and government level. Despite the existence of an agreed CRS between the project team and the internal client customers, mismatches often occurred between the project goals and the expectations of the internal clients. This often led to attempts by the internal client customers to change the scope of the project as they began to realise the mismatch between the project goals and their business requirements. However, to achieve the project goals, it was important to maintain the integrity of the project scope and endeavour to manage stakeholder expectations by other means.[105,106] However, even documenting an agreed CRS with the IE internal client customer was no guarantee of success either, because, unless the client has a good technical perspective "you really don't realise what you're getting till you get it"[107].

5.4.1.3 Stakeholder Management

It is only since 2000, with the roll-out of the NDPs, that capital projects on a continuous scale became prevalent in IE. Prior to this, the traditional priorities for management in Operations were timetable compliance, industrial relations, cost reductions, and health and safety. During the early 2000s, maintaining the continual involvement of internal client customers, such as Operations and Maintenance, during the delivery of capital projects was

[103] IE interview No. 10, May 2009
[104] IE interview No. 1, May 2008
[105] IE interview No. 14, Mar 2010
[106] IE interview No. 26, May 2011
[107] IE interview No. 12, Feb 2010

on ongoing challenge for project teams and one that was key to successful project outcomes.[108] This was partly due to scepticism and a lack of technical expertise on the part of Operations at the start of the NDPs coupled with the autonomy of professional groups within an organisation with a traditional functional design.[109,110,111] However, it was acknowledged that Operator involvement has improved during the NDP era from 2000-2013 and greatly benefits the alignment of expectations during the project life cycle, from feasibility stage through to handover stage.

5.4.2 PROJECT STRUCTURING

5.4.2.1 Project Governance

During the 2000s, such was the volume of large capital projects being delivered by IE that various Advisory Groups were established to "vet and monitor"[112] the delivery of large capital infrastructure projects on behalf of the IE Board. In effect, they were sub-committees of the IE Board and represented an intermediate layer between IE senior management and the IE Board itself, Fig. 5.6. The composition of the Advisory Groups was drawn from senior IE management personnel, including the PMOs, and external personnel with expertise from the private sector, "who were very senior managers in outside industries"[113].

[108] IE interview No. 10, May 2009
[109] IE interview No. 15, Mar 2010
[110] IE interview No. 13, Mar 2010
[111] IE interview No. 5, Jul 2008
[112] IE interview No. 18, Aug 2010
[113] IE interview No. 13, Mar 2010

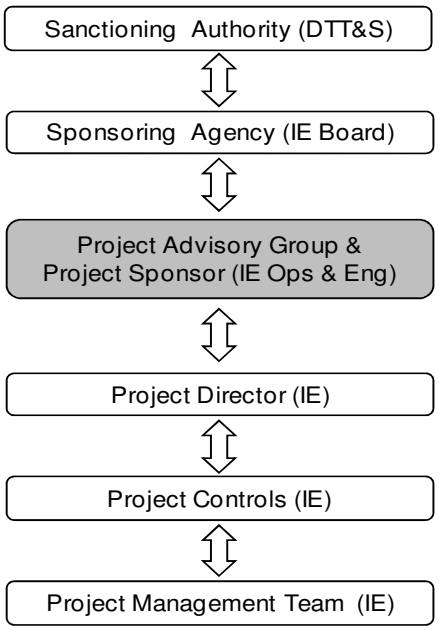


Fig. 5.6 IE Project Governance - Capital Projects

5.4.2.2 Contracting

With the start of the NDPs in 2000, IE embraced the opportunity to upgrade the railway and this approach had the full support of senior management. Moreover, IE had very good rapport with the then Dept. of Transport (DoT)[114] and EU funding agencies through the Dept. of Finance (DoF). However, because of the magnitude of the initial NDP investment levels and the demanding timescales, IE pursued a combination approach that involved building an internal PMC, by increasing its resource base, and, in addition, out-sourcing the project management of specific large and major capital projects. However, initially, IE had unsatisfactory experiences with the out-sourcing of two large capital projects, or significant modules therein, and, while each unsatisfactory experience was different in its own way,[115] a common feature was the difficulty of integrating the new project with the existing railway infrastructure.[116] Successful integration relies much on localised expertise in IE, which is embodied in the collective experience of IE's staff and is knowledge that is largely informal, personalised, and not fully documented. If the outsourcing experience at the start of the 2000s had been more favourable, it may have led IE to continue out-sourcing the project management of capital projects. This would have led IE to develop a PMC to coordinate

[114] Since 2011, the Department of Transport, Tourism, and Sport (DTT&S)
[115] "All happy families resemble one another but each unhappy family is unhappy in its own way." Leo Tolstoy, Anna Karenina, Part 1, Ch. 1, opening line.
[116] Cf. Section 'PMC Catalyst Events'

external project managers rather than a full-service internal PMC that could project manage major capital projects from start to finish.[117] One key lesson learned from these experiences was that it was unrealistic to out-source large capital projects, because in-house PM expertise was needed to manage such projects, especially in respect of the localised expertise for integrating a new project with the existing railway infrastructure.[118]

Over time, three main variations emerged regarding the involvement of external consultants in PM responsibilities, two of which led to the development of a full-scale PMC in IE in tandem with the co-development of the PMOs. In short, these were: (1) a consultant-led approach, where the consultants had design and build responsibility – poor results; (2) a consultant sub-contract approach, where consultants were responsible for specific work deliverables - acceptable results; and (3) an in-house PMC approach "supported by consultants but fairly strongly not driven by consultants"[119], either on site or remotely - better results. An additional underlying reason for the adoption of this approach towards external consultants was the perceived lack of ownership, and hence accountability, on the part of consultants towards the achievement of project goals to the satisfaction of IE's project sponsors.[120,121]

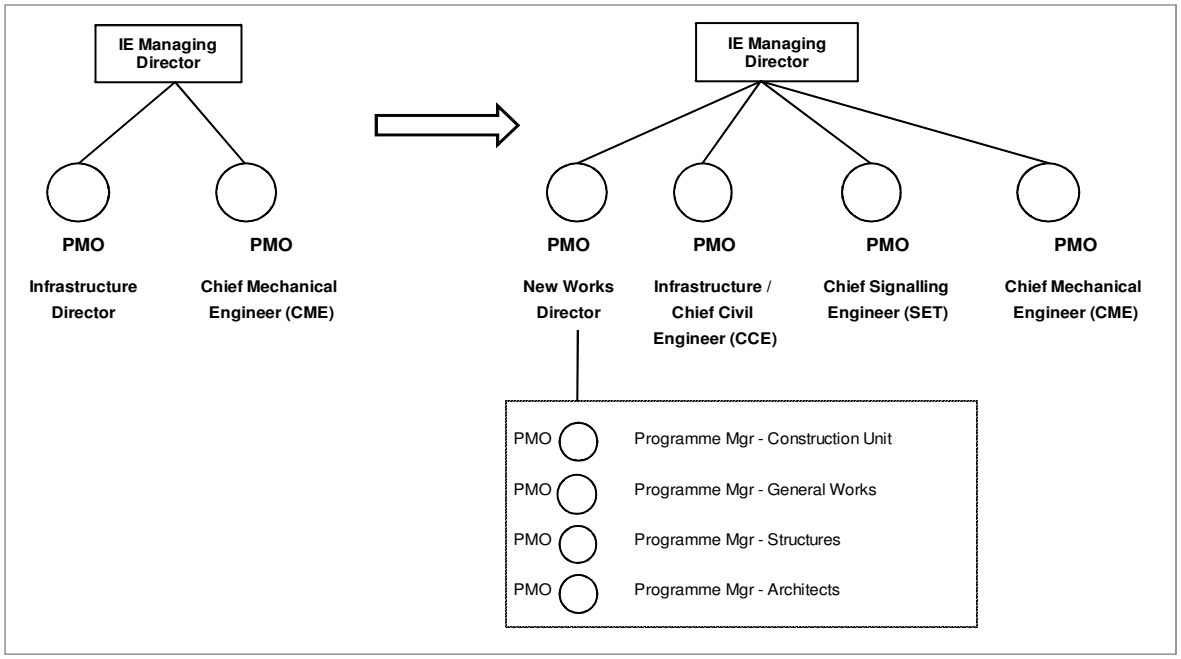
5.4.2.3 Organisational Forms

In IE, maintenance projects are considered as non-capital, whereas asset renewal and new assets are considered as capital projects. Before the 2000s, the approach to maintenance and capital projects in IE was centred around two PMOs, the Chief Mechanical Engineer (CME) (rolling stock) and Infrastructure (civils, track, signalling). These were separate from the operational divisions of IE and were dedicated to delivering maintenance projects and occasional capital projects. The two PMOs had co-developed with IE's operational capability to perform maintenance projects in support of its main core competence of running a nationwide train service.

IE responded pro-actively to the opportunity afforded by the NDPs to upgrade the railway network, both fixed infrastructure and rolling stock. In early 2001, the organisational arrangements for delivering capital projects were reconfigured and this practice of continuously reconfiguring the organisation for delivering capital projects continued during the 2000s. The flexible approach to organisational design consisted of configuring

[117] IE interview No. 12, Feb 2010
[118] IE interview No. 15, Mar 2010
[119] IE interview No. 13, Mar 2010
[120] IE interview No. 10, May 2009
[121] IE interview No. 26, May 2011

organisational resources to deliver projects using an experience-led approach[122] rather than populating a pre-ordained organisation chart with personnel to match the chart.



(Source: This Study)

Fig. 5.7 IE Project Management Offices (PMO)

In 2001, the Infrastructure Division was reorganised into two divisions, or two PMOs: (1) New Works Division with responsibility for capital projects; and (2) Infrastructure Division with responsibility for non-capital track maintenance projects and the capital safety and renewal investment programmes, Fig. 5.7.[123] Later, in 2006, the signalling resources from these two PMOs were reconfigured into a third PMO (SET)[124] with responsibility for non-capital and capital SET projects. The PMO approach for delivering capital projects was in contrast to delivering projects either within functional units or using a matrix management approach that uses resources from multiple functional units. Within the New Works Division, the Construction Unit (CU) was set-up as a PMO with dedicated resources for the management of large and major projects, such as the Heuston Redevelopment Project. In effect, CU was a PMO within its parent PMO, New Works. From 2002 to date, CU has been responsible for delivering the three largest NDP projects in IE's recent history totalling €650m – Heuston Redevelopment Project (€117m) in 2003, DART Upgrade Project

[122] IE interview No. 14, Mar 2010
[123] IE Track Safety & Renewal Programmes (5-year)
[124] Signalling, Electrical, and Telecoms

(€175m) in 2006, and the ongoing Kildare Route Project (€357m), due for completion in 2012.

Thus, during the 2000s, the number of PMOs for capital projects increased from two PMOs in 2000 to four PMOs in 2006. Before the 2000s: (1) Infrastructure Division Chief Mechanical Engineer Division (CME) and (2) Chief Mechanical Engineer Division (CME). After a decade during the 2000s: (1) New Works Division, (2) Infrastructure Division, (3) Signalling, Electrical, and Telecoms Division (SET), and (4) Chief Mechanical Engineer Division (CME). Within New Works, there were a further four Programme Units, or PMOs, including Construction Unit (CU), Fig. 5.7.

Organisational Design

Interestingly, the ongoing organisational arrangements that co-developed with the PMC in IE were designed around function and available expertise[125] rather than the other way around, namely, designing an organisational capability with supporting organisational arrangements and, then, recruiting personnel to fill the organisation. By organising and reorganising the PMOs around the abilities of specific individuals, this reflected a high level of trust by senior management in the designated managers with responsibility for the PMOs and this led to a relatively high degree of autonomy for the project team in the PMOs. However, a disadvantage of this approach lies in the uneven development of PMC across the PMOs in IE, which may vary with the capability of the individual around which the PMO is organised.[126]

PMO Major Projects

The Heuston Redevelopment Project was the first major project under the NDPs that was delivered by CU using a dedicated PMO approach, which was generally acknowledged to be beneficial.[127] The skill-set in CU included project management, planning, quantity surveying, signalling, overhead line, sub-stations, civil engineering, architecture, Operations liaison, property, public relations, administration, and accounting. Having a cross-functional dedicated team that was working full-time on the project was very synergistic for the delivery of the project and yielded a range of benefits: common purpose and focus; minimum bureaucracy; speedy resolution of project issues; flexibility; professional development; enhanced communication; timely decision making; and team spirit – "We're in

[125] IE interview No. 14, Mar 2010
[126] IE interview No. 35, Oct 2011
[127] IE interview No. 5, Jul 2008

this together!"[128]. Being co-located as a project team also promoted easier and more frequent interactions between team members, so that "queries could be resolved quickly"[129]. Because of the one-off nature of capital projects, the size of CU expanded and contracted to match the project portfolio it was delivering. This flexible aspect of 'inner' and 'outer' cohorts of team members was a defining characteristic of the CU team and one that ensured continuity of its character, or "culture"[130].

5.4.3 PROJECT MANAGEMENT PROCEDURES

In the late 1990s, when it was apparent that IE was going to be engaged in delivering capital projects during the 2000s for many years to come, it was decided to introduce a set of PM procedures to act as a framework for delivering projects over the project life cycle that supported the achievement of the '3-pillar' project goals of scope, budget, and timescale.[131] In due course, a set of seven Project Management (PM) procedures were issued[132] with an over-arching first PM procedure (PM-001, Project Start-Up Procedure), "which was a general overview of the entire PM process from cradle to grave of a project".[133]

5.4.3.1 PM Procedures - 1999 to 2010

During this period, an initial set of seven PM procedures[134] were drafted and released. The process areas of PM that were covered included project set-up, project programming, cost control, work breakdown structure, value management, contract change control, and risk and contingency. At the same time, there was a system of monitored compliance to ensure that all capital projects above a minimum threshold[135] were compliant to the full requirements of the PM procedures. This was implemented through a centralised Project Controls office. Projects with budgets below this level were subject to a scaled version of the PM procedures. As the level of project activity increased during the 2000s, the responsibility for compliance was distributed among the Programme Managers, with senior management oversight, rather than through a centralised Project Controls office.

[128] IE interview No. 7, Jul 2008
[129] IE interview No. 8, Jul 2008
[130] IE interview No. 7, Jul 2008
[131] IE interview No. 19, Aug 2010
[132] Project Management (PM) procedures PM-001 to PM-007
[133] IE interview No. 19, Aug 2010
[134] Project Management (PM) procedures PM-001 to PM-007
[135] Circa €50,000

5.4.3.2 PM Procedures - 2010 to Date

After a decade of successfully delivering hundreds of capital projects during the 2000s, valued circa €3,000m excluding rolling stock, the current phase involves the updating and expansion of IE's original set of documented PM procedures from the late 1990s into a consolidated Project Management Framework (PMF), Fig. 5.8. This documents IE's PMC as a robust organisational capability and aligns the PMF with recent changes in public sector guidelines for delivering capital projects. This was organised around a PMF working group comprised of the CU Programme Mgr., this researcher, and two external consultants. One informant, an external consultant with experience of the rail sector and pharmaceutical sector, estimates that IE's PMF compares with the top 10% of either sector.[136]

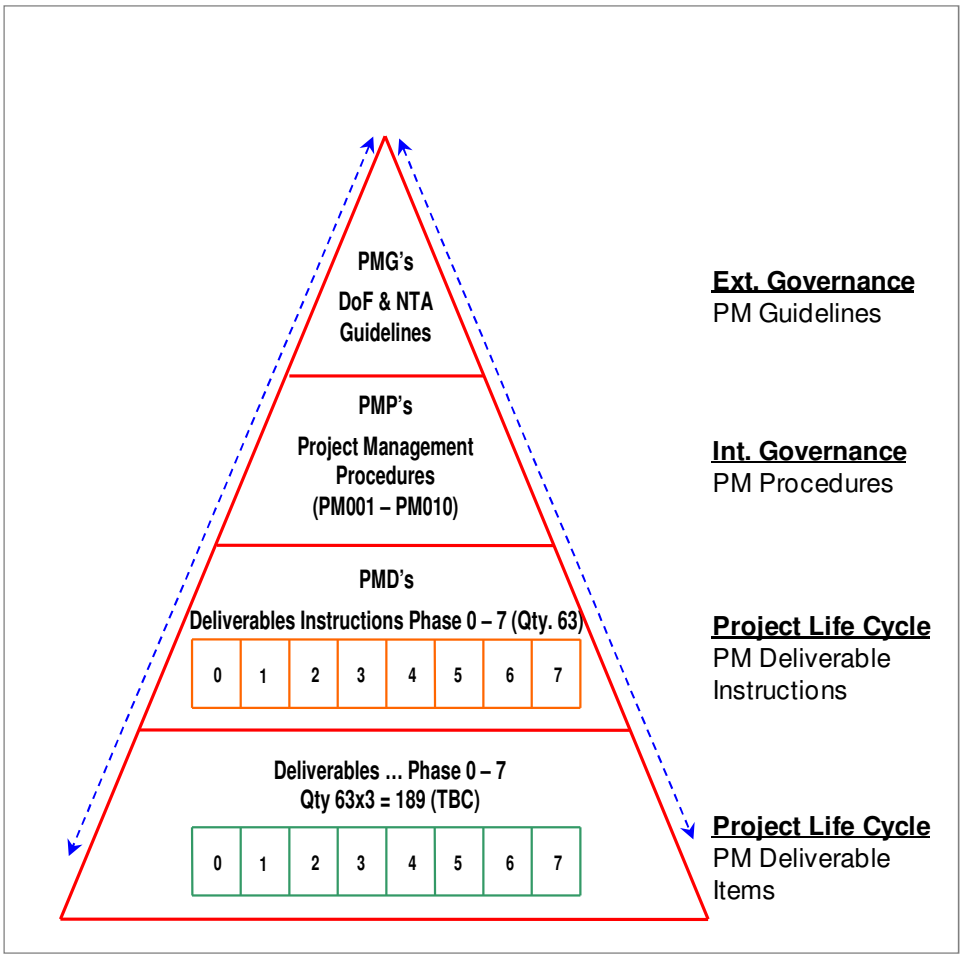


Fig. 5.8 IE Project Management Framework (PMF)

[136] IE interview No. 35, Oct 2011

As with the original set of PM procedures that were issued after 1999, the updated PMF process is characterised firstly as a governance framework to guide the delivery of capital projects over the project life cycle to achieve successful project outcomes, in terms of scope, budget, timescale, and quality. Secondly, the PMF is a strategic business process that will support the achievement of IE business goals into the future by synergising with other related strategic business processes, for example, lean management systems, supply chain management, and total quality management. Thirdly, the PMF is a knowledge management process that aims to foster the creation of project-related organisational knowledge and its dissemination for the achievement of personal and organisational goals through knowledge-based activities such as continuous improvement, lessons learned, and experience sharing. Analogous to an ISO-9000 Quality System,[137] the PMF process was conceptualised around four interrelated levels, which are briefly described in the following sections.

In parallel, other IE/CIE company-wide procedures were also under continual review, which impacted directly on the delivery of capital projects in IE, e.g., policies on procurement, legal, safety, and human resources. During the updating of the PM procedures for the PMF, a balance had to be achieved between, on one hand, the level of detail in the procedures, and, on the other hand, the level of discretion allowed to project team members in resolving unforeseen situations.[138] In addition, it is the management of the application of the PM procedures that really counts rather than their possession by the organisation and project team.[139]

Level 1: External Governance

Level-1 represents the external environment of IE as a commercial semi-state organisation delivering a national train service, which is subject to national and EU legislation in respect of company law, public procurement, safety, health, employee law, etc. Within this general external environment, IE also belongs to the set of PSOs, in common with all government departments, agencies, local authorities, agencies, and semi-state organisations, which, together, comprise the public sector arena.

Level 2: Internal Governance

At level-2 of the PMF, the original set of PM procedures that were issued by IE in the late 1999s were updated and expanded to reflect the maturity of IE's PMC and also for

[137] International Organization for Standardization, widely known as ISO, based in Switzerland
[138] IE interview No. 32, Jul 2011
[139] IE interview No. 35, Oct 2011

consistency with international references, such as PMBoK (PMI)[140] and PMBoK (APM)[141]. This led to additional PM procedures for new knowledge areas under the PMF framework, Fig. 5.9.

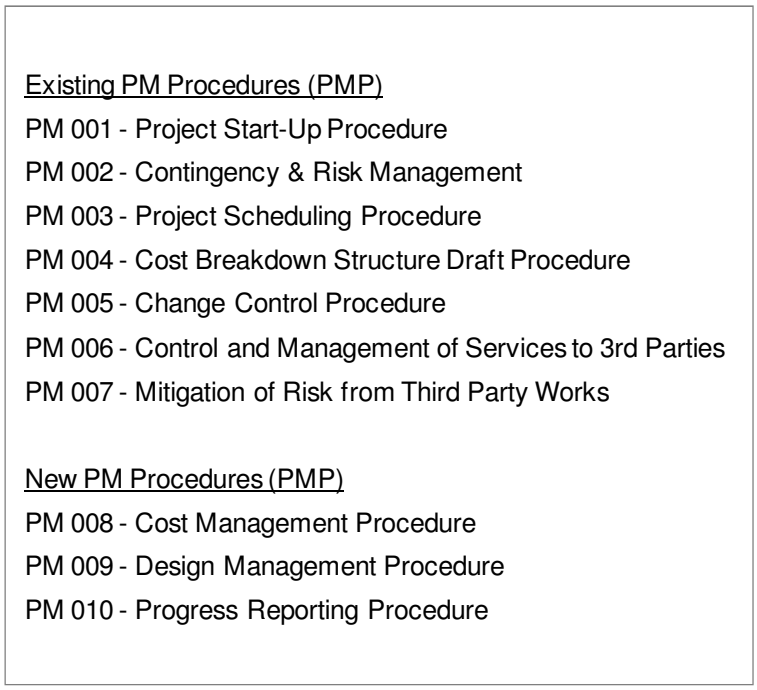


Fig. 5.9 PMF Level 2 - Project Management Procedures (PMP)

Level 3: Project Life Cycle (Deliverable Instructions)

Under the PMF, the project life cycle is sub-divided into eight phases and the work-package approach in the original PMPs was transitioned to a gate-review approach in line with the National Transport Authority (NTA) guidelines of 2009. At this level-3 of the PMF, there are eight phases, or gates, in the project life cycle and sixty three PM Deliverable Instructions (PMD), or approximately eight per phase.

Phase 0: Programme Overview & Requirement Definition
Phase 1: Scheme Concept & Feasibility
Phase 2: Option Selection
Phase 3: Outline Design
Phase 4: Statutory Process
Phase 5: Advanced Works, Further Design, & Procurement
Phase 6: Construction & Implementation
Phase 7: Close Out & Review

[140] PMI (2004). *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*. Newton Square, PA: Project Management Institute, USA.
[141] APM (2006). *APM Body of Knowledge*. Princes Risborough, Bucks., UK: Association for Project Management, UK.

Level 4: Project Life Cycle (Deliverable Items)

Level-4 of the PMF is an archived collation, phase by phase, of the deliverable items that are mandated by the previous level-3 PMDs, in compliance with the level-2 PMPs and the level-1 external requirements. It provides documented verification that a capital project that is delivered under the PMF has been verifiably compliant with the overall requirements of the PMF process, Fig. 5.10.

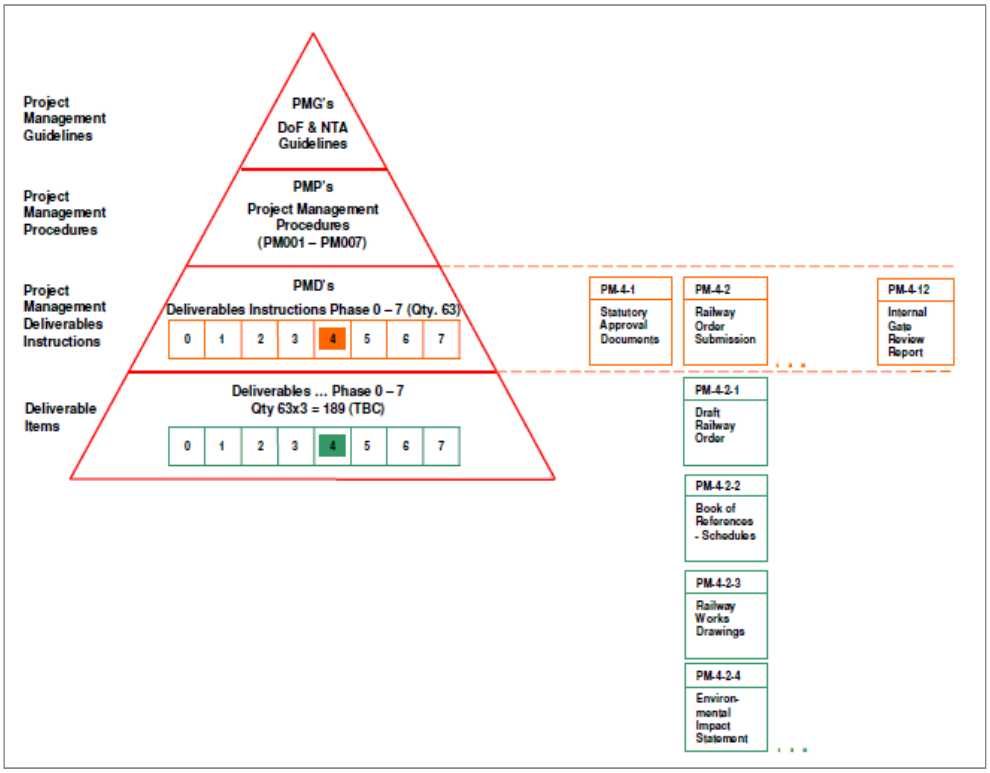


Fig. 5.10 PMF Level 4 - Project Management Deliverable Items

PMF Rollout & Implementation

As the PMF is a comprehensive process for the delivery of capital projects in IE, it encompasses projects across the gamut of budget scales, from small to medium to large to major. In order to cope with such variety, the PMF is scalable in terms of deliverable items at level-4 and only projects over €30m[142] require a full suite of deliverable items, which could average four, or five, for each of the sixty three PMDs at level-3. Projects with budgets under

[142] Currently under review by National Transport Authority (NTA)

€30m are required to be compliant with a scaled version of the PMF process. This means that for projects over €30m, a full complement of deliverable items at level-4 could reach 252, or 315, items (63 PMDs x4, or x5). In order to facilitate the dissemination and utilisation of the PMF process, the software application MS SharePoint[143] is being used. This IE intranet platform facilitates access to all procedures and templates relating to PMF and acts as a repository for lessons learned during project delivery and, also, for deliverable items at designated gate-reviews.

5.4.4 PROJECT RESOURCES

In general, during the 2000s, the availability of resources was not a constraint for delivering projects under the NDPs. This was more the case with external contractors than with limited internal resources, such as Track and Signalling personnel, which needed to be allocated on a priority basis. As a dedicated PMO that was focused on delivering major projects in IE, Construction Unit (CU) was in the enviable position of having the same multi-annual organisational stability as the multi-annual major projects it was charged with delivering. This is in contrast to other PMOs in IE with small- and medium-scale projects with project life cycles of three to six months, whose team members were engaged in delivering several projects concurrently.

5.4.4.1 Project Manager & Leadership

In addition, CU was fortunate in having a Programme Manager from 2000 to 2010 who promoted a teamwork environment that was characterised by project goals, mutual trust, openness, and team problem-solving, which aimed to engender a sense of "We're in this together!"[144] Other characteristics of the Programme Manager that were identified by CU team members were his willingness to take difficult decisions, when needed, and his ongoing disposition towards solving project problems by arriving at a tentative solution and, then, "get the programme and people together"[145] to further brainstorm the problem collectively. However, the Programme Manager at project level needed support from the project governance structure for his/her projects, especially in terms of decision making. Projects need decisions, or a bias for action, to resolve the myriad problems that require timely solutions over the project life cycle. And decisions don't need to be optimal, or always right,

[143] Web application platform developed by Microsoft Corporation (USA)
[144] IE interview No. 7, Jul 2008
[145] IE interview No. 9, Jul 2008

to keep the project trajectory on track but there needs to be decision-making rather than decision-deferring.[146]

5.4.4.2 Project Teamwork

Few with experience of capital projects would doubt the combined importance of leadership *and* teamwork for successfully delivering projects, as remarked: "first of all ... you need a good project manager on board"[147] and also teamwork, because "that's the kernel of the project, the teamwork"[148]. Teamwork doesn't happen spontaneously by itself; it seems to be a combination of team leadership, team members, circumstances, and some luck besides.[149] For teamwork to be successful, "you need everybody to cooperate"[150] in order to achieve the goals of the project. In CU, the key benefits of promoting trust,[151] support, and empowerment were the resulting teamwork and learning that yielded a range of benefits, such as: common purpose and accountability; collective problem-solving; flexibility; professional development; enhanced communication; timely decision making; and team spirit.[152]

Professional Development

Learning and professional development were an integral part of how capital projects were delivered in CU, as core team members gained experience and confidence in an atmosphere of support, mutual trust, and empowerment. This was acknowledged by project team members, one commenting: "we were able to take a lot of decisions without [Programme Manager] but would inform him and he might change it, on occasion".[153] Another saw team members in CU taking responsibility and "making the decisions that they have to make"[154], in order to achieve their work objectives. And another recognised the beneficial effects of support and teamwork on team members and on the project delivery timescale.[155] This theme of the key importance of teamwork is one that is shared across the PMOs in IE's New Works Division and one that is contrasted favourably with lower levels of teamwork in other parts of IE.[156,157]

[146] IE interview No. 27, Jun 2011
[147] IE interview No. 15, Mar 2010
[148] IE interview No. 12, Feb 2010
[149] As Isaiah Berlin observed: "There is always the part played by pure luck, which, mysteriously enough, men of good judgment seem to enjoy rather more often than others. This, too, is perhaps worth pondering."
[150] IE interview No. 10, May 2009
[151] IE interview No. 28, Jun 2011
[152] IE interview No. 7, Jul 2008
[153] IE interview No. 8, Jul 2008
[154] IE interview No. 9, Jul 2008
[155] IE interview No. 9, Jul 2008.
[156] IE interview No. 11, May 2009
[157] IE interview No. 34, Jul 2011

Project Team Meetings

In the CU PMO, which delivered the three biggest capital projects for IE during the 2000s totalling €650m, a key coordinating mechanism at project level was the weekly team meeting that was attended by the project manager, his direct reports, and other key project stakeholders. These meetings usually lasted over three hours, were well attended, and the recorded minutes were circulated to the attendees and other project stakeholders across IE. The team meeting served many functions at many different levels: it was part social and part bureaucracy; part exploratory and part decision making; part design review and part design change; and part rational and part behavioural. Above all, it was a critical forum for sharing the experience of delivering the project goals. This revolved around project goal-setting and collective problem-solving, which was facilitated by an atmosphere of trust, support, and empowerment that promoted the sharing of information, discussion of ideas, and dissemination of knowledge. It was recognised by project team members as a 'must attend' weekly meeting to keep abreast of 'what was going on' in CU.[158]

For internal works staff gangs, the daily "tool-box talk"[159] is an equivalent 'must attend' meeting, during which they engage with the ganger on a briefing of the scheduled work for the day, safety issues, etc. After the briefing, the ganger's briefing book is signed-off by the gang team members.[160]

5.4.5 PROJECT SYSTEMS

In addition to documenting its PM procedures, IE also introduced IT systems on several fronts to facilitate the efficiency and effective delivery of capital projects. Firstly, in project planning, software packages like MS Project[161] and Primavera[162] were introduced in 2000 to enable the systematic scheduling of all work activities relating to specific projects. In addition, the budget value of work completed at any interim point in a project could be estimated and project activities could be resource-loaded to facilitate out-turn cost forecasting. Secondly, project procurement (purchasing) was streamlined after the introduction of SAP[163] in 1999/2000, IE's company-wide enterprise resource planning (ERP) system. Thirdly, project cost control was enhanced by the utilisation of SAP as IE's financial system and also by the introduction of an intranet timesheet system for office staff

[158] IE interview No. 24, Apr 2011
[159] IE interview No. 29, Jul 2011
[160] IE interview No. 34, Jul 2011
[161] Microsoft application
[162] Oracle application
[163] SAP (Systems, Applications, and Products in Data Processing), German software company founded in 1972

in 2003/4, in order to substantiate project reimbursement claims from the exchequer. Fourthly, project reporting was to see a more gradual evolution than planning, procurement, and cost control, because "up until then, there wasn't a massive culture of reporting and accountability and responsibility".[164] Initially, reports using Word[165] were used to report on the larger projects and this progressed to using Excel[166] report formats. Finally, in the mid 2000s, the intranet was harnessed to streamline the reporting of the majority of capital projects being delivered by IE using two formats - PIMS (Project Integrated Management System) and IPMS (Integrated Project Management System).[167]

Project systems also extended to administrative processes that supported the delivery of capital projects. Ongoing audit inspections from within CIE and from national and EU agencies acted as a valuable feedback loop to continuously improve the efficiency and effectiveness of administrative, safety, and reporting systems.[168] However, like electricity, project systems, once in place, tend to be taken for granted as a normal part of the project environment. This is especially the case for younger team members, whose memory does not include the pre-Microsoft and pre-internet eras. For older team members, the opportunity to innovate in PM that is afforded by up-to-date project systems has not gone unnoticed.[169,170]

[164] IE interview No. 19, Aug 2010
[165] Microsoft application
[166] Microsoft application
[167] IE interview No. 19, Aug 2010
[168] IE interview No. 31, Jul 2011
[169] IE interview No. 1, May 2008
[170] IE interview No. 35, Oct 2011

5.5 PMC DEVELOPMENT OUTCOMES

The previous three sections have discussed the development of PMC in IE in terms of context and stimulus, practice and learning, and PMC dimensions. The main purpose of this final section is to discuss the organisational outcomes for IE in developing a PMC as a strategic business process in the 2000s, in terms of external and internal outcomes, maturity level, and future development.

5.5.1 EXTERNAL OUTCOMES

The development of PMC as a new organisational capability in IE was a key enabler for achieving the upgrading of the railway infrastructure during the 2000s under the framework of the NDPs. Flowing from this business achievement, other institutional success criteria that were important for IE included ongoing government approval, access to ongoing financial resources, and enhanced legitimacy with the public.[171,172] This was a double achievement for IE, in terms of firstly achieving its business development goals and, secondly, developing a new organisational capability as a strategic business process on a par with IE's lean management systems, supply chain management, and quality systems. This enhanced IE's business position as it positions itself for the challenges and opportunities of a deregulated railway sector across the EU.

5.5.2 INTERNAL OUTCOMES

For capital projects in the private sector, the most widely cited key performance indicators (KPIs) for a delivered project scope are cost, time, and quality, the so-called 'iron triangle' of PM. In the public sector, the same set of KPIs feature among the primary goals for capital projects but the ranking order is different from the private sector. After safety, the most important KPI for IE was delivering the project scope. After project scope, the most important project goals were cost and timescale, which are inter-connected. The different priorities of project goals between the private and public sectors seems to underline a mutual misunderstanding between PM practitioners in both sectors, with the private sector envious of the 'looseness' of KPIs in the public sector and the public sector envious of the 'certainty' of the KPIs in the private sector, e.g., the 'iron triangle' of cost, time, and quality.[173]

[171] IE interview No. 1, May 2008
[172] IE interview No. 14, Mar 2010
[173] IE interview No. 15, Mar 2010

Apart from the achievement of targets for scope, cost, timescale, and quality, other institutional KPIs were also important for the project team, such as recognition of the development of a PMC as an organisational capability and, as a result, increased legitimacy with senior management and the Board of IE. There was a general consensus among informants that IE's newly acquired PMC was well recognised within IE up to Board level but not outside IE, despite the successful delivery of hundreds of capital projects during the 2000s.[174]

PMC Scope & Scale

In the PMOs in IE, excluding rolling stock, capital projects during the 2000s varied from high-volume projects that were small or medium scale (under €50m) to low-volume projects that were large scale or major (over €50m). The latter group were significant in terms of budget expenditure (56%) but low in project volume terms (2%), Fig. 5.3. This variation in project volumes and budget scales engendered a differential development of PMC within and between the PMOs in IE. The major complex projects gave rise to the development of a PMC that was more strategic, dynamic, and less imitable in character, while the high-volume projects led to a PMC that was more repeatable and generic. Thus, IE's PMC encompasses the capability to successfully deliver small projects (< €2m), medium projects (€2m to €50m), large projects (€50m to €100m), and major projects (>€100m).

5.5.3 PMC MATURITY LEVEL

To appreciate the sea change that has occurred in the perception of IE's PMC by senior management within IE and by central government, it is worth noting that, in the early 2000s, the Railway Procurement Agency (RPA)[175] rather than IE was favoured with delivering the LUAS light rail system for Dublin city. However, by 2010, IE had become the lead PM organisation for the delivery of the multi-billion euro DART Underground Interconnector project,[176] circa €2.5bn, something hardly conceivable a decade earlier.[177]

While it is difficult to make comparisons between IE's railway-based PMC and that of other sectors, nevertheless, an external PM consultant to IE with international experience of the

[174] IE interview No. 14, Mar 2010
[175] Established in Dec 2001 (first board meeting Jan 2002) and subsumed the role of the former CIE Light Rail Project Office. See RPA website www.rpa.ie/en/rpa/about/Pages/background.aspx (accessed 28 Oct 2010)
[176] See DART Underground website www.irishrail.ie/projects/dart_underground.asp
[177] IE interview No. 13, Mar 2010

rail sector, and pharmaceutical sector estimates that IE's PMC in the New Works PMO is positioned in the top quartile in all sectors.[178]

5.5.4 PMC FUTURE DEVELOPMENT

While it is recognised within IE and at government level that IE has developed a robust PMC that consistently delivers the '3-pillar' project goals of scope, budget, and timescale, it is also acknowledged that its PMC would be enhanced by an increased commercial perspective.[179,180] This may be possible in a narrow sense but is a complex issue, given the political nature and lack of commercial viability of some capital projects that are undertaken in the public interest in PSOs, e.g., Western Rail Corridor by IE, rural electrification by the ESB, etc. This 'public interest' dimension is as an intrinsic feature across public sector commercial semi-state organisations, which differentiates their 'commercial' status from private sector commercial organisations.

[178] IE interview No. 35, Oct 2011
[179] IE interview No. 23, Apr 2011
[180] IE interview No. 32, Jul 2011

Chapter 6

Case Study No. 2: Electricity Supply Board (ESB)

6.1 INTRODUCTION [181]

By the late 1990s, it was apparent to ESB senior management that there was an urgent business need to upgrade the ESB's networks, especially the medium-voltage distribution network. This need was driven by several factors, including high growth levels in peak-demand in the 1990s of 5% p.a. and under-investment in the networks in the 1980s and 1990s. In addition, with market deregulation, the networks had become a pivotal business platform. Also, by the late 1990s, the twin launch of the Euro and the National Development Plans (NDP, 2000, 2007) combined to provide an unprecedented stimulus to the economy and to demand for electricity into the future. In order to address this pressing business need, the ESB established the Networks Renewal Programme (NRP project) to undertake the task of renewing the networks to an accelerated timetable. The NRP project would draw on both internal and external resources to achieve its task. In this, the NRP project represented a deliberate, planned, approach to upgrading the networks whose scale, scope, timescale, and budgetary implications were appreciated at the outset by ESB's senior management.

Over time, under the NRP project, a new organisational capability developed as a 'networks project management capability' (Networks PMC) that successfully delivered the NRP project between 2001 and 2005/6. This was a remarkable achievement for the ESB, considering the "low base"[182] of experience in large-scale network projects that existed in the ESB before the NRP project. Previously, ESB's project management capability traditionally revolved around the construction of large power stations (Generation PMC), which is now based in ESB International (ESBI). In the event, the NRP project involved investment levels of approximately €3,000m between 2001 and 2005, or up to €5,000m when subsequent years

[181] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)
[182] ESB interview No. 13, May 2011

are taken into account.[183] This represents additional investment levels above previous levels of approximately €2,200m between 2001 and 2005 comprised of €500m in the transmission network and €1,700m in the distribution network. At peak times, the NRP project involved up to 1,800 contractor personnel comprising 17 nationalities provided by up to 14 EU-wide contractors. Underlining the development of its Networks PMC was a view at ESB senior management level that projects promote the generation of knowledge and the sharing of knowledge. This is because "knowledge is embedded in people"[184], which is complemented by organisational arrangements, documented procedures, etc., rather than as a detached commodity that can be found in books or electronic databases.

This case study of ESB Networks is a retrospective longitudinal account of the development of ESB's Networks PMC during the delivery of the NRP project, which is grounded in thirteen semi-structured interviews with key informants involved in the rollout of the NRP project. It is also supplemented by three interviews with informants of the Generation PMC, who were familiar with aspects of the NRP project. In addition, data have been collated from secondary and other sources, such as ESB documents, reports, books, periodicals, electronic media, etc. Taken together, they represent a cross-sectional and longitudinal perspective on the development of the ESB's Networks PMC in the early 2000s. The case study presentation is broadly organised around the PMC process model that was introduced in Chapter 4 - Methodology as a guide for data collection and analysis, Fig. 4.3, p. 92.

6.2 NETWORKS PMC DEVELOPMENT - CONTEXT & STIMULUS

This section outlines the context and stimulus for PMC development in ESB Networks as a case study organisation.

6.2.1 ELECTRICITY IN IRELAND - OVERVIEW[185]

Since its formation in 1927 to date, there is no doubt that the ESB fulfilled and exceeded its statutory mandate with regard to continuity of supply. During this period, the ESB grew commensurately and developed diverse organisational capabilities around its core

[183] IEE Presentation by ESB Networks, Nov 2005
[184] ESB interview No. 7, Jan 2011
[185] Main sources for ESB history are (1) Manning, M. & McDowell, M. (1984). *Electricity supply in Ireland: The history of the ESB*. Dublin: Gill & Macmillan, and (2) ESB website, www.esb.ie (accessed Nov-2011)

competencies for delivering electricity across the supply-chain, namely, capabilities in the key activities of power generation, network transmission, and network distribution. By the time the ESB was established in 1927[186] as a state-owned body to develop and operate Ireland's electricity network, there were some 300 different bodies generating and supplying electricity in different parts of the country, including five major companies and sixteen local authorities. Over time, these were incorporated as part of the ESB, so that, when Ireland joined the EU[187] in January 1973, the ESB was the dominant provider of electricity on a national basis in Ireland.

From the 1930s onwards, the growth in demand for electricity was truly remarkable with levels increasing from 48 MW (megawatts) in 1930 to 4,000 MW by the year 2000, Fig. 6.1, an 80-fold increase! In this, the Rural Electrification project played a big part. Compared to the building of the first hydro power station at Ardnacrusha in 1929, with its international profile and contractors, the Rural Electrification scheme in the 1940s to 1960s was "very much a home grown affair"[188], involving the deployment of PM expertise by the ESB to the building of a country-wide network for the transmission and distribution of electricity. This project was the direct ancestor on the NRP project that was undertaken by the ESB in the early 2000s but, on this occasion, as a five-year project.

Year	Peak Load (MW)	Increase by Decade %	Compound Annual Increase %
1930	48		
1940	119	148%	9.5%
1950	251	111%	7.7%
1960	412	64%	5.1%
1970	1,203	192%	11.3%
1980	1,800	50%	4.1%
1990	2,400	33%	2.9%
2000	4,000	67%	5.2%

Fig. 6.1 ESB Peak-Load Growth Trend[189]

[186] Electricity Supply Board Act , 1927, established ESB as a statutory corporation
[187] In 1973, known as the European Communities (EC), inclusive of the European Economic Community (EEC)
[188] ESB interview No. 12, May 2011
[189] Adapted from Manning & McDowell (1984, p. 236) and IEE Presentation by ESB Networks, Nov 2005

During the intervening years, ESB developed a PM expertise in the area of power stations, which was deployed less after the commissioning of Moneypoint in 1987, Ireland's largest power station with an output of approximately 900 MW fuelled by coal, or 20% of the national peak-demand. Even though this project management capability (PMC) based on power stations may not have been directly applicable to ESB's networks, nevertheless, it represented an inherited legacy of related expertise that served as an internal benchmark for the development of an equivalent PMC for ESB's networks under the NRP project.[190]

6.2.2 NETWORKS PMC EXTERNAL CONTEXT PRE-2000

6.2.2.1 Electricity Growth Trends

Since its establishment in 1927, the ESB has made a significant investment in power station capacity to keep pace with the demands of Ireland's growing economy. This was done by firstly exploiting the country's natural resources that were suitable for electricity generation, such as hydro and peat, in addition to using imported fossil-fuels.

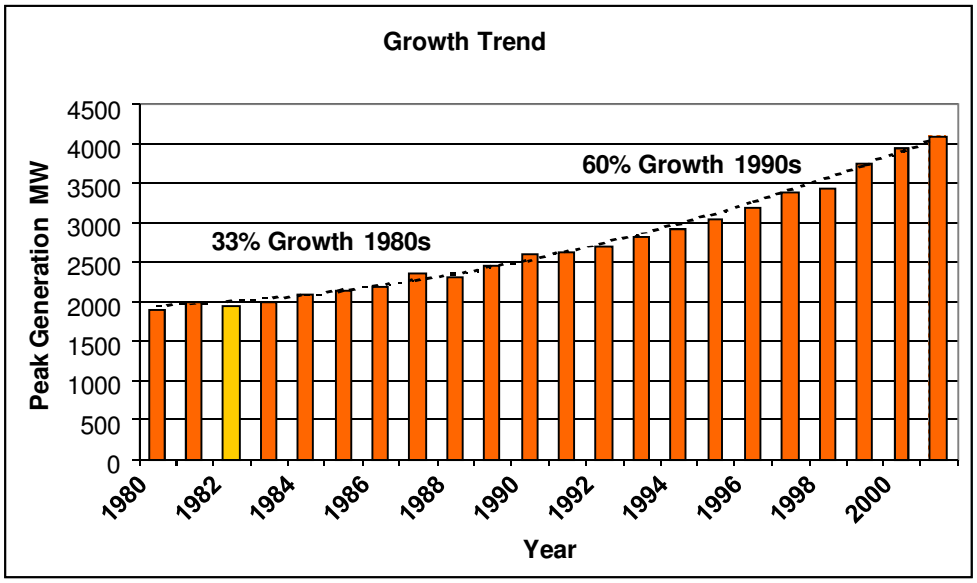


Fig. 6.2 ESB Generation Capacity Expansion 1980 to 2000[191]

As a result of keeping pace with the growth in demand for electricity, the ESB had experienced a doubling and more in peak-load demand during the twenty years from 1980 to

[190] ESB interview No. 11, May 2011
[191] Adapted from IEE Presentation by ESB Networks, Nov 2005

2000, Fig. 6.2. During the 1980s, peak-load had increased by approximately 33% from 1,800 MW in 1980 to 2,600 MW in 1990 and, during the 1990s, by approximately 60% from 2,600 MW in 1990 to 4,000 MW by 2000. Taken together, this increase from 1,800 MW in 1980 to 4,000 MW in 2000 represents an increase of 120%, or a compound annual growth rate of 4.1%, which was lower in the 1980s (2.9%) and higher in the 1990s (5.2%).

6.2.2.2 EU Strategic Plans

As part of the EU-wide deregulation of the electricity market,[192] the government established the Commission for Energy Regulation (CER) in 1999[193] to act as regulator of the electricity and gas sectors in Ireland. In 2000, the electricity market was opened up to competition by 30%, allowing approximately 400 of the largest electricity customers to choose their own supplier. The market was fully open to competition in 2005, two years earlier than required under the EU Electricity Directive. Also in 2000, the government established EirGrid[194] to operate the electricity transmission network - the national grid - separately from the ESB under licence from CER. However, EirGrid was not operationally vested until 2006.

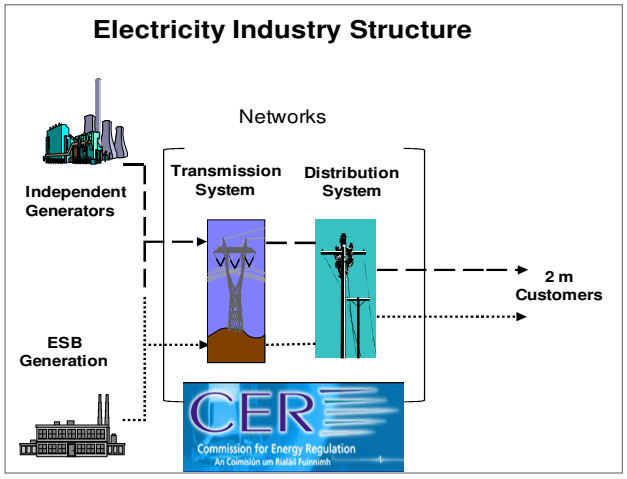


Fig. 6.3 Deregulated Electricity Industry Structure[195]

By then, the ESB electricity supply-chain from power plants to end-user customers was divided into three segments to allow access to independent suppliers to all parts of the supply-chain. The three segments consist of: (1) generation level; (2) transmission level at

[192] EU Directives Nos. 96/92/EC, 2003/54/EC, 2009/72/EC
[193] Originally as the Commission for Electricity Regulation under the Electricity Regulation Act, 1999
[194] European Communities (Internal Market in Electricity) Regulations, 2000 (SI 445 of 2000) giving further effect to EU Directive No. 96/92/EC
[195] Adapted from IEE Presentation by ESB Networks, Nov 2005

110/220/400 kv (kilovolt), owned by the ESB, operated by EirGrid under licence from CER, and maintained by the ESB under licence from CER; and (3) distribution level to end-user customers, owned, operated, and maintained by the ESB under licence from CER, Fig. 6.3. In 2011, under deregulation, the ESB's proportion of national operating capacity is less than 40%, in line with the cap established by CER. Also, it should be remembered that, under deregulation, the ESB had to divest itself of installed generating capacity of approximately 1,400 MW by retirement of plant or by sale, e.g., Tarbert power station.[196]

6.2.2.3 Government Strategic Plans

As part of the market deregulation process, the government's strategy involved vesting the electricity supply-chain, which the ESB previously owned and controlled, with the Commission for Energy Regulation (CER), an independent body with powers to issue licenses to companies, including the ESB, to operate and/or maintain the various segments of the supply-chain. In the event, CER licensed EirGrid to operate the transmission network and the ESB to operate the distribution network. The ESB was also licensed by CER to maintain the two networks, high-voltage transmission and medium-voltage distribution.

6.2.2.4 ESB Strategic Plans

Before deregulation, as a vertically integrated organisation, the ESB had developed broad-based organisational capabilities that spanned generation, transmission, and distribution to the end-user customer. In the new deregulated environment, the ESB's main 'core competence' revolved around its capability to install, maintain, and upgrade the networks, supported by its significant generating capacity, as one among an increasing number of generating companies, Irish and international. In addition, under deregulation, with its emphasis on competition among market players which discourages vertical integration, companies could opt to specialise in different aspects of the supply-chain. The scope of the NRP project was aimed at the renewal and upgrading of both the transmission network (high-voltage) and the distribution network (medium-voltage) against the background of the following environmental conditions.

Firstly, as previously discussed, since the 1990s, EU policy was firmly aligned with increasing competition in the electricity markets of member states. Thus, with market deregulation, generation capacity and end-user customers had become more fragmented but the networks remained in common use by all the suppliers and customers. For the ESB, the

[196] ESB interview No. 15, Aug 2011

networks had become a core business platform for the organisation into the future as never before.

Secondly, the ESB experienced a doubling and more in peak-demand over the previous twenty years from 1,800 MW in 1980 to 4,000 MW in 2000, Fig. 6.2. The annual compound growth rate in the 1990s was approximately 5% p.a. If this growth trend continued throughout the 2000s, the peak-demand would increase by a further 65% by the end of the decade with a multiplier effect on the networks, already under strain.

Thirdly, during the 1980s and 1990s, the networks had not received the same level of investment as the power stations and, even in 2000, some network hardware still dated from the earlier Rural Electrification programme of the 1940s to 1960s.[197,198]

Fourthly, the Euro was launched in January 1999 with notes and coins in circulation three years later in 2002. The single currency meant access to credit at low interest rates, representing a stimulus for investment in the private and public sectors and for electricity demand across the economy.

Lastly, in November 1999, the government launched the first of two consecutive 7-year National Development Plans (NDP, 2000, 2007),[199,200] which together represented a 14-year programme of government-led investment in national infrastructure totalling approximately €230bn. This combination of the Euro and the NDPs represented a framework for economic buoyancy that would underline growth in electricity demand over the next decade, which increased the urgency of renewing the networks in the ESB.

The original timeline for the delivery of the NRP project was contemplated between 10 and 20 years, which was a significant increase over existing levels of network renewals using ESB's internal resources that would have taken up to 70 years. This was based on doing 1,000 km (kilometres) of renewals annually over ESB's networks of 70,000 km.[201] However, by 1999/2000,[202] in the changed world of market deregulation and higher levels of expectation from government and consumers alike, the timeline was accelerated to five years at the instigation of ESB senior management, subject to resource procurement and funding approval. This was going to necessitate the introduction of external contractors to deliver the

[197] ESB interview No. 1, Dec 2010
[198] ESB interview No. 15, Aug 2011
[199] NDP (2007). National Development Plan 2007 – 2013. Dublin: The Stationery Office. Revised in 2011.
[200] NDP (2000). National Development Plan 2000 – 2006. Dublin: The Stationery Office
[201] ESB interview No. 10, Mar 2011
[202] ESB interview No. 4, Jan 2011

NRP project, something that was previously opposed by ESB's unionised staff but was eventually agreed with the ESB's trade unions in 2001. The funding arrangements for the NRP project were part of the negotiation process between the ESB and CER under the first Price Control Review (PR1), 2001 to 2005.[203] This underscored the advantage of a full-time independent regulator that could focus on long-term investment decisions for the energy sector rather than a government department with a portfolio of variable responsibilities.

6.2.3 NETWORKS PMC INTERNAL CONTEXT PRE-2000

6.2.3.1 Industrial Relations

Historically, trade unions in the ESB had been opposed to the idea of contracting external suppliers to perform work relating to the construction, maintenance, and renewal of the networks in the ESB. This work was normally done by the ESB's internal resources, such as technicians, fitters, electricians, apprentices, etc. However, in 2001, the Programme to Achieve Competitiveness and Transformation (PACT) was agreed between the ESB and the ESB Group of Unions. The purpose of PACT was "to increase cost efficiency, introduce new and more efficient work practices, reduce staff numbers, and facilitate *the employment of external contractors in core network and generation activities*"[204] (italics added). This opened the way for the NRP project to be undertaken over a five-year accelerated timescale using external contractors.

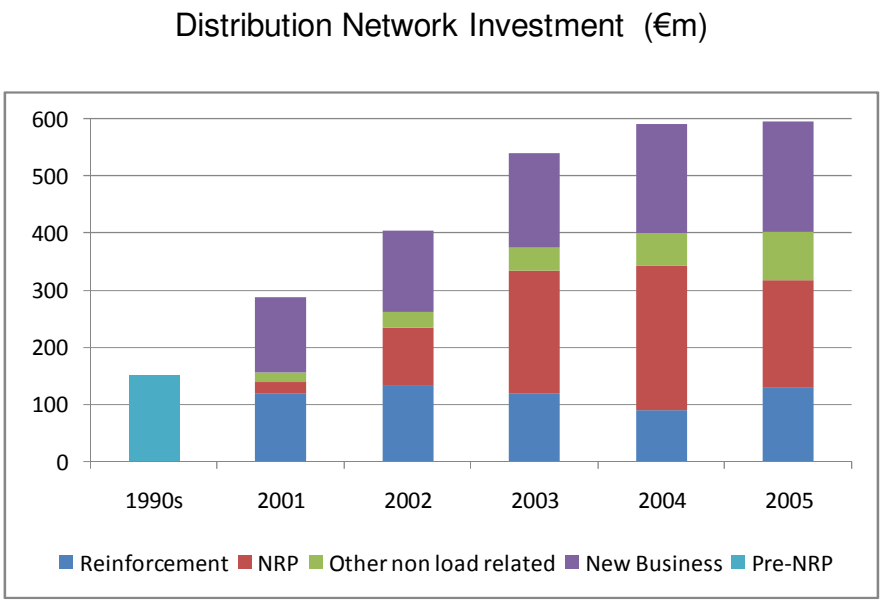
6.2.4 NETWORKS PMC PROJECT DELIVERY CONTEXT PRE-2000

6.2.4.1 Scope and Scale of the Networks Renewal Programme (NRP Project)

The scope of the NRP project included the renewal of both the transmission and distribution networks but, at distribution level, it was decided to focus on the medium-voltage level (10 kv / 20 kv) and to defer the renewal of the low-voltage level (220 v / 380 v) until after the NRP project. This was done to achieve the "best bang for buck in terms of value"[205], because the low-voltage domestic level was more recently built and, hence, in better condition than the medium-voltage part of the distribution network, some of which still dated from the Rural Electrification scheme of the 1940s to 1960s. Overall, between 2001 and 2006 under the NRP project, over 63,000 km at medium-voltage level were renewed and upgraded and

[203] ESB interview No. 4, Jan 2011
[204] ESB Annual Report 2003, p. 16
[205] ESB interview No. 13, May 2011

over 2,000 km at high-voltage transmission level, Fig. 6.4. In addition, the associated wood-poles, pylons, transformers, and sub-stations were also renewed and upgraded.



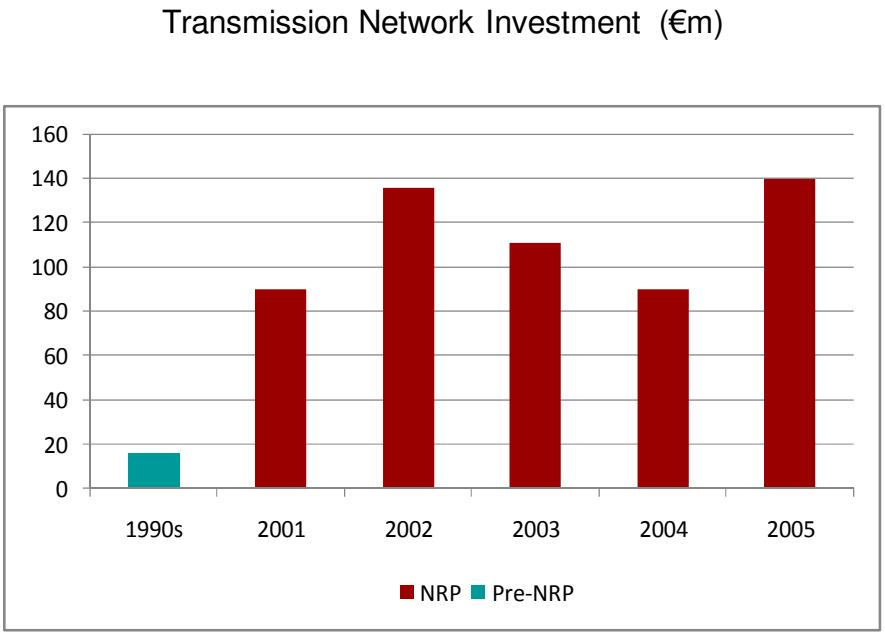


Fig. 6.4 Networks Renewal Programme - Distribution and Transmission[206]

[206] Adapted from IEE Presentation by ESB Networks, Nov 2005

6.3 NETWORKS PMC DEVELOPMENT – PRACTICE & LEARNING

This section outlines the practice and learning involved in PMC development in ESB Networks as a case study organisation.

6.3.1 THEORY AND PRACTICE

In ESB Networks, its Networks PMC co-developed with the organisational arrangements that were configured to support the delivery of the NRP project and, also, with the PM process framework for the procedures and processes by which it was delivered. In order to develop its Networks PMC, the organisation needed to learn by increasing its knowledge about the formal-based and experience-based aspects of delivering EBS Networks capital projects. An essential element in the approach to developing a Networks PMC as an organisational capability was a senior management view that 'knowledge is embedded in people'. Because of this, Networks PMC is an organisational practice based on the knowledgeability of people that is enacted in the delivery of capital projects in EBS Networks. In this, the Networks PMC became constituted by its practice and the organising forms that enabled its practice, such as organisational arrangements, documented procedures and processes, etc. While it could be said that this emergent process is learning-by-doing, it seems difficult to contemplate learning-by-doing from a blank canvass without seeing in one's mind in advance what one is proposing to do, or to have seen something similar done previously by another and remembered it.

6.3.2 GOAL-DIRECTED PROBLEM-SOLVING

The approach taken by ESB Networks in delivering the NRP Project was based on projects as arenas for the creation and utilisation of new organisational knowledge by problem-solving around pre-established project goals.[207] Therefore, instead of organising the NRP project as a multi-annual, production-like, project of largely repeatable network refurbishment, it was organised as a series of discrete projects among multiple contractors over a multi-annual timescale within the overall framework of the NRP project.

[207] ESB interview No. 7, Jan 2011

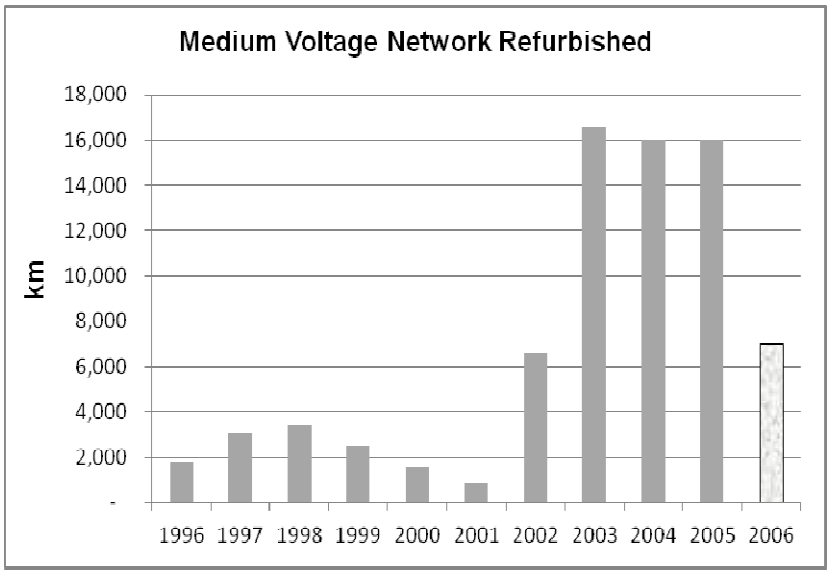


Fig. 6.5 Networks Renewal Programme - Medium-Voltage Network[208]

To appreciate the scale of the NRP project, one needs to understand the sheer extent of the medium-voltage network in the ESB that were refurbished under the NRP project, Fig. 6.5. At peak-times, this was 16,000 km (kilometres), or 10,000 miles, in 2003, 2004, and 2005, the equivalent of the distance from Achill Island to Los Angeles and back for three consecutive years![209] The combined length at medium-voltage level between 2001 and 2006 was over 63,000 km, which, together with the high-voltage transmission level, is approximately 65,000 km. In addition to line cable, the associated wood-poles, pylons, transformers, and sub-stations were also renewed and upgraded. To sustain this level of output, a relentless focus was required on the part of the entire project team to achieve targets, day after day, week after week, like a well-oiled machine that is running at a rhythm consistent with its own capability. Having the overall goals of the NRP project established by ESB corporate allowed the project, in turn, to determine a target that acted as a pace-setter for the entire project endeavour and the development of its Networks PMC. Even if the NRP project goals were not explicit all the time, they were ever-present as tacit presuppositions for NRP project personnel.

[208] Adapted from IEE Presentation by ESB Networks, Nov 2005
[209] ESB interview No. 10, Mar 2011

6.3.3 NETWORKS PMC DEVELOPMENT LEVELS - PMC ECOLOGY

There is little doubt in ESB Networks that the ramp-up of the NRP project using Contracting Partners was an ongoing stimulus to organisational learning on a grand scale, as remarked: "When we started off on the NRP project ... we were learning and we were learning hugely!"[210] In order to successfully deliver the NRP project, the key PM process activities of goal initiation, planning, executing, and closing with monitoring and control throughout were involved at all levels of ESB Networks PMC ecology - project board, project organisation, project supervision, and project works staff, Fig. 6.6.

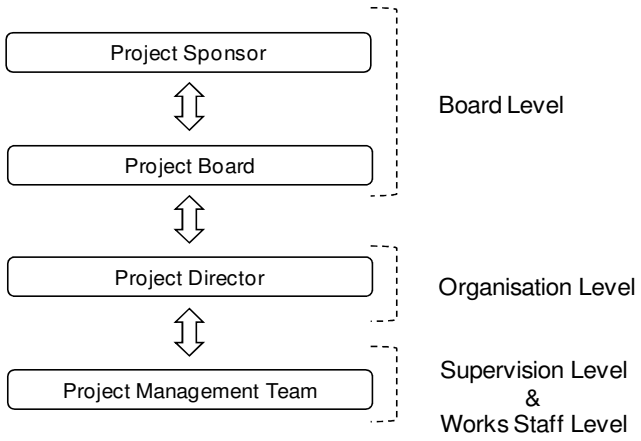


Fig. 6.6 ESB Project Governance & Networks PMC Ecology

Almost every aspect of PM over the project life cycle involves mini-cycles of goals, planning, executing, and closing, either within each phase of the project life cycle or between the main phases of feasibility, design, execution, and handover. Thus, for example, setting project goals involves a mini-cycle of goals, planning, executing, and closing for the overall activity of establishing the project goals and for each of the sub-activities comprising the overall activity. Under the NRP project, this PM heuristic was formalised as part of the PMI framework as PMI Process Groups consisting of initiate, plan, execute, and close with monitoring and control throughout, Fig. 6.7.

[210] ESB interview No. 12, May 2011

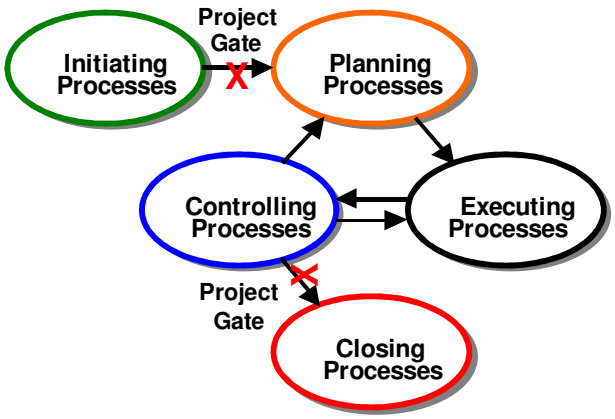


Fig. 6.7 ESB Project Management Initiative (PMI) - Process Groups[211]

6.3.3.1 Networks PMC Board Level

In the ESB, capital projects across the organisation are overseen by a project board, which is in interface between the main board and the project organisation. It functions as an inter-active forum for enhanced project oversight, decision-making, support, and participation for key stakeholder groups throughout the project life cycle. It plays an important role in the monitoring and control of major capital projects, such as the NRP project, in devising, reviewing, and regularising information reporting requirements.

6.3.3.2 Networks PMC Organisational Level

At organisation level during the NRP project, initiating and controlling were key activities of the PMI Process Groups. The process of initiating, or goal-setting, involved setting overall goals for the NRP project that were consistent with the ESB's corporate strategy, which, in turn, was aligned with government and EU policies for the energy sector. Controlling at this level worked in tandem with other levels of control for the NRP project, especially at board level and at project level. During the NRP project, project review meetings took place every month and a performance review every quarter. The monthly project meetings were linked to the monthly payment cycle for the contractors and focused on key performance indicators (KPI) such as safety, quality, scope, and cost, including variations.[212] Unless performance levels for safety and quality were achieved, payments could be delayed or withheld for further inquiry.[213]

[211] Adapted from IEE Presentation by ESB Networks, Nov 2005
[212] ESB interview No. 12, May 2011
[213] ESB interview No. 15, Aug 2011

Networks PMC Knowledge Aspects

During the reviews, the information flow was two-way with both the ESB and contractor personnel making presentations on various aspects of the project delivery. In effect, the review meetings became a collective shared experience of the delivery of the NRP project and this facilitated information sharing, problem-solving, dissemination of ideas, and the reinforcement of a common purpose. However, in common with experience in other organisations, ESB Networks is reviewing how lessons learned workshops can be conducted more systematically and their results disseminated more effectively.[214] It was also recognised that lessons learned workshops may be capturing only one kind of shared knowledge that can be documented, whereas, "there's a much more informal type of sharing that's not only lessons learned"[215], which involves sharing the experience of knowing something as well as sharing informational knowledge.

6.3.3.3 Networks PMC Project Level (Supervision)

Before the NRP project, documented PM procedures in ESB Networks did not exist in the same comprehensive and integrated manner like the PMI framework. In this pre-PMI environment, expertise at delivering networks projects was acquired largely by on-the-job learning through project-based problem-solving that involved a combination of existing expertise, theory, and practice. Because of the absence of a formal holistic process such as PMI, experienced practitioners were capable of managing their projects "more or less in their heads"[216], supported by document-based materials procurement and other processes. In many ways, then, what the PMI framework achieved was to codify existing undocumented processes and procedures[217] and to greatly expand their scope into a holistic framework for the management of networks projects over the project life cycle.

During the NRP project, a key activity of the PMI Process Groups was the planning process, which became the key mechanism for coordinating in advance the activities of the multiple contractors involved in Contracting Partners. In addition to the planning process for project activities relating to the NRP project, the execution and controlling processes were complementary processes to the planning process that were crucial for delivering the planned work activities to achieve overall project goals. This revolved around getting work delivered by using PMI procedures, templates, checklists, and job-aids,[218] which ensured that the work performed by contractors was compliant to ESB standards of safety and quality. This was

[214] ESB interview No. 6, Jan 2011
[215] ESB interview No. 12, May 2011
[216] ESB interview No. 10, Mar 2011
[217] ESB interview No. 13, May 2011
[218] ESB interview No. 13, May 2011

done by linking quality with contractor payments. On a monthly basis, the payment applications that were submitted by the contractors were subject to review and approval before being authorised for payment and part of this review process involved an assessment of the quality of the work performed by the contractor.[219]

Networks PMC Knowledge Aspects

While the documented side of the PMI framework was highly praised by senior project managers, it was also acknowledged that the development of a Networks PMC around the PMI was dependent on establishing a consensus among the project team members for its effective implementation. This recognised the Networks PMC as an organisational capability that was exercised through a collective enactment and whose development required information sharing,[220] especially through face-to-face sharing of examples of physical tasks and information sharing relating to such tasks.[221] This involved participants re-living their experience of delivering the project for others to absorb the information as a re-enacted experience, thus, becoming a collective virtual experience. For this sharing to be effective, mutual trust needed to be established between the ESB Networks supervisory personnel and the contractors and amongst the contractors themselves.

Of course, much sharing of information and its inherent experiential dimension is informal and spontaneous and is often motivated by a shared interest in solving a collective problem for the achievement of an overall project goal, e.g., exchanging information and other cues at the photocopier. This is linked to a recognition, often unstated, that organisational knowledge is a web of knowledge to which all staff contribute and to which all have access in accordance with their needs and dispositions. Indeed, organisational culture and national culture that is characterised by a degree of informality linked to curiosity may assist this process.[222] In addition, experienced ESB project managers understand the limitations of documented procedures, no matter how comprehensive, and appreciate that expertise beyond the requirement of procedures is embodied in expert practitioners whose expertise is largely undocumented but is on display.[223] In many organisations, such people fill-in the missing gaps in documented procedures, because expert practitioners understand the 'why' behind the 'what' and the 'how' of the procedures.[224]

[219] ESB interview No. 15, Aug 2011
[220] ESB interview No. 12, May 2011
[221] ESB interview No. 12, May 2011
[222] ESB interview No. 7, Jan 2011
[223] ESB interview No. 12, May 2011
[224] ESB interview No. 14, Jun 2011

6.3.3.4 Networks PMC Project Level (Works Staff)

Before the NRP project, the prevailing culture towards work at works staff level was practice-led. This was focused on getting the job done and resolving problems along the way with nominal levels of documented work instructions. This does not mean that tasks were done in an *ad-hoc* way but, rather, that the formal process for doing a task was more encoded in routine practices and artefacts than in documents. Because they are largely undocumented, routine methodologies allow the possibility of innovation to resolve new problems within an established process range and, so, establish a new expectation level. In contrast, at supervisory level, a greater emphasis was placed on understanding the formal documentation relating to a task before it was undertaken, i.e., drawings, procedures, etc. This difference in approach influenced the roll-out of the Project Management Initiative (PMI) at works staff level with a greater emphasis on the experience aspect of knowledge, supported by the formal procedures, rather than *vice versa*.[225,226]

Networks PMC Knowledge Aspects

Learning, too, was a two-way process with contractor personnel, with contractors and ESB Networks personnel learning from one another recursively. This was not just about sharing experiences about the performance of specific tasks to achieve a required technical specification but, also, the sharing of information about Work Method Statements for the overall management of work packages.[227] This unique environment of up to 1,800 contractor personnel from about 14 contracting companies under Contracting Partners, many of which were non-Irish, also offered an unparalleled opportunity for mutual learning amongst participants with EU-wide experience.[228]

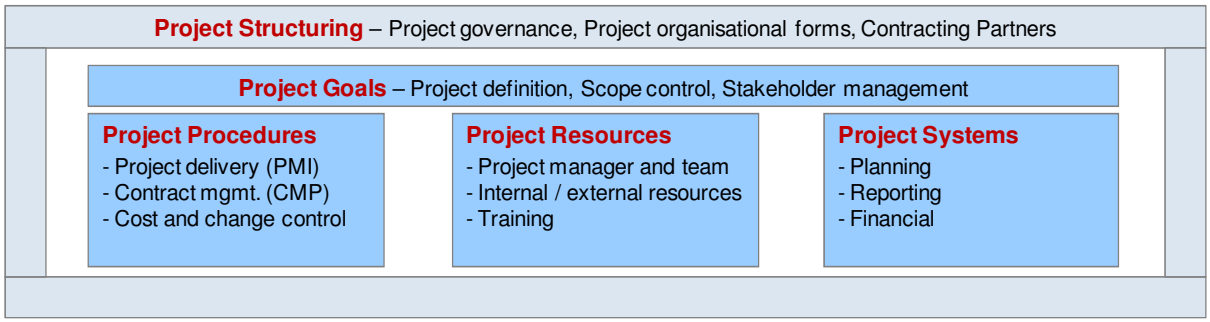
But communicating information to people does not guarantee either its absorption or adoption by those who receive the information. What seems to be required for information to 'stick' is a desire on the part of information recipients to absorb and to hold the information as though it were a personal goal that is held in common with the other members of the project team. In effect, the project goals need to become a shared value system, or belief system.[229,230] Thus, collaborative teamwork,[231] mutual trust, motivation, encouragement, suggestion, peer pressure, and commercial reward were all at play in the forging of a

[225] ESB interview No. 6, Jan 2011
[226] ESB interview No. 8, Feb 2011
[227] ESB interview No. 5, Jan 2011
[228] ESB interview No. 14, Jun 2011
[229] ESB interview No. 14, Jun 2011
[230] ESB interview No. 8, Feb 2011
[231] ESB interview No. 8, Feb 2011

common purpose under the leadership of Contracting Partners to deliver the goals of the NRP project.[232,233]

6.4 NETWORKS PMC DIMENSIONS

This section outlines the dimensions of PMC development in ESB Networks as a case study organisation. The ESB Networks case study was undertaken in parallel with, but later than, the Irish Rail (IE) case study. As the PMC process model was broadly similar in both organisations, the representation of the PMC dimensions in ESB Networks is informed by the IE case study and *vice versa*, Fig. 6.8.



(Source: This Study)

Fig. 6.8 ESB Networks PMC Dimensions – Goals, Structures, Procedures, Resources, & Systems

6.4.1 PROJECT GOALS

In 2001, at the beginning of the NRP project, the project timescale was 15 years, which was a significant increase in the level of network renewals before the NRP project. However, with the appointment of a new Chief Executive (CEO) in the ESB in 2002,[234] the timeline for the NRP project was accelerated to five years. This meant that the timescale for the NRP project was five years from 2001 to 2005 (original) or from 2002 to 2006 (effective) but, more importantly, it meant that there was a clear unambiguous project goal with top-level management support for its realisation.[235] Such an ambitious goal required ESB to develop a

[232] ESB interview No. 10, Mar 2011
[233] ESB interview No. 12, May 2011
[234] Padraig McManus
[235] ESB interview No. 12, May 2011

new organisational capability by reconfiguring its resource base to meet this challenge head-on. Indeed, this was the stated objective of the CEO, as remarked:[236]

> It had to be a paradigm change and that happened … That's what he actually wanted to achieve and he actually got it and he said: "Now, there's an organisation capability that will bring that [paradigm change] and deliver it [NRP project] subsequently".

6.4.2 PROJECT STRUCTURING

6.4.2.1 Project Governance

In keeping with the ESB's approach to managing capital projects across the organisation, the NRP project had a governance structure similar to that shown in Fig. 6.9, which functioned as an inter-active framework for enhanced project oversight, decision-making, support, and participation for key stakeholder groups throughout the project life cycle. Generation capital projects in the ESB also have a similar governance structure and, because of their one-off nature and the importance of front-end feasibility activities, the Project Board also plays a prominent role in their gestation and delivery.[237] So much so, that experienced project managers in the ESB learn to use Project Boards for support and guidance on a range of issues relevant to a successful project outcome, not least the ongoing support of key stakeholders for the project.

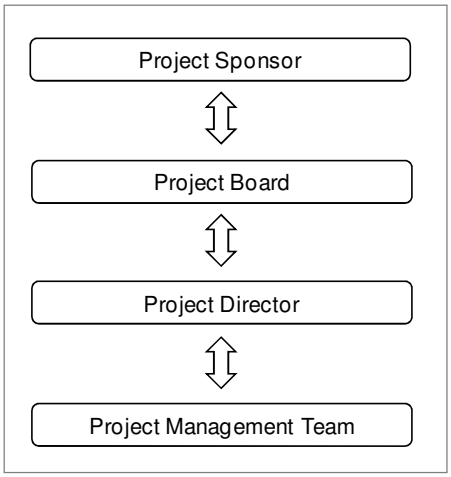


Fig. 6.9 ESB Project Governance Structure

[236] ESB interview No. 11, May 2011
[237] ESB interview No. 9, Mar 2011

6.4.2.2 Organisational Forms

In order for ESB Networks to successfully deliver the NRP project to a five-year accelerated timescale, it was decided by ESB senior management to reorganise ESB Networks around the idea of PM as a 'core competence' in ESB Networks and a 'core supporting competence' across the ESB, Fig. 6.10. Up to then, ESB Networks had been a geographical regional model with twelve branches rolling up to four regions.

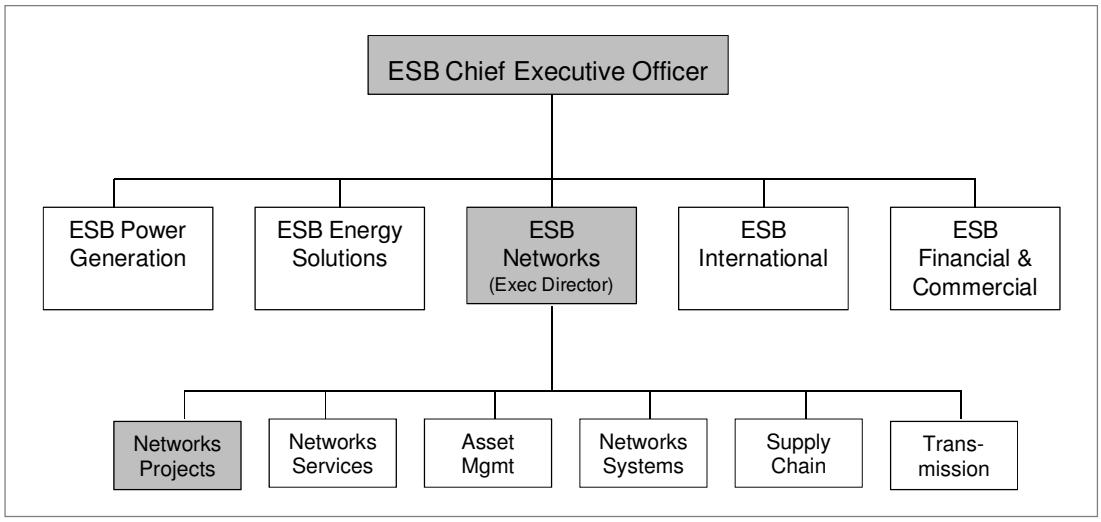


Fig. 6.10 ESB Networks Organisation - Networks Renewal Programme[238]

Because of the aggressive ramp-up required to deliver the NRP project and the involvement of multiple external contractors, a centralised functional approach was substituted for the geographic regional model by reconfiguring the resources within ESB Networks to form a dedicated organisation called Networks Projects to deliver the NRP project, Fig. 6.10. As a deliberate organisational strategy by ESB Networks, this was intended to send a signal that PM was viewed by senior management as a 'core competence' in ESB Networks[239] for delivering the NRP project and for career development into the future.[240, 241] The functional approach to Networks Projects involved designing the organisational form *ex ante* and filling the positions by transferring personnel from other parts of the ESB to Network Projects,[242] rather than building organisations around existing personnel capability.[243]

[238] Adapted from IEE Presentation by ESB Networks, Nov 2005
[239] ESB interview No. 7, Jan 2011
[240] ESB interview No. 11, May 2011
[241] ESB interview No. 7, Jan 2011
[242] ESB interview No. 14, Jun 2011
[243] ESB interview No. 7, Jan 2011

This involved pooling the prior knowledge that is 'embedded in people' and embedding the new organisational capability in the ESB through the agency of the practitioners of the new expertise. So, although function-led, the resulting organisational capability was an amalgam of function and experience, or 'function-cum-experience'. What seemed to drive the development of the ESB's Networks PMC was project-based learning, which was enabled by organisational arrangements to facilitate the delivery of the NRP project goals through project problem-solving, which was grounded in project-based goal-directed learning, as remarked:

> [W]e pool them together and that's pooling the knowledge ... by moving people around, we embed the knowledge in the organisation and we also improve the sharing, and the learning, and the cross fertilisation from each other.[244]

6.4.2.3 Contracting Partners

From the beginning of the NRP project, it was acknowledged that delivering the project was going to involve the participation of external contractors, whose number would eventually exceed the internal resources of ESB Networks. This required the Networks PMC to develop a supply-chain expertise that, on one hand, developed the PM expertise of ESB Networks' internal resources and, on the other hand, developed the PM expertise to coordinate the participation of multiple external contractors in delivering modules of the NRP project under ESB supervision.[245] This was done by developing a partnering approach to the NRP project contractors called Contracting Partners, where the emphasis was on partnership rather than traditional contracting.

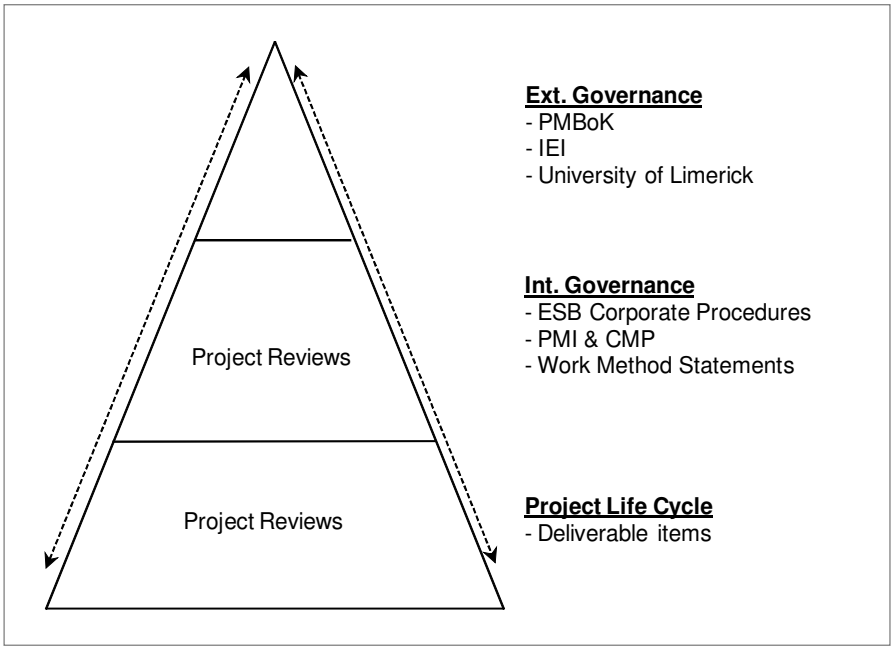
ESB Networks were keenly aware that programmes such as the NRP project had been undertaken in other countries with unfavourable outcomes. In the ESB's own history, nothing comparable had ever been undertaken since the Rural Electrification scheme in the 1940s to 1960s, which was a leisurely timescale in comparison to the envisaged five-year timescale of the NRP project.[246] Even though Contracting Partners was an outsourcing approach to developing a Networks PMC, it was outsourcing that was ESB-led and managed - "we were very much in the middle of it"[247] - rather than turnkey, contractor-led, outsourcing. Effectively, this meant that ESB Networks provided the ongoing project management of the NRP project and the contractors provided the works staff resources, together with their supervisory and management resources for liaison with ESB Networks.

[244] ESB interview No. 7, Jan 2011
[245] ESB interview No. 7, Jan 2011
[246] ESB interview No. 12, May 2011
[247] ESB interview No. 15, Aug 2011

At peak times under the NRP project, there were up to 1,800 contractor staff on the ground from about 14 contractor companies comprising 17 different nationalities.[248,249,250]

6.4.3 PROJECT MANAGEMENT PROCEDURES

Under the NRP project, the framework for the PM process procedures was organised around three inter-active levels, Fig. 6.11. At the first level of 'external governance', the documented procedures were informed by international best practice, such as PMBoK (PMI, 2004)[251], and were validated, in turn, by external bodies, such as Engineers Ireland[252] and the University of Limerick. The second level of 'internal governance' revolves around ESB Network's Contract Management Procedures (CMP) and the procedures of the Project Management Initiative (PMI) - not to be confused with the PMI professional body (USA) - where both CMP and PMI operate together in a complementary fashion.[253] The third level of the framework consists of a database of all the deliverable items that are required to be generated as a project is delivered through its life cycle under the PM process framework.



(Source: This Study)

Fig. 6.11 ESB Project Management Process Framework

[248] ESB interview No. 15, Aug 2011
[249] ESB interview No. 10, Mar 2011
[250] ESB interview No. 13, May 2011
[251] Project Management Book of Knowledge (PMBoK) of the Project Management Institute, USA (PMI)
[252] The Institution of Engineers of Ireland (IEI)
[253] ESB interview No. 12, May 2011

An immediate benefit of the PMI roll-out for the development of ESB Networks PMC was the effect of establishing a common language among project team members through which information could be captured and shared more easily.[254] This benefit of a common language was also highlighted in ESBI's Generation PMC after the roll-out of the Project Delivery Model (PDM),[255] which took place shortly after the PMI. In addition, it facilitated the sharing of the collective experience of delivering the project goals as both input and output of that shared experience.

6.4.3.1 Contract Management Procedures (CMP)

With the ramp-up of the NRP project in 2001/2, ESB Networks was able to build on its pre-existing civils contracts to establish a set of CMPs to support the outsourcing of a large part of the network refurbishment work through Contracting Partners, Fig. 6.12. This evolution of the CMPs continued throughout the NRP project with tenders referenced to the CMP requirements.[256] Unlike the traditional re-measureable civils contracts, which foster an adversarial claims culture with unpredictable financial out-turns,[257] the outsourcing approach under Contracting Partners was based on partnership. This was characterised by a long-term commercial relationship supported by the PMI framework process.

1. Foreword	10. Progress Meetings and Reporting
2. List of Sections	11. Materials Management
3. Responsibility Table	12. Environmental Management
4. Staffing and Facilities	13. Safety Regulations
5. Competency Assurance	14. Quality Policy
6. Operator Approval	15. Quality Control
7. Work Programming	16. As Built Records
8. Wayleaves and Access	17. Change Control
9. Supply Continuity	18. Payment Application
	19. Management and Overhead Charge Structure

Fig. 6.12 ESB Contract Management Procedures (CMP) Framework[258]

[254] ESB interview No. 12, May 2011
[255] ESB interview No. 16, Oct 2011
[256] ESB interview No. 8, Feb 2011
[257] ESB interview No. 12, May 2011
[258] Adapted from IEE Presentation by ESB Networks, Nov 2005

6.4.3.2 Project Management Initiative (PMI)

As previously discussed, the PMI framework was based on the US version of PMBoK,[259] which is recognised internationally as a professional standard for PM. This was amended and expanded to suit the needs of ESB Networks for delivering the NRP project. From the start, it was recognised that the NRP project was a multi-annual project that was focused on the refurbishment of the medium-voltage and high-voltage networks, which involved project activities that were repeatable, although variable within a predictable range of parameters. In addition, it was going to be a high-volume project delivery environment that needed to be scaleable for different work packages being awarded under the NRP project.[260] This was in contrast to the project management of the construction of a power station, or a wind farm, which is a one-off, high-variability, project setting. With this in mind, the PMI procedures were organised into one manual, which was a combination of procedures and work instructions in an ISO-9000 sense, Fig. 6.11, 6.14.

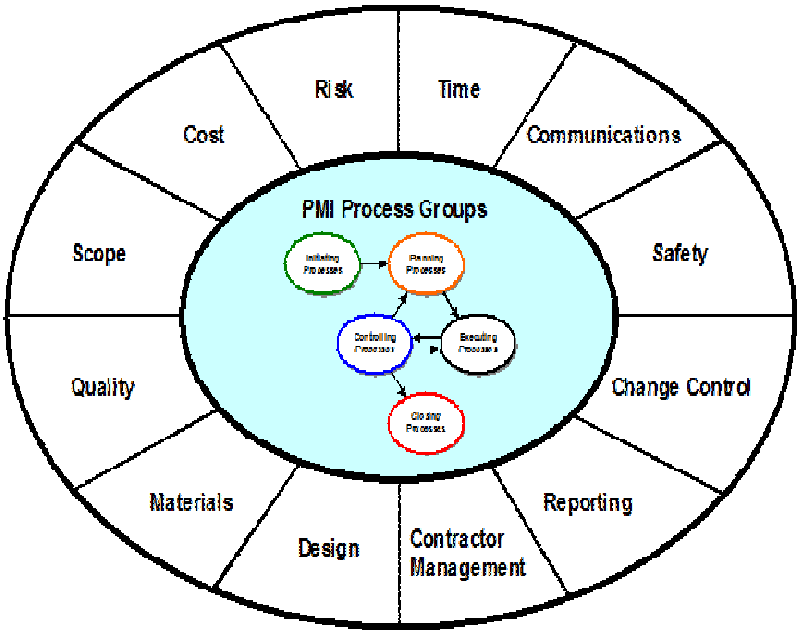


Fig. 6.13 ESB Project Management Initiative (PMI) Framework[261]

The PMI framework consists of twelve knowledge areas, which are applied to different parts of the project life cycle (feasibility, design, execution, hand-over) through the PMI Process Groups of initiate, plan, execute/control, and closure, Fig. 6.13. The PMI Process Groups are

[259] Project Management Book of Knowledge (PMBoK) of the Project Management Institute, USA (PMI)
[260] ESB interview No. 6, Jan 2011
[261] Adapted from IEE Presentation by ESB Networks, Nov 2005

a PM heuristic for planning and delivering work packages that is used within and between project life cycle phases. Each knowledge area is self-contained within the PMI manual, complete with theory, relevance, checklists, and templates for application, whose use was monitored initially but is now delegated to the project manager.[262] In ESB International (ESBI), the approach to implementing the Project Delivery Model (PDM) for the Generation PMC is broadly similar to the Networks PMC, in terms of viewing the Project Management Office (PMO) in a supporting guardianship role for the Generation PMC rather than a policing role,[263] Appendix III.

PMI Training & Rollout

An extensive training programme was established to support the roll-out of the PMI, which consisted of one day of off-line training per module of the PMI's twelve modules, or twelve days in total over one year - a day per month.[264] Because of the significant investment in training by the ESB and as way of promoting PM as an attractive career development path, the training was developed in association with the University of Limerick and accredited through Engineers Ireland.[265] The training was organised as a combination of theory and practice, or formal and experiential, with a view to making it a lived experience rather than a formality of 'ticking boxes' to report that everyone was trained.[266] So, for example, each participant was required to select a project, or an aspect of a project, which then became their test project[267] for the one year training on PMI. Through the 'test project', they put into practice the concepts underlying the processes and procedures of the PMI that were overviewed in the classroom part of the training. It was also a two-way process, in the sense that the training informed the delivery of the NRP project and, in turn, the field experience of the initial modules of the PMI provided feedback that informed the drafting of the later modules of the PMI manual. In effect, it was a case of the concurrent development of the Networks PMC's theory and practice.

In recognition of the problem-solving nature of project settings, the PMI manual offers toolbox options and reference examples to promote innovation in the generation of project-specific solutions for the project at hand within the process range of the project technical specification. Otherwise, if the PMI were overly prescriptive, it acted as a brake on innovation.[268] Under the PMI, all contractors were required to generate their own Work

[262] ESB interview No. 6, Jan 2011
[263] ESB interview No. 16, Oct 2011
[264] ESB interview No. 6, Jan 2011
[265] The Institution of Engineers of Ireland (IEI)
[266] ESB interview No. 8, Feb 2011
[267] ESB interview No. 8, Feb 2011
[268] ESB interview No. 8, Feb 2011

Method Statements (WMS), which was a methodology statement of how they were going to perform the work consistent with the technical and safety requirements of the NRP project.[269] This meant that each of up to 14 different contractor companies comprising 17 nationalities were using different WMS's for the same task! Although seemingly counter-intuitive, this approach was applied to project work activities with a narrow process range, which encouraged innovation in the methodology of how the task was performed while keeping input and output conditions tightly controlled to ESB standards.[270] This harnessed the innovation capability of up to 1,800 contractor personnel under controlled condition and provided ESB Networks and the contractors with an invaluable mutual learning opportunity to pool their expertise and thereby to upgrade it. This empowerment of contractors, within an agreed range of ESB standards, was part of the two-way process of establishing trust that promoted teamwork on the NRP project for the mutual benefit of participating stakeholders.

6.4.4 PROJECT RESOURCES

6.4.4.1 Project Manager & Leadership

In ESB Networks as in PM text-books, there is a wide variety of views about project manager leadership and its role in delivering a successful project. Nevertheless, the NRP project was fortunate in having a senior manager of high calibre in charge of Contracting Partners, a crucial component of the NRP project. This was evident in the high respect in which he was held by his colleagues, who regarded him as highly capable, tough, fair, and passionate about achieving the goals of the NRP project.[271] He was also credited with introducing a level of accountability in project delivery similar to the private sector.

Notwithstanding the identity of the elusive X-factor(s) that makes a project team better than average, some views point to the importance of leadership that is grounded in people-skills for promoting teamwork to a level of synergy that is greater than the sum of the parts.[272] Whether this is innate or learned is a different matter! For the ESB in general, with its strong representation of graduates from engineering and science, it is an ongoing challenge to transition project managers from being good engineers to being good people managers, or from being 'project engineers' to being 'project managers'.[273,274] There was also a view that project managers have certain innate qualities, including a pre-disposition to act rather than

[269] ESB interview No. 5, Jan 2011
[270] ESB interview No. 6, Jan 2011
[271] ESB interview No. 12, May 2011
[272] ESB interview No. 16, Oct 2011
[273] ESB interview No. 7, Jan 2011
[274] ESB interview No. 16, Oct 2011

deliberate; to have confidence, or foreknowledge, of delivering unrealised projects into an unknown future; and to have an appetite for calculated risks rather than being risk averse.[275]

6.4.4.2 Project Teamwork

Much debate has surrounded the topic of the relative importance of the project manager and the other members of the project team and views within ESB Networks reflect the mainstream variety of opinion on this subject. However, there was broad agreement on the importance of the project manager as a facilitator of the development of teamwork among team members, without which the team was not going to reach its full potential. Although, good players are always important in a football team, a squad of top-class players is no guarantee of success.[276] Indeed, some feel that "the important thing a good manager can do is get a great result with decidedly average players".[277] Conversely, a project manager that is not perceived as good can de-synergise the project team.[278]

At the heart of delivering the NRP project at local project level was the ongoing project teamwork that developed as a cohesive team culture based on confidence, trust, interdependence, leadership, and the challenge of delivering the NRP project goals, in terms of kilometres of cable per day, per week, etc.[279] And not just a one-off challenge either but a goal-directed and paced challenge over the duration of the multi-annual NRP project life cycle; a marathon rather than a sprint. Trust, too, was a two-way street with contractors empowered "to make a certain amount of decisions"[280], including their own Work Method Statements (WMS) that allowed contractors to innovate in their methodology, provided the task was compliant in terms of technical specifications and safety standards.

[275] ESB interview No. 11, May 2011
[276] ESB interview No. 8, Feb 2011
[277] ESB interview No. 11, May 2011
[278] ESB interview No. 11, May 2011
[279] ESB interview No. 8, Feb 2011
[280] ESB interview No. 5, Jan 2011

6.4.5 PROJECT SYSTEMS

At organisation level, ESB Networks used systems such as the ISO-9000[281] quality system and the PAS-55[282] asset management system, the latter replacing ISO-9000 in Networks Projects as the quality assurance system of choice.[283] This change occurred under the NRP project and reflected a holistic perspective on the asset management of the networks over its economic life cycle, rather than the truncated project life cycle which ends with the hand-over to the client customer. Of course, ESB Networks' safety system took precedence above all other systems, in order to ensure the performance of work to the highest safety standards for the benefit of all stakeholder groups, internal and external.

As part of a large organisation with 10,000+ employees at the time, ESB Networks was able to leverage the organisational IT capability of the wider ESB organisation to put in place an up-to-date IT infrastructure to support the delivery of the NRP project. This included the SAP[284] application package for procurement and finance, and MS Project[285] for project planning. However, systems don't deliver projects, people do; and it is as a key enabler that project systems add value for delivering a project on-time, on-budget, and fit-for-purpose.[286] Furthermore, like electricity itself, it is often the absence of project systems that is noticed more that their presence,[287] which suggests that their true worth lies in becoming taken-for-granted, rather like a tacit presupposition. This is also evident in new recruits endeavouring to follow project systems and older personnel with a level of expertise that is enhanced beyond the rules of formal-based systems.

[281] International Organization for Standardization, widely known as ISO, based in Switzerland
[282] Publically Available Specification (PAS), published by the British Standards Institution and endorsed by the Institute of Asset Management (UK)
[283] ESB interview No. 5, Jan 2011
[284] SAP (Systems, Applications, and Products in Data Processing), German software company founded in 1972
[285] Microsoft application
[286] ESB interview No. 14, Jun 2011
[287] ESB interview No. 11, May 2011

6.5 NETWORKS PMC DEVELOPMENT OUTCOMES

The previous three sections have discussed the development of Networks PMC in the ESB in terms of context and stimulus, practice and learning, and Networks PMC dimensions. The main purpose of this final section is to discuss the organisational outcomes for the ESB in developing a Networks PMC as a strategic business process in the early 2000s, in terms of external and internal outcomes, knowledge management, and maturity level.

6.5.1 EXTERNAL OUTCOMES

The Networks PMC was instrumental in the successful delivery of the project goals of the NRP project for the ESB. This was a double achievement for the ESB, in terms of firstly achieving the NRP project business goals and, secondly, developing a new organisational capability on a par with its pre-existing Generation PMC. This enhanced ESB's position in the energy market, where its networks competence, rather than its traditional generation competence, was becoming strategically key to its long-term business future in a deregulated energy market.

Supply Chain Aspect of Networks PMC

Because the PMC in ESB Networks was developed with Contracting Partners as an essential component, it is not surprising that the contractors participating in the NRP project also developed a PMC as part of ESB's extended Networks PMC. Moreover, the expertise that was acquired by the contractors was perceived to be on a par with the ESB's own PMC.[288] This had the effect of invigorating, rather than diluting, the internal component of ESB's Networks PMC, which was focused on managing the organisational interface between the multiple contractors in Contracting Partners and the ESB.

6.5.2 INTERNAL OUTCOMES

The development of a Networks PMC as an organisational capability in ESB Networks is an ongoing work in progress, whose progress to date is readily acknowledged by senior management within the ESB. The NRP project was a five-year programme, 2001/2002 to 2005/2006, that achieved its macro-level business objectives by consistently achieving the micro-level targets of safety, quality, scope, budget, and timescale on a daily, weekly, and

[288] ESB interview No. 11, May 2011

monthly basis across the NRP project organisation. In addition, the Networks PMC achieved its own goals for training, professional development, and stakeholder satisfaction. Perhaps, the enduring legacy of the Networks PMC will be more subtle and long-term, in terms of contributing to making ESB a 'learning organisation'. In this, it has already influenced the thinking of senior management about how to manage the most vital asset of them all - the organisation's knowledge base.

6.5.2.1 Networks PMC - Knowledge Management Implications

By viewing the locus of organisational knowledge as 'embedded in people' rather than written in documents, procedures, etc., this informs an approach to the management of knowledge that resonates with the master-apprentice model but one that requires some organisational redundancy for successful implementation.[289] Currently, this approach is being tested in ESBI, where a person that is due to retire is paired with his/her replacement for a year before retirement, so that the replacement person can observe, learn, and dialogue with their senior colleague in the exercise of his/her work before retirement.[290] Database excerpt from senior management:

> [D]own the years, we've struggled with this concept of knowledge management ... for sure, documenting your processes and documenting best practices in your processes is a really good thing to do but ... just taking what somebody else has written down is only part of the picture. The whole picture is what somebody learns through their life experiences and how you manage the acquisition of knowledge through life experiences and on the job assignments, and rotations. And moving up people into different roles and different responsibilities I believe is a key part of knowledge management.[291]

By viewing knowledge as 'embedded in people', ESB has realised that an organisational capability such as Networks PMC is enacted as an organisational practice by people who are 'embedded in the organisation' with their knowledgeability, which is a combination of formal informational knowledge and experiential knowledge. With this approach to organisational knowledge, ESB integrates strategic HRM and organisational design around the common objective of managing organisational knowledge as a human resource rather than as a commodity resource that can be managed with IT technology. This advances ESB as a 'learning organisation', where the organisation learns through increasing the knowledge that is embedded in its people, who are embedded in the organisation.

This means that an essential aspect of transferring new expertise across the organisation involves a rotation of personnel with expertise to other parts of the organisation where such expertise is needed; or, where there is a requirement for new learning in response to new

[289] ESB interview No. 7, Jan 2011
[290] ESB interview No. 14, Jun 2011
[291] ESB interview No. 7, Jan 2011

organisational challenges. In this way, prior learning by the newcomer is brought to bear on problems by seeing them in a different way to existing staff and the same problems are incorporated into the theory of the newcomer by reflexivity.[292] In keeping with a view of organisational expertise that is based on knowledge which is 'embedded in people', the organisational goal behind Networks Projects and the ongoing development of ESB Networks PMC was something akin to Schumpeter's idea of 'creative destruction'. This revolved around the idea of driving the development of the Networks PMC expertise through the centre and, then, disseminating it away from the centre by dismantling the centralised organisation and embedding the Networks PMC expertise in the organisation through the practitioners of the Networks PMC.[293]

6.5.3 NETWORKS PMC MATURITY LEVEL

Since its foundation in 1927, the ESB has prided itself in fulfilling its statutory mandate in term of continuity of electricity supply, which was underpinned by the development of a Generation PMC to undertake the expansion of its portfolio of power stations throughout the country. At ESB corporate level, what the NRP project succeeded in demonstrating was the coming of age of the ESB's Networks PMC in relation to delivering capital projects on a grand scale, on a par with ESBI's power station Generation PMC. Indeed, the feeling was that, under the NRP project, ESB's Networks PMC had developed and succeeded as an organisational capability where international attempts at networks renewal on a similar scale had been unsuccessful.[294] This was due in no small way to ESB Networks working assumption that organisational knowledge is 'embedded in people', who must be embedded in the project organisation to participate in the exercise of the Networks PMC as an organisational practice.

[292] ESB interview No. 8, Feb 2011
[293] ESB interview No. 7, Jan 2011
[294] ESB interview No. 12, May 2011

Chapter 7

Empirical Findings & Elaboration of Concepts

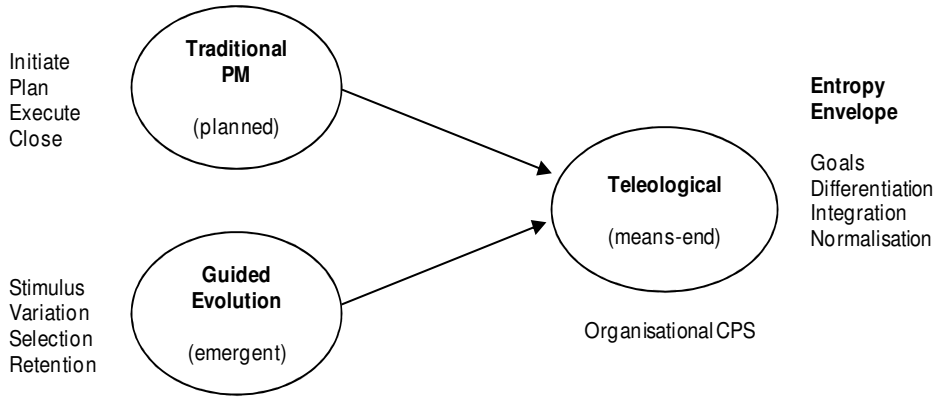
7.1 INTRODUCTION [295]

The main purpose of this chapter is to elaborate further the concepts from Chapter 3, Initial Conceptual Development - Capability Development as Organisational Complex Problem-Solving (CPS), with the case data now presented and, then, to discuss the findings in relation to the data, literature, and conceptual development. The findings revolve around PMC development through complex learning processes based on organisational problem-solving, the central research theme of this study. As previously highlighted, this is an exploratory investigation that is presented in linear sequence, even though it has been a multi-stranded process of inquiry throughout. The data in the study play a dual interactive role of inspiring conceptual development and illustrating their working in different practical settings.

Building on Chapter 3 together with the literature and the case study data, this chapter will show that organisational capability development can be better viewed as means-end teleology, based on organisational CPS, than as either traditional PM or guided-evolution. This synthesis is a key aspect of this study and is shown in Fig. 7.1. The synthesis offers an enhanced description of the capability development process and also offers better prospects for informing management practice. To this end, the discussion will harness the following tentative PM definitions that were presented at the conclusion of Chapter 3, which, taken together, represent an integrated knowledge-based view of projects as process and PM/PMC as organisational practice.

> A project is a mode of organising to accomplish a temporary undertaking.
>
> Project management is an organisational competence in organising to accomplish temporary undertakings.
>
> Project management capability is a strategic organisational competence in organising to accomplish complex temporary undertakings.

[295] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)



Perspective	Approach & Process Group	Key Influences
Traditional PM	Planned --- Initiate Plan Execute Close	PM Professional Bodies - PMI (2004) - APM (2006)
Guided Evolution	Emergent --- Stimulus Variation Selection Retention	**Evolutionary Problem-Solving / Guided Evolution** Campbell (1960); Popper (1972); Lovas & Ghosal (2000) **Capability Development** March (1991); Teece & Pisano (1994); Teece et al. (1997); Zollo & Winter (2002); Teece (2007) **PMC Development** Brady & Davies (2004); Lindkvist (2008); Söderlund (2008); Söderlund et al. (2008)
Teleological	Means-End --- Goals Differentiation Integration Normalisation	**Capability Development – Contingency Approach** Schumpeter (1942); Lewin (1947); Lawrence & Lorsch (1967) **PMC Development – Contingency Approach** Lindkvist et al. (1998); Davies & Brady (2000); Davies & Hobday (2005); Söderlund & Tell (2009) **Teleological Problem-Solving – This Study** Entropy envelope of disorder-order with variable amplitude and velocity. Problem-solving as 'learning-organising' through differentiation-integration. **Projects as Process & PM / PMC as Practice – This Study** A project as a process ... a mode of organising: Weick (1979, 1995); Lundin & Söderholm (1995); Packendorff (1995); Engwall (1998); Engwall et al. (2003); Linehan & Kavanagh (2006) PM as practice: Schön (1983); Engwall (2002); Winter et al. (2006) **PMC Development – This Study** Organisational complex problem-solving (CPS) Goals – Formation – Integration – Normalisation

(Source: This Study)

Fig. 7.1 Organisational Capability Development - From Traditional PM and Guided-Evolution to Teleological

This chapter will critically evaluate the case study data with the literature and the conceptual development as a response to the main Research Question[296] of the investigation. The main process insight of this study is that PMC is seen to be developed as a dynamic organisational capability in complex PM settings through organisational complex problem-solving (CPS). This builds upon and extends the emerging PMC literature with implications for traditional PM research and practice in three main areas. Firstly, the development of PMC as an organisational capability is a learning process of 'dissipative organising' from 'order to *disorder* to order' rather than from 'order to order' under traditional PM. Secondly, the study supports an integrated knowledge-based view of projects as 'process' and PM/PMC as 'practice'. Thirdly, using the lens of PM as practice, a 'distributed organising' approach is suggested for coordinating the formation of 'complex knowledge' under organisational CPS, which is inherently emergent and dynamic. The distributed coordination is based on what this study terms a 'common will of mutual interest' as a distributed tacit dimension (Polanyi, 1967). This contrasts with the 'centralised planning' approach of traditional PM, which assumes that knowledge is manifest in pre-given plans that are executed with little organisational learning expected beyond the application of prior knowledge.

[296] How do learning processes underpin the development of PMC in complex organisational settings?

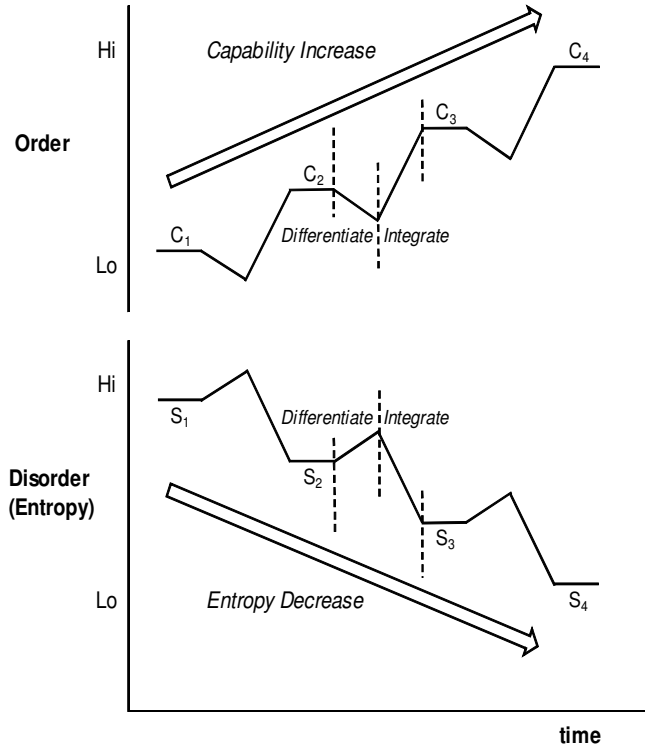
7.2 ORGANISATIONAL CAPABILITY - ELABORATION OF CONCEPTS

This section elaborates on the initial conceptual development of Chapter 3 to discuss the development of organisational capabilities as a multi-cycle learning process based on organisational CPS, the central research theme of this study. This involves activity cycles of differentiation (disorder) and integration (order) that follow a path from 'order to *disorder* to order' rather than from 'order to order'. This conceptual elaboration, which is inspired by the data and the literature, will illuminate, and be illuminated by, the subsequent sections of this chapter as illustrations of the concepts in different practical settings (Siggelkow, 2007).

7.2.1 ORGANISATIONAL CAPABILITY DEVELOPMENT AS INCREASING ORDER

If we consider various cycles of the two-stage problem-solving dialectic of differentiation and integration, Fig. 7.2, organisational capability is developed by a net continuous reduction in the levels of overall entropy (disorder) from S_1 to S_2 to S_3 to S_4, which is paralleled by a net continuous increase in the overall levels of order from C_1 to C_2 to C_3 to C_4. This is a multi-cycle version of the single-cycle model that was introduced in Chapter 3, Fig. 3.3, p. 63. However, because of the way knowledge is created through a two-stage dialectical process, the path from 'order to order' lies from 'order to *disorder* to order'. Thus, for an organisation to develop from a capability level C_2 to C_3, organisational entropy (disorder) must necessarily increase on a temporary basis through differentiation activities before organisational order can be increased to a higher level than before through integration activities.

As illustration, we can see this sequence of 'order-*disorder*-order' unfolding at macro-level and micro-level in the case study database. At macro level, both IE and ESB embarked on delivering their PMC programmes by putting in place organisational forms for their PMCs that were less formal than the main organisation. At project-level, this allowed the project teams to engage in all the necessary disaggregating activities that are necessary before a project is executed, e.g., detail design to component level. Also at macro level, both IE and ESB put in place programme governance arrangements that monitored and controlled the overall programme delivery that were more stringent than the main organisation. At project-level, this was paralleled by frequent communication between team members, both formal and informal, that ensured the ongoing integration of the collective team effort to achieve the overall programme goals.



(Source: This Study)

Fig. 7.2 Organisational Capability Development as Net Entropy Decrease

The research finding of less-structured organisational arrangement in project settings is not new in the literature (Burns & Stalker, 1961). However, what is novel is the underpinning of this finding with a knowledge-creating perspective that is grounded in Popper's (1972/1979) elaboration of the Greek problem-solving dialectic of antithesis and synthesis with the addition of an order-disorder perspective using entropy. With this new perspective, the non-equilibrium process of knowledge-creating innovation is more amenable to robust analysis. Accordingly, what lies beneath Schumpeter's (1942/1976) organisation-driven 'creative destruction' is the desire of organisations and societies to innovate, which can only be done by, firstly, moving from order to disorder before, secondly, reaching a higher level of order. Similarly, if the change is driven by the external environment, organisations need to respond by developing new capabilities, which requires new 'requisite knowledge' to be created to match the external change (Nelson & Winter, 1982). This requires a net increase in order from 'order to *disorder* to order' rather than from 'order to order'. Increasing organisational capability by increasing organisational order is a process of continuous improvement that is potentially open-ended, subject only to the imagination of managerial expertise, Fig. 7.2 (Penrose, 1959/1995).

7.2.2 THE EQUILOGICAL STRUCTURE OF LEARNING PROCESSES

A key contribution of Weick (1979, 1995) is to highlight that organisations are essentially about *organising* and *sense-making* rather than being organised, i.e., organisations are dynamic rather than static. From Chapter 3, the main conceptual insight of this study is that sense-making as knowledge-making involves organising order *and* disorder. This is a synonymous duality process of 'learning-organising' through the knowledge activities of differentiation (disorder) and integration (order), which follows a path from 'order to *disorder* to order' rather than from 'order to order'. The structure of knowledge-creating is viewed as a process that is 'equilogical', which is implicitly multi-path and multi-outcome, Fig. 3.1, p. 60. However, while the structure of learning processes may be equilogical, specific learning processes and learning outcomes are not deterministic. Using a PM analogy, the project life cycle is a logical structure for the delivery of projects that is equilogical for all projects but this does not imply equal outcomes (Morris, 2002). The multi-path aspect of equilogical processes reflects choice over specific processes that may yield different outcomes, while adhering to a common underlying logic.

In so far as the structure of knowledge-creating is equilogical and based on differentiation-integration, this suggests that organisational context plays the role of 'nurture' to initiate, foster, enable, motivate, or unwittingly hinder, the emergence of the equilogical 'nature' of learning processes for strategic objectives. Stated differently, learning processes involve a logical structure of differentiation and integration, regardless of context and regardless of outcomes. However, this chapter will show that, because the structures of PMC complex learning processes are equilogical, the approach to PMC development in IE and ESB needed to be different because their contexts were different. Compared to each other, IE's approach was more emergent than planned and ESB's approach was more planned than emergent, although each approach was planned (learning-before-doing) and emergent (learning-by-doing) on its own terms. This suggests a balance between two sets of requirements, external environment *and* internal learning, rather than a contingent approach that emphasises the environment (Burns & Stalker, 1961).

7.2.3 ORGANISATIONAL CAPABILITY DEVELOPMENT AS ORGANISATIONAL CPS

When the idea of teleology, or means-end, is combined with the key organising activities of differentiation and integration under a problem-solving rubric, a new perspective emerges, namely, 'goals-differentiation-integration-normalisation', which is a key driver of the development process of goals, practice, and learning. This means that the three perspectives on capability development – routines, resources, learning – can be viewed holistically, rather than separately, under a two-stage problem-solving rubric that underpins the mutual constitution of knowledge-creating and organising forms. This occurs through the two-stage problem-solving dialectic of high-entropy disordering differentiation activities followed by low-entropy ordering integration activities as organisational 'complex problem-solving' (CPS), Table 7.1. This is a reformulation of Table 2.7, p. 34, which was previously presented as a synthesis of the literature based on the evolutionary cycle of stimulus-variation-selection-retention, but is now based on means-end teleology, Fig. 7.3.

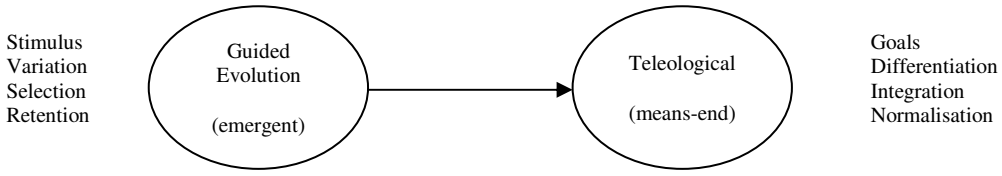


Fig. 7.3 Organisational Capability Development - From Guided-Evolution to Teleological

From the point of view of differentiation activities, Table 7.1, expanded organisational/resource forms accompany the high-entropy problem-solving activities in the business strategy literature, which are manifest as 'adapting' (Teece & Pisano, 1994), 'experience accumulation' (Zollo & Winter, 2002), and 'enhancing' (Teece, 2007). Similarly, in the PM literature, the high-entropy problem-solving activities are manifest as 'variation' (Lindkvist, 2008), 'relating' (Söderlund *et al*., 2008), and 'shifting' (Söderlund, 2008). Neither the expanded organisational/resource forms nor the high-entropy problem-solving activities are a pre-condition of the other. As a mutually constituted synonymous duality, organisational/resource forms and knowledge creation through problem-solving co-exist as mutual pre-requisites, one for the other. The common denominator is entropy expansion that is an attribute of knowledge-creating through high-entropy, disaggregating, problem-solving and more disordered organisational/resource forms. In a PM setting, this is equivalent to the 'feasibility' and 'planning' phases, where design solutions are expanded out

to component level. This simultaneously engenders organisational/resource forms and disaggregating activities as problem-solving knowledge creation.

Teleological		ENTROPY INCREASE	ENTROPY DECREASE	
CAPABILITY DEVELOPMENT →	GOALS	PRACTICE ←---→	LEARNING	DEVELOPMENT
Teleological - Generic				
PROBLEM-SOLVING LEARNING→	GOALS	DIFFERENTIATION	INTEGRATION	NORMALISATION
ORGANISATIONAL CHANGE				
Schumpeter (1942)	business change	destruction	creation	
Lawrence & Lorsch (1967)	business change	differentiation	integration	
Guilford (1956)	goals	divergent	convergent	
Lewin (1947)	business change	unfreeze	change	freeze
ORG. CAPABILITY DEVELOPMENT				
Brown & Duguid (1991)	business objectives	work / practice	learning	innovation
Teece & Pisano (1994)	business change	adapting	integrating	reconfiguring
Teece et al. (1997)	business change	co-ordinating	learning	reconfiguring
Zollo & Winter (2002)	business change	experience accumulation	knowledge articulation	knowledge codification
Teece (2007)	business change	sensing	seizing / combining	reconfiguring
PM CAPABILITY DEVELOPMENT				
Lindkvist & Söderlund (2002) - project level	project goals	variation	learning	
Söderlund et al. (2008) - project level	project goals	relating	reflecting	routinising
Lindkvist (2008) - organisation level	business objectives	variation	learning	retention
Söderlund (2008) - organisation level	business objectives	shifting	adapting	leveraging
Teleological - Problemistic				
PROBLEM-SOLVING LEARNING→	GOALS	DIFFERENTIATION	INTEGRATION	NORMALISATION
ORG. CAPABILITY DEVELOPMENT				
March (1991)	business objectives	exploration	exploitation	
PM CAPABILITY DEVELOPMENT				
Brady & Davies (2004) - organisation level	business objectives	exploration	exploitation	

(Source: This Study)

Table 7.1 Organisational Capability Development as Organisational Complex Problem-Solving

As the second part of the two-stage problem-solving dialectical process that mutually constitutes organising forms and knowledge-creating, the integration activities engender more ordered organisational/resource forms and low-entropy problem-solving activities, Table 7.1. These include the synthesising activities of 'integrating' (Teece & Pisano, 1994), 'knowledge articulation' (Zollo & Winter, 2002), and 'combining' (Teece, 2007) in the business strategy literature, as well as 'learning' (Lindkvist, 2008), 'reflecting' (Söderlund *et*

al., 2008), and 'adapting' (Söderlund, 2008) in the PM literature. Again, the common denominator is the entropy contraction that accompanies more ordered organisational/resource forms and low-entropy aggregating problem-solving. In a PM setting, this is equivalent to 'executing' the design solutions that were previously expanded out to component level during the 'planning' phase. This simultaneously engenders organisational/resource forms and aggregating activities as problem-solving knowledge creation.

When organisational capability development is viewed in terms of exploration and exploitation (March, 1991; Brady & Davies, 2004), this can also be reinterpreted under the teleological approach of goals-differentiation-integration-normalisation but with under-stated normalisation, Table 7.1. In this way, it can be viewed holistically as a two-stage problem-solving dialectic that has knowledge growth and organising form at its heart, which avoids the dichotomisation of exploration and exploitation as unrelated activities (Dosi & Marengo, 1993). Exploration corresponds to knowledge-creating that is characterised by high-entropy disaggregating problem-solving and looser organising forms. In contrast, exploitation corresponds to knowledge-creating that is characterised by low-entropy aggregating problem-solving and tighter, more ordered, organising forms. However, unlike full cycle teleology, capability development through exploration and/or exploitation is more fragmented and *ad hoc* than sustained, which may suit organisations that develop project capabilities with their termination in mind, e.g., the film industry (DeFillippi & Arthur, 1998).

In new product development, the empirical investigation of Schulze and Hoegl (2006) shows that, during the concept phase, Nonaka and Takeuchi's (1995) SECI[297] organisational process of 'socialisation' was positively correlated and 'externalisation' negatively correlated. During the development phase, 'combination' was positively correlated and 'socialisation' and 'internalisation' negatively correlated. This offers empirical support from the literature for the idea that knowledge-creating is grounded in a two-stage problem-solving process of organising activities of differentiation and integration. Using the language of disorder-order, it seems that high-entropy problem-solving during the concept phase is facilitated by high-entropy disorganising activities such as 'socialisation'. Then, low-entropy problem-solving during development is facilitated by low-entropy organising activities such as 'combination'. Furthermore, it seems that high-entropy disaggregating problem-solving takes place at individual level and low-entropy aggregating problem-solving at group level.

[297] SECI model of knowledge creation – socialisation, externalisation, combination, and internalisation

In a further echo of the idea of two-stage problem-solving associated with activities of disaggregating differentiation and aggregating integration, Iansiti and Clark (1994) outline the dynamic capability (DC) development process through the two stages of 'concept development' and 'implementation'. Each stage involves problem-solving but 'concept development' is wide-angle, high-entropy, differentiation, compared to the narrowing that is involved in the 'implementation' stage, which is low-entropy integration. Their view of knowledge is multi-facetted and includes procedural knowledge (know-how), propositional knowledge (know-that), designs, plans, customer needs, etc. In this scheme, it is the integration of the different kinds of existing and new knowledge deriving from problem-solving that forms the basis of the capability building process. Furthermore, in contrast to Schön (1983), Orlikowski (1996, 2002), Nicolini *et al*. (2003), Gherardi (2006), and Tsoukas (1996, 2005), they do not load the knowledge dice in favour of either traditional abstract 'known' knowledge or more recent 'knowing' knowledge. Instead, they adopt an 'extended' Pragmatist approach that seeks to integrate both kinds of knowledge holistically into 'useful actions' that are context specific. Unfortunately, they do not clarify their methodological perspective in respect of knowledge, which is a foundational element of their DC development process, nor do they attempt to define knowledge, preferring, instead, to adopt an instrumental pragmatic approach that is focused on outcomes.

7.2.4 PMC AS ORGANISATIONAL PRACTICE

Using a practice-oriented approach, this study views projects as modes of organising for accomplishing temporary undertakings. As an organisational capability, PMC is viewed as a strategic organisational competence in organising to accomplish complex temporary undertakings. Central to this view are organising activities as modes of learning, or knowledge-creating and organising forms as a mutually constituted duality. If organising activities are linked to the configuration of resources as a form of problem-solving, then, configuring as a mode of organising physical and social resources also involves learning as a mode of 'learning-organising'. In this way, PMC can also be viewed as the enacted competence of an organisation to purposefully configure project resources to deliver stakeholder objectives (Penrose, 1959/1995; Wenger, 2001; Orlikowski, 2002; Tsoukas, 2005; Helfat, 2007). As modes of organising for temporary task-based undertakings, projects are theatres of goal-directed enacting, learning, and development, where learning is a bridge between practice and development that is grounded in problem-solving as a non-equilibrium process of knowledge creation and utilisation (Weick, 1979; Schön, 1983; Brown & Duguid, 1991; Iansiti & Clark, 1994; Lundin & Söderholm, 1995; Lindkvist & Söderlund, 2002).

7.3 PMC DEVELOPMENT CONTEXT - EXTERNAL & INTERNAL

The previous section elaborated further the initial conceptual development from Chapter 3 that capability development can be viewed as a learning process based on organisational CPS, the central research theme of this study. This is grounded in goal-setting teleology, in contrast to guided-evolution with underlying randomness that is better suited to populations than specific projects and organisations (Lovas & Ghosal, 2000). This section begins the discussion of the empirical findings with the external and internal contexts of public sector organisations (PSO) and how these contrast with the private sector for developing PMC. The subsequent sections are broadly organised around the PMC process model that was introduced in Chapter 4 - Methodology as a guide for data collection and analysis, Fig. 4.3, p. 92.

This study differs from PMC development in the empirical PMC literature in three important respects. Firstly, this study has investigated the development of PM as an organisational capability (PMC) through complex learning processes as a central research theme in two government-owned PSOs. This empirical setting contrasts with the PMC literature, which is weighted towards the private sector. Secondly, the focus of much research in PMC development is on project-based organisations (PBO) for which PM is their 'core competence' (Prahalad & Hamel, 1990). For both IE and ESB as PSOs, PMC is an important 'core supporting competence' to their main business of a national train service (IE) and the supply of electricity (ESB). Thirdly, both IE and ESB were subject to a major change in their external environment, which was dynamic and sustained.

Both IE and ESB represent complex organisational settings within a wider public sector that is subject to ongoing government and EU policy (Thompson, 1967). Even though both IE and ESB are 'commercial' state organisations[298] with an expected market ethos, this often conflicts with their public service obligations as delivery agencies of government and EU policy. Accordingly, the New Public Management (NPM) agenda of managerialism, accountability, and value-for-money in commercial PSOs is often balanced by considerations of redistributive public policy (Dunleavy & Hood, 1994; Ferlie, Ashburner, Fitzgerald, & Pettigrew, 1996; Pollitt, 2001). For PSOs charged with delivering capital projects, the NPM environment has been characterised by "uncertainty, ambiguity and stakeholder management

[298] In Ireland, these are referred to as 'commercial semi-state organisations', or 'commercial semi-states'

issues that are multifaceted and complex" (Crawford, Costello, Pollack, & Bentley, 2003, p. 443).

7.4 PMC DEVELOPMENT - DYNAMIC ENVIRONMENTAL STIMULUS

This section will discuss the dynamic economic stimulus of the 2000s and how this was a determinant for the complex problem space/time in which IE and the ESB developed their PMC. This is elaborated in terms of entropy amplitude change (ΔS) and pace of entropy change (dS/dt).

7.4.1 ORGANISATIONAL POSITIONS, PROCESSES, & PROSPECTS

Even though IE and the ESB are both government-owned PSOs, their historical development paths as public utilities have been different, which influenced their respective trajectories with respect to delivering capital projects (Teece *et al*., 1997; Helfat, 2007). In turn, this influenced the organisational capability set that each PSO could use at the start of the 2000s as a foundation on which to develop their PMC in response to the major economic stimulus of the 2000s. In addition, the differential between their prior path positions and the economic stimulus at the outset of the 2000s would determine their entropy envelope in problem space/time, in terms of the amplitude of entropy change (ΔS) and the pace of entropy change (dS/dt) in which their PMC was developed.

7.4.2 DYNAMIC ECONOMIC STIMULUS OF THE 2000S

As discussed in the Literature Review, by the late 1990s, two significant macro-economic events were converging to set the scene for a dramatic increase in the Irish national economy over the following decade. Firstly, the Euro was launched in January 1999 and, three years later in 2002, notes and coins were in circulation. The single currency meant access to credit at low interest rates, which represented a stimulus for investment in both the private and public sectors. Secondly, in 2000, the government launched the first seven-year National Development Plan (NDP, 2000) with a budget of €52bn. This was followed by a successor seven-year plan, from 2007 to 2013, with a budget of €184bn (NDP, 2007).[299] Together, they represented a 14-year government-led programme of investment in national

[299] Revised in 2011

infrastructure totalling approximately €236bn, which would have economic multiplier effects across the entire economy. Because of the under-investment in the railway over previous decades, IE was a direct beneficiary of the NDPs in the 2000s and the ESB was an indirect beneficiary through the economic multiplier effect.

However, the scope and scale of capital projects to be undertaken under the NDPs were not fully known, or agreed, with the government at the outset of the NDPs. Nor was the 7-year budget allocation to IE from the NDP agreed at the outset. Indeed, central government itself was following an incremental approach to the NDPs, because it was impossible to guarantee in advance the exchequer revenues and borrowings required to underwrite the NDPs. In 2000, when the first NDP was launched, no one had clear visibility of the second 7-year NDP (2007) that followed the first 7-year NDP (2000). If economic circumstances had been unfavourable during the first NDP, the second NDP might not have happened. Likewise, if favourable economic conditions had continued, a third NDP may have followed the second NDP and so on.

Therefore, during the 2000s, the development of IE's PMC was more organic than pre-planned (Burns & Stalker, 1961), more emergent than deliberate (Mintzberg & Waters, 1985), with early successes creating a positive dynamic for the continuing development of its PMC.[300] In contrast, when the ESB decided to proceed with the NRP project and develop a Networks PMC, this represented a deliberate, planned, initiative whose scale, scope, timescale, and budgetary implications were appreciated at the outset by ESB's senior management. Importantly, the ESB had influence over the funding for the NRP. Thus, the ESB approach to developing its Networks PMC was more deliberate than IE's emergent approach but the Networks PMC was also emergent on its own terms and IE's PMC was planned on its own terms.

7.4.3 ECONOMIC STIMULUS AS A DETERMINANT OF PMC PROBLEM SPACE/TIME

Using Swinth's (1971) profile of complex organisational problems and their solutions, it can be readily seen that, for IE and ESB Networks, the development of their respective PMC qualifies as complex problem-solving (CPS) in problem space/time that is unstructured and non-linear. For ease of reference, Swinth's profile is repeated as follows (1971, pp. B68-9, italics added):

[300] IE interview No. 13, Mar 2010

(1) Usually the solution must serve a variety of organizational objectives, and satisfy the goals of a number of participants.

(2) *There is typically a high degree of interdependence between parts*. The decisions of any one center frequently have consequence for other centers in the system.

(3) *Such tasks are too complex to be readily understood and solved by one person or group*. It is necessary to put together knowledge, information, and action from several sources.

(4) The cause of the novelty is typically a changing world: change in external environment, or change in the goals of the system. *Or the novelty is in the unknowns at the frontier of knowledge* or at the interface arising from combining existing ideas and techniques in a new way.

As discussed in Chapter 3, Initial Conceptual Development - Capability Development as Organisational Complex Problem-Solving, the entropy envelope of problem-solving can be characterised by the amplitude of entropy change (ΔS) and the pace of entropy change (dS/dt). This is based on the two-stage problem-solving activities of differentiating and integrating, which mutually constitute knowledge-creating and organising forms. Therefore, it seems appropriate to identify criteria from the data that can be used to make a determination of the initial position of IE and the ESB in their respective PMC problem space/time. Accordingly, based on the dataset, seven criteria are offered in Table 7.2 for distinguishing between IE and ESB in problem space/time at the outset of the 2000s. From this, we can profile the respective entropy envelopes within which PMC was developed over time, in terms of the amplitude of entropy change (ΔS) and the pace of entropy change (dS/dt).

The estimates are based on the case study narrative and do not include a weighting of the criteria, which could affect the overall assessment that is shown in Fig. 7.4. The criteria are indicative of the multi-dimensional nature of the PMC problem space/time. Each dimension varies with time and has a varying amplitude (ΔS) and pace of change (dS/dt). The detailed multi-dimensional nature of the PMC problem space/time is beyond the analysis of this exploratory research, which will limit itself to an aggregate assessment of the overall entropy amplitude change (ΔS), the pace of entropy change (dS/dt), and the likely trajectory during the development of PMC. A brief summary of the criteria assessments in Table 7.2 now follows.

Business risk is seen as higher for ESB than IE in this study, because the success of the NRP project was likely to have a greater impact on their business model in the context of a deregulated electricity market. For both IE and ESB, the scope of the multi-annual programme of project delivery that underpinned the development of their respective PMCs

was assessed on a par in terms of entropy amplitude change. IE was assessed higher on the pace of entropy change for this dimension, because the scope of the ESB's NRP project was largely quantifiable from the outset, whereas the scope profile of IE's projects was changing year on year under the NDPs, in consultation with the government. For broadly similar reasons, IE was assessed higher for programme design complexity, both for entropy amplitude change and the pace of entropy change. This reflects an evaluation that the design of the ESB's NRP project for its duration was characterised by more standardisation with local variations compared to the portfolio of IE's projects that was changing substantially year on year with less repetition.

Complex Problem Criteria	Entropy Change (ΔS)			Pace of Entropy Change (dS/dt)		
	Lo	Med	Hi	Lo	Med	Hi
Business Risk		IE	ESB		IE	ESB
Programme Scope Complexity			IE / ESB		ESB	IE
Programme Design Complexity		ESB	IE		ESB	IE
Programme Duration Uncertainty	ESB	IE		ESB	IE	
Programme Funding Uncertainty	ESB	IE		ESB		IE
Regulatory Uncertainty	IE		ESB	IE	ESB	
Stakeholder Uncertainty		IE / ESB			IE / ESB	

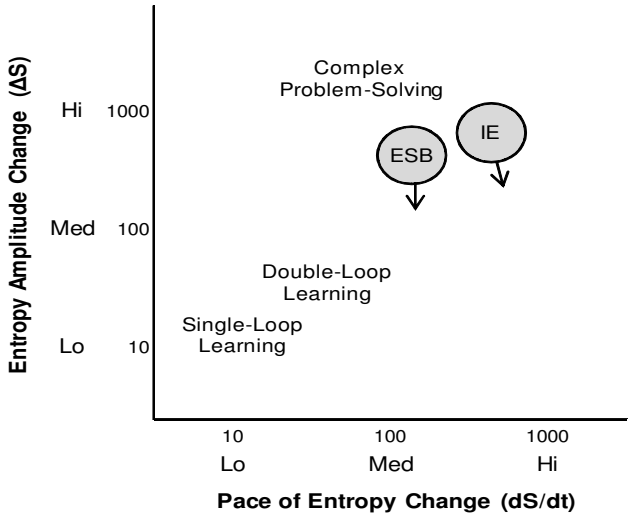
(Source: This Study)

Table 7.2 Problem Space/Time Criteria - IE & ESB, circa 2000

The uncertainty attaching to the programme duration and funding largely go together for public-sector organisations (PSO) like IE and ESB. The ESB was assessed with a lower risk because of its self-financing profile and IE was assessed with a higher risk because of the intrinsic uncertainty attaching to the ongoing funding of the first NDP (2000) and, later, the second NDP (2007).

With regard to regulatory uncertainty, ESB was assessed higher that IE in this study, due mainly to the deregulated electricity market at the outset of the NRP project. This is reflected in a high-level entropy amplitude change for ESB and low-level for IE. However, the pace of entropy change is assessed at medium-level for ESB, because the EU and government policy change for the energy sector, though significant for the ESB, were set to bring about change

that was largely predictable. In contrast, IE's regulatory environment during the 2000s was stable in comparison to the ESB, although this is set to start changing from 2013 onwards. Lastly, stakeholder uncertainty is rated on a par between IE and ESB. Externally, both PSOs were largely working within the envelope of their existing networks, in order to upgrade and enhance their infrastructure. Internally, both PSOs were unionised and procuring external contractors to participate in the development of their PMC to successfully deliver the overall project programme.



(Source: This Study)

Fig. 7.4 Problem Space/Time - PMC Initial Position & Trajectory

The overall initial position of IE and the ESB in their respective PMC problem space/time is shown in Fig. 7.4, together with the estimated trajectory of their positions during the development of their PMCs. This is an aggregation of the seven complex problem criteria in Table 7.2. The evaluation from the database is that the entropy amplitude change reduced for both IE and the ESB over time, in line with the increasing level of maturity of their PMCs. As the competence level of their PMCs grew, each incremental quantum of CPS change, as reflected in new project delivery challenges, caused less entropy amplitude change in the PMC entropy envelope. However, the pace of entropy change continued to increase for IE compared to the ESB, due mainly to the changing scope of their project portfolio year on year under the NDPs and the uncertainty relating to programme funding and duration, both of which have accelerated since the start of the financial crisis in 2008. The overall trajectory in problem space/time influenced contrasting contextual approaches to achieving a comparable objective of PMC development - IE's approach was more emergent than the

ESB's more planned approach, although each approach was emergent and planned on its own terms.

7.5 PMC DEVELOPMENT - PROCESS GROUPS

This section will discuss the process groups of the PMC in IE and the EBS as equilogical variations of goals, formation (differentiation), integration, and normalisation. PMC development is identified as a complex problem setting, which cannot be completely specified in advance and where 'total planning' under traditional PM is untenable. The study proposes distributed organising using a common will of mutual interest for coordinating the interplay between contextual 'knowing' knowledge (know-how, etc.) and abstract 'known' knowledge (design, plans, etc.) (Kolb, 1984).

7.5.1 PMC PROCESS GROUPS AS ORGANISATIONAL CPS

7.5.1.1 PMC Development Levels - IE & ESB

As discussed in detail in the case study, IE's PMC developed as a multi-level PM ecology at five levels during the 2000s - project external, project governance, project organisation, project supervision, and project works staff. This multi-level development process involved knowledge creation and utilisation activities that revolved around cycles of goals, formation (differentiation), integration, and normalisation. In delivering the NRP Project in the ESB, the key PM process activities of goal initiation, planning, executing, and closing with monitoring and control throughout were involved at all levels of ESB Networks PMC - project board, project organisation, project supervision, and project works staff. This approach was formalised in the PMI framework of ESB Networks, which was modelled on the PMBoK of the Project Management Institute (USA) and also revolved around cycles of goals, formation (differentiation), integration, and normalisation. The PMC process groups that were implicated over the project life cycle at each of the levels of PMC development in IE and the ESB are now summarised from the case study narrative and are shown in Table 7.3, which is a reformulated version of the earlier Table 7.1 of this chapter, where Table 7.1 is a reformulation of the earlier Table 2.7, p. 34, in the Literature Review.

Teleological		ENTROPY INCREASE	ENTROPY DECREASE	
CAPABILITY DEVELOPMENT →	**GOALS**	**PRACTICE ←---→ LEARNING**		**DEVELOPMENT**
Teleological - Generic				
PROBLEM-SOLVING LEARNING→	**GOALS**	**DIFFERENTIATION**	**INTEGRATION**	**NORMALISATION**
ORGANISATIONAL CHANGE				
Schumpeter (1942)	business change	destruction	creation	
Lawrence & Lorsch (1967)	business change	differentiation	integration	
Guilford (1956)	goals	divergent	convergent	
Lewin (1947)	business change	unfreeze	change	freeze
ORG. CAPABILITY DEVELOPMENT				
Brown & Duguid (1991)	business objectives	work / practice	learning	innovation
Teece & Pisano (1994)	business change	adapting	integrating	reconfiguring
Teece et al. (1997)	business change	co-ordinating	learning	reconfiguring
Zollo & Winter (2002)	business change	experience accumulation	knowledge articulation	knowledge codification
Teece (2007)	business change	sensing	seizing / combining	reconfiguring
PM CAPABILITY DEVELOPMENT				
Lindkvist & Söderlund (2002) - project level	project goals	variation	learning	
Söderlund et al. (2008) - project level	project goals	relating	reflecting	routinising
Lindkvist (2008) - organisation level	business objectives	variation	learning	retention
Söderlund (2008) - organisation level	business objectives	shifting	adapting	leveraging
PMC Development (IE & ESB)	**Goals**	**Formation**	**Integration**	**Normalisation**
PMC Development - External	goals	consulting	drafting	publishing
PMC Development - Board	goals	devising	implementing	regularising
PMC Development - Organisation	goals	designing	configuring	transferring
PMC Development - Project (Supervision)	goals	planning	executing	handover
PMC Development - Project (Works Staff)	goals	survey/design/plan	implement	handover
monitoring & controlling	→	→	→	→
PM - PMBoK				
PMI (2004) - process groups	initiating	planning	executing	closing
monitoring & controlling	→	→	→	→
Teleological - Problemistic				
PROBLEM-SOLVING LEARNING→	**GOALS**	**DIFFERENTIATION**	**INTEGRATION**	**NORMALISATION**
ORG. CAPABILITY DEVELOPMENT				
March (1991)	business objectives	exploration	exploitation	
PM CAPABILITY DEVELOPMENT				
Brady & Davies (2004) - organisation level	business objectives	exploration	exploitation	

(Source: This Study)

Table 7.3 PMC Development as Organisational Complex Problem-Solving (CPS)

Using Fig. 7.1 as a reference, Table 7.3 summarises the literature and the data in this study as a synthesis of (1) the planned approach of traditional PM with (2) the emergent guided-evolutionary approach of the capability literature into (3) a tentative teleological approach to capability development based on means-end problem-solving learning. Using Daft and Weick's (1984, p. 289) typology of organisational interpretation modes, means-end teleology is equivalent to a 'discovering' mode based on an analysable environment and active search, planned PM is equivalent to a 'conditioned viewing' mode that is also based on an analysable environment but passive search, and emergent guided-evolution is equivalent to an 'enacting' mode based on an unanalysable environment and experimental search. The salient differences appear to be between means-end teleology as a goal-directed active search process and emergent guided-evolution as an undefined experimental search process. In contrast, planned PM appears as goal-driven but with a contingent and passive search process, i.e., without a professional commitment to learning.

The means-end teleological approach of Table 7.3 combines the PMI (2004) heuristic of plan-execute-close with the evolutionary heuristic of variation-selection-retention as manifestations of the logical structure of knowledge-creating in the teleological activities of differentiation-integration-normalisation. This serves to highlight the main process insight of this study, which is that organisational capabilities, including PMC and dynamic capabilities (DC), are developed through learning processes based on organisational CPS. As empirical examples, PMC in IE and the ESB is seen to be developed as an organisational capability through equilogical cycles of goals, formation (differentiation), integration, and normalisation, Table 7.3. This contributes a knowledge-creating perspective based on problem-solving to the PMI's (2004) well-known equilogical process group of initiating, planning, executing, and closing with monitoring and control throughout, Table 7.3. In addition, this also contributes empirical support with a theoretical underpinning for the concept of the 'learning organisation' (Weick & Westley, 1996/2002), which adheres to the same logical structure of differentiation-integration at individual level and organisation level, Fig. 3.1, p. 60 & Table 7.3, p. 187.

The main process insight flows directly from the view in this study that a project is a mode of organising to accomplish a temporary undertaking and PMC is an organisational competence in organising to accomplish complex temporary undertakings, both of which are modes of 'learning-organising'. This involves the equilogical two-stage knowledge creation activities of differentiation-integration that underpin complex problem-solving as an engine of knowledge growth for capability development (Iansiti & Clark, 1994), which progresses from 'order to *disorder* to order' rather than from 'order to order'. Overall, the process

insight is grounded in a cumulative interaction of literature, data, and conceptual development as follows:

(a) Projects and PM as modes of 'learning-organising', Sect. 2.5.2.1.1 & Sect. 3.7
(b) Logical Structure of Knowledge-Creating, Fig. 3.1, p. 60
(c) Knowledge-Creating as Net Entropy Decrease, Fig. 3.3, p. 63
(d) Organisational Capability Development as Net Entropy Decrease, Fig. 7.2, p. 174
(e) PMC Development as Organisational Complex Problem-Solving (CPS), Table 2.7, p. 34, Table 7.1, p. 177, & Table 7.3, p. 187

7.5.1.2 PMC Development - Organisational CPS Learning Mechanisms

The development of PMC in IE and the ESB as a multi-level PM ecology through organisational CPS will now be discussed at project external level, project board level, project organisation level, project supervision level, and project works-staff level. As observed by Bogner and Thomas (1994), "Competencies evolve through an iteration of doing, learning, and doing some more. Each sequence expands knowledge and enriches core competence" (p. 118). However, even though informants in IE and the ESB readily acknowledge *ex post* that new PMC expertise was developed during the 2000s, the details of the learning processes involved in developing capabilities seem largely concealed *ex ante* from PMC practitioners. Following Wenger (2001), this is because they do not think of their practice as learning, even though "what they learn *is* their practice" (p. 95, original italics). Paraphrasing this insight for PMC development, the reason why PMC practitioners do not think of problem-solving as learning is that solving problems '*is*' their job, i.e., their practice.

Thus, as Wittgenstein (1969/1989) observes enigmatically, "practice has to speak for itself" (§139), which implies that the learning processes that are involved in developing a new organisational practice, such as PMC, are displayed in the behaviour of PMC practitioners as they *learn* to practise their new craft through PMC problem-solving (Schön, 1983; Mintzberg, 1979b). This involves the knowledge-creating activities of differentiation and integration, Table, 7.3, which both involve the interplay of contextual 'knowing' knowledge (know-how, etc.) as apprehension and abstract 'known' knowledge (designs, plans, etc.) as comprehension (Popper, 1972/1979; Kolb, 1984).

Project External Level

In the public sector, the Department of Finance (DoF) has a major influence on government policy towards public capital projects that has direct regulatory effect on PSOs that are

funded by central government, including IE. In the early 2000s, the DoF "focused on policy"[301] and issued a Capital Works Management Framework (CWMF) together with a suite of Guidance Notes (GN) and a new form of fixed-price lump-sum contract for consultancy services and construction contracts - the GCCC contracts (Government Construction Contracts Committee). To achieve this level of development, the DoF established clear policy objectives for the delivery of capital works by PSOs. In addition, it consulted widely with the multiple stakeholder groups that were likely to be affected by a change in government policy and with sources of 'best practice' for PMC, national and international. Database DoF excerpt:

> [I]n November/December 2004 we had just started drafting the contracts and we had them to the Industry by June of 2005. And then we had 18 months of ... debate".[302]

Subsequent to the consultative process, the DoF coordinated the drafting of the new PMC framework documents at policy level, as remarked later: "we appointed [X] for the Public Works Contracts and we appointed [Y] to draft a new Consultant's Contract".[303]

Finally, on an ongoing basis, the DoF published the new PMC policy documentation for dissemination across the public sector, including PSOs. The development of PMC at this level was underpinned by iterative feedback processes of monitoring and control, not least through the agency of the Public Accounts Committee of the Dáil[304] and the office of the Comptroller and Auditor General. As modes of learning-organising at this PMC development level, differentiation/formation activities include *consulting* and *benchmarking* with stakeholder groups, integration activities include *drafting* policy documents, and normalisation activities include *publishing* and *disseminating* policy documents, Table 7.3, p. 187.

Project Board Level

As discussed in the case studies, IE and the ESB developed a multi-level project governance structure that included participation at project board level of personnel with significant PM experience in the private and public sectors, domestic and international, as remarked: "these were people who were very senior managers in outside industries".[305] In 2003 in the case of IE, the project board decided to bring a major project in-house, which had been sub-contracted, and complete the delivery with an IE project management team. This triggered additional levels of information on the progress of the project that were devised and

[301] IE interview No. 22, Jan 2011
[302] IE interview No. 22, Jan 2011
[303] IE interview No. 22, Jan 2011
[304] Dáil Éireann, the first chamber of the Ireland's bicameral parliament
[305] IE interview No. 13, Mar 2010

implemented by the project board. The revised reporting requirements then became regularised for subsequent capital projects, as remarked:

> [T]he chairman of ... the advisory group actually then reported ... to the [IE] Board ... that in fact the processes that were being followed were right or, if they weren't right, they ... [could] suggest direction and, in some cases, insist on directional changes.[306]

As modes of learning-organising at this PMC development level, differentiation/formation activities include *devising* project reporting, integration activities include *implementing* reporting formats and review, and normalisation activities include *regularising* reporting content and review, Table 7.3, p. 187.

Project Organisation Level

This was a key level of PMC development in IE, as it represented an interface between, on one hand, senior management and IE's Board and, on the other hand, the project delivery resource levels. Priorities at this level included defining project goals around the 3-pillars of scope, budget, and timescale, as remarked: "it all came down to those 3-pillars [scope, budget, timescale] … if you got those three right, you were delivering!"[307] In addition, senior management prioritised drafting and issuing PM procedures and the provision of systems for procurement, planning, and finance. Database excerpt:

> So, at the centre you had the 3-pillars [project goals - scope, budget, timescale] and, then, it was how we brought about improvements to those and it was based on the procedures, systems, people, and, then, the organisational structure ... [as] the surrounding envelope.[308]

In IE, organisational arrangements needed to be designed and configured to support the development of its PMC to deliver its programme of projects under the NDPs. In this, an emergent approach was taken to organisational arrangements, which revolved around a combination of function and "the expertise that is available to us"[309] rather than function alone.

Likewise in ESB Networks, a key priority was designing its organisational arrangements to facilitate the development of its Networks PMC. The approach was more deliberate than in IE and revolved around function and recruited expertise, as remarked by senior management: "we design the organisation ... and [then] we put people into them".[310] Initiating and controlling were also key activities of the PMI Process Groups, i.e., "you start off in a

[306] IE interview No. 13, Mar 2010
[307] IE interview No. 19, Aug 2010
[308] IE interview No. 19, Aug 2010
[309] IE interview No. 14, Mar 2010
[310] ESB interview No. 7, Jan 2011

particular way, you have structured review meetings, you have a formalised change process".[311] During the NRP project, project reporting was a constant feature - weekly, monthly, and quarterly. Using a partnership approach, these meetings greatly facilitated the exchange of information and the experiences of the collective action of delivering the NRP project (Czarniawska-Joerges, 1989, 1992), as remarked: "while that [PMI Procedures] was a great set of tools, we also needed to create certain fora for the sharing of information among supervisors and clerks of work".[312] The communication of the tacit dimension of the experience of collective action served to further entrain a common will of mutual interest in the NRP project goals among the project team. Communal leadership also played an important role in promoting shared goals and team working.[313]

From a knowledge-based view, the sharing and transfer of PMC expertise was not considered totally satisfactory by senior management in both IE and the ESB. Some felt that the traditional 'lessons learned' process of documenting informational knowledge might be missing the experiential knowledge that resides in "people's heads",[314] which is more informal and difficult to document than formal 'known' knowledge (design, plans, etc.). In the words of one informant, "there's a much more informal type of sharing that's not only lessons learned"[315] This finding is prevalent across the PM knowledge management literature, which runs counter to the traditional PM assumption that knowledge is something that can be detached from the knowing subject (Egbu, 2004; Anumba, Egbu, & Carrillo, 2005). Database excerpt:

> [I]t occurred to me that the conversation we had was based mainly on our experiences. /.../ And we discussed the implications of doing something and I realised, afterwards, [that] I don't think there's a manual in the country that it would be written in.[316]

As modes of learning-organising at this PMC development level, differentiation/formation activities include *designing* organisational arrangements, integration activities include *configuring* organisational arrangements, and normalisation activities include *transferring* PMC expertise across the organisation through flexible organisational arrangements, Table 7.3, p. 187 (Teece & Pisano, 1994; Teece *et al*., 1997; Teece, 2007).

[311] ESB interview No. 14, Jun 2011
[312] ESB interview No. 12, May 2011
[313] ESB interview No. 12, May 2011
[314] IE interview No. 13, Mar 2010
[315] ESB interview No. 12, May 2011
[316] IE interview No. 31, Jul 2011

Project Supervision Level

This is the PMC level where continuous day-to-day PM takes place, in contrast to the policy and organisational levels of PMC where activity can be more punctuated. During the 2000s, hundreds of capital projects were successfully delivered by IE that ranged in budget from small to medium, to large, to major projects - see Figs. 1.1 & 1.2, p. 7. At the project supervision level of IE's PMC, the process group activities revolved around "Board approval, budget, CRS, planning, reporting, handover"[317], which resonates with the PM literature, especially the PMBOKs of the professional bodies (PMI, 2004; APM, 2006). However, in the PMBoKs, the idea of PM as an organisational capability (PMC) is under-developed and, moreover, the PMI process group is functional in orientation without a theoretical underpinning. This study contributes a knowledge-creating learning perspective based on problem-solving to the PMI's well-known process group of initiating, planning, executing, and closing with monitoring and control throughout.

At project level (supervision) of the Networks PMC in the ESB, planning, execution, and controlling processes were crucial for delivering the NRP project to achieve overall project goals. Moreover, this process group was mandated by the Project Management Initiative (PMI) of ESB Networks for delivering the NRP project, which was explicitly based on the PMBoK of the US-based Project Management Institute (PMI, 2004).[318] In this, collective action was underpinned through ongoing meetings by participants re-living their experience of delivering the project for others to absorb the information as a re-enacted experience. In this way, it became a communal virtual experience that served to further entrain a common will of mutual interest in the NRP project goals (Czarniawska-Joerges, 1989, 1992), as remarked:

> [M]any of these things are sitting around the table in a conference room, talking about it and that's how we would have rolled this out, in that sort of format. And, typically, you'd go through work examples and so on."[319]

From a knowledge-based view, it was recognised by experienced PM personnel in both IE and the ESB that PM expertise was a combination of theory and practice that comprised documented procedures, informal knowing, and knowledge that could be displayed but not explicated. As part of the PMC's common will of mutual interest, networks of knowledgeable personnel were important as repositories of insights into 'why' things were done as opposed to 'how' things were done. What was invisible to the naked eye was the communication of the tacit dimension of 'expert' knowledge between different practitioners,

[317] IE interview No. 11, May 2009
[318] ESB interview No. 6, Jan 2011
[319] ESB interview No. 12, May 2011

which is driven by a common will to commune their experiences (Polanyi, 1967), as remarked:

> [W]hen standards were pretty new in the system, you just referred to the people who originally developed the standards, because they had the reasoning and thought process 'why things were done'.[320]

As modes of learning-organising at this PMC development level, differentiation/formation activities include *planning* project works, integration activities include *executing* project works, and normalisation activities include the *handover* of projects to stakeholder clients, Table 7.3, p. 187 (PMI, 2004; APM, 2006).

Project Works Staff Level

At this PMC level in IE, the process group was a reflection of the process group at project supervisory level and was summarised by an informant as "survey, design, plan, and implement"[321], which can be represented as goals, plan (survey, design), implement, and handover with monitoring and control throughout (PMI, 2004; APM, 2006). From a knowledge-based view, PMC expertise in IE was traditionally acquired through a craft approach of on-the-job training, when, as a new employee, "[y]ou went straight out, you were probably in with a gang and you learned from them".[322] This has recently changed to a competency-based approach of formal training and practice. Nevertheless, practical knowledge is valued among works staff, which is supported by the close-knit community of gangers and works gangs that embodies its common will of mutual interest, "for instance, if one gang got a new tool, the other gang will have a look to see how it works".[323] What is invisible to the eye is the communication of the tacit dimension of 'expert' know-how between different practitioners that is driven by a common will to commune their experiences (Polanyi, 1967; Czarniawska-Joerges, 1989, 1992). This organisational unit structure has remained largely unchanged throughout the 2000s.

At project level (works staff) of the Networks PMC in the ESB, the roll-out of the PMI was practice-led and supported by procedures, rather than *vice versa*. The NRP project provided a unique learning environment with up to 1,800 EU-wide contractor personnel comprising 17 nationalities provided by about 14 contracting companies. Learning was a two-way process with contractors and ESB Networks' personnel learning from one another, as remarked: "it has worked very well, in the sense that we found contractors doing things that we wouldn't

[320] IE interview No. 17, Aug 2010
[321] IE interview No. 28, Jun 2011
[322] IE interview No. 33, Jul 2011
[323] IE interview No. 33, Jul 2011

have done and [reflected] 'I wonder would that ... work for us?'."[324] Under the pro-active leadership of the NRP project, collaborative teamwork, trust, motivation, peer pressure, and commercial reward were all at play in the forging of a common will of mutual interest to deliver the NRP project.

As modes of learning-organising at this PMC development level, differentiation/formation activities include *planning* project tasks, integration activities include *implementing* project tasks, and normalisation activities include the *handover* of project tasks to other project team members, Table 7.3, p. 187.

Multi-Level PMC Coordination as a Common Will of Mutual Interest

The PMC process groups of IE and the ESB that are summarised in Table 7.3, p. 187, as 'goals-formation-integration-normalisation' highlight the two-stage problem-solving processes of differentiation/formation (disorder) and integration (order) that take place in tandem at the five levels of PMC development as a PM ecology (Grabher, 2002, 2004). In this, the entropy envelope of PMC development in IE and the ESB was multi-level and interrelated. In PM, it is plausible to propose the development of local PM expertise as an exercise in traditional PM. This assumes knowledge is detached from the knowing subject and can be applied by a competent PM practitioner to an agreed project plan. However, this is less plausible in the multi-level complex project environment of PMC development as an organisational capability. In contrast, this is an exercise in organisational CPS, where a complete knowledge of a complex project and its solution is not given to a single individual but to the project team as a whole as an emergent enactment of distributed organising (Hayek, 1945).

Based on the case data, this study suggests that the development of a PMC in IE and the ESB would not have been possible without the agency of a distributed coordinating mechanism, such as a common will of mutual interest, which was fostered and paced by goal alignment at organisation level, government level, and EU level. This bottom-up view of organisational knowledge resonates with the idea of organisations as systems of distributed knowledge rather than concentrated knowledge (Tsoukas, 1996, 2005; Orlikowski, 2002; Nicolini *et al*., 2003; Gherardi, 2006). Under this view, organisational capability is a competence that is enacted through the distributed knowledge of its practitioners. This study supports this view and extends it with the addition of a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967) for coordinating the interplay of tacit rationality between

[324] ESB interview No. 5, Jan 2011

contextual 'knowing' knowledge (know-how, etc.) and abstract 'known' knowledge (designs, plans, etc.) (Kolb, 1984). Importantly, a common will of mutual interest needs ongoing pacing as a mutual commitment that is based on the willingness of all who participate in, and benefit from, its mutual purpose. An important meaning of 'context', then, is the contextual specificity of 'knowing' knowledge, which is an irreversible process through space/time. This contrasts with abstract 'known' knowledge, which is regarded as reversible and relatively 'timeless'.

7.5.2 PMC AS A DYNAMIC ORGANISATIONAL CAPABILITY

As previously discussed, the literature on dynamic capabilities (DC) revolves around business practices that are brought into play in response to the stimulus of a changing environment, where DC practices involve a combination of organisational routines, resources, and learning. The changing organisational environment can be either internal or external, which acts as a change dynamic for business problems that require problem-solving through management decision-making (Hayek, 1945). The development of organisational capabilities can be viewed as a problem-solving response to a change in the knowledge equilibrium of the environment that has created problems or opportunities for the organisation. This is a development process of 'dissipative organising' that involves the three aspects of stimulus, inquiry, and form (Prigogine, 1980). The stimulus is the problem to be solved, the problem-solving inquiry consists of the differentiation-integration activities, and inquiry and organising forms are a synonymous duality of 'learning-organising'.

As learning processes, practitioner heuristics are intrinsically dynamical. However, the learning dynamics are second-order to the first-order environmental change dynamics. Using a resource perspective, the focus of DC is on purposefully adapting the organisation's resource base in response to environmental change (Helfat, 2007), which is a knowledge-cum-resource view and akin to a strategic capability (Chandler, 1990). The cycle starts with a change in the knowledge environment and ends with the resource base being adapted by management through problem-solving heuristics that create and utilise knowledge with which to reconfigure the resource base. Accordingly, the PMC that was developed in IE and ESB can be regarded as a strategic capability or a dynamic organisational capability (Söderlund, 2005, 2008; Söderlund & Tell, 2009) or as a PM innovation capability (Davies & Hobday, 2005; Brady & Hobday, 2011). As a 'core supporting competence' in IE and the ESB as PSOs, PMC can also be regarded as a dynamic capability (Winter, 2003).

A common aspect of organisational capabilities, including DC, is the complex organisational environments in which they are developed, both in the private and public sectors. This study has shown that organisational CPS, based on knowledge-creating activities of differentiation (disorder) and integration (order), underpins capability development across the business and PM domains, in both the private and public sectors. Accordingly, this study supports a view that organisational capability development, including DC, is a form of organisational CPS, Table 7.3, p. 187.

7.5.3 PLC-ENTRAINMENT

From a knowledge-based view, the capability development process can be understood as problem-solving cycles of goals (objectives), practice (enactment), learning (enactment), which together promote development (normalisation). The project life cycle (PLC) is a defining characteristic that demarcates project management from other areas of management. In this, project goal-setting is the main driver of the teleological process of problem-solving that underpins the development of PMC as an organisational capability throughout the project life cycle (Morris, 2002; Van de Ven, 1992). Accordingly, it is useful to think of the PLC as a meta-level goal, or metronome, or entrainment device, which sets the pace for the goal-driven problem-solving and learning that underpins the development of PMC throughout the project life cycle (Lindkvist *et al*., 1998; Söderlund, 2010).

This PLC pace-setting is termed in this study 'PLC-entrainment' and is manifest in the tacit pulse, or beating heart, of the problem-solving project management process of goal-setting, planning, executing, and closure (PMI, 2004; APM, 2006). This underpins the PMC developmental cycle of goals, practice, and learning at all levels of the organisation (Kreiner, 2002; Enberg *et al*., 2006). In addition to PLC-entrainment as an overall goal-driver, a key element of the PMC development cycle is practice as a process of learning (Wenger, 2001). As a 'complex organisational practice', PMC is a goal-directed, problem-solving, generative process for knowledge creation and utilisation to successfully deliver complex temporary undertakings. This is manifest in the equilogical PMC process group of goals, formation (differentiation), integration, and normalisation, Table 7.3, p. 187.

If the life cycle of a project is divided into different phases of goal-setting, planning, execution, and closure (Adams & Barndt, 1983; King & Cleland, 1983; PMI, 2004), the overall PLC-entrainment of the project triggers in each phase of the life cycle a process group mini-cycle of goals, formation (differentiation), integration, and normalisation. This

engenders a PMC developmental cycle of goals, practice, learning, and development. Thus, the first phase of goal-setting triggers a process group mini-cycle of goals, formation (differentiation), integration, and normalisation together with a PMC developmental mini-cycle of goals, practice, learning, and development. And so on for the other project phases of planning, execution, and closure. Therefore, within each phase of the project life cycle and throughout the life cycle from start to finish, the PLC-entrained, problem-solving, practice of PM engenders multiple process groups of goals, formation (differentiation), integration, and normalisation together with PMC developmental cycles of goals, practice, learning, and development. In IE and the ESB, the development of a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967) was fostered around overall project goals that were challenging for both organisations. Furthermore, this common will was paced towards achieving the mutual goals of project delivery and PMC development using the project life cycle as an entrainment heuristic (Lindkvist *et al*., 1998; Kreiner, 2002; Enberg *et al*., 2006; Söderlund, 2010).

As Czarniawska-Joerges (1992, p. 33) observes, collective meaning is not required for collective behaviour but, rather, the sharing of the *experience* of collective action. People of a similar culture can share the communal experience of its enactment but can have different interpretations of its meaning. In developing a PMC in IE and ESB Networks, the fostering and pacing of project goals through PLC-entrainment enabled the convergence of multiple meanings, or "subuniverses of meaning" (Berger & Luckmann, p. 86), to a narrow distribution around a desired target.

7.5.4 A COMMON WILL OF MUTUAL INTEREST IN ORGANISATIONAL CPS

Once Hayek's (1945) 'specification problem' is acknowledged in complex PM settings, it is no longer tenable to proceed under the assumption of 'total planning' of traditional PM. Briefly, Hayek (1945) highlighted a practical knowledge problem in complex problem settings, because the complete data are never given "to a single mind which could work out the implications, and can never be so given" (p. 519), which he describes as "a problem of the utilization of knowledge not given to anyone in its totality" (p. 520). The knowledge Hayek (1945) had in mind was contextual knowledge that was only known to the "man on the spot" (p. 524), which can be viewed as 'knowing' knowledge. He recommended that any solution to this practical problem needed to use contextual knowledge "that is dispersed among many people" (*ibid*., p. 530).

This study proposes that complex projects, too, cannot be *completely* specified or comprehended in advance by a single individual, except in outline or in part (Smith, 1776/1981; Hayek, 1945; Swinth, 1971; Weinberg, 2001; Snowden, 2002). The total complexity is not 'given' to a single individual nor can it be, because it is like an emergent prototype with incomplete Lego blocks of knowledge. Even with a team of planners on a complex project, if no single individual can comprehend the project interconnectivity in its entirety, then, no one can preclude the possibility of 'gaps' between constituent parts of the plan. While adjacent interfaces can be detailed between parts of a linear plan like links in a chain, this approach may reduce but not eliminate the potential for 'gaps' in a complex 'network' plan that no single individual comprehends in its entirety, e.g., PERT diagrams.[325] These gaps are like untapped knowledge, or 'unknown knowns' (Cleden, 2009), that may exist at the outset of the project or emerge over time. Using metaphors to synthesise the literature and the data, complex problem-solving (CPS) is more like painting a landscape than the mechanical assembly of an elaborate jigsaw. In a jigsaw, the pieces and their connectivity are known in advance but, in a landscape painting, while the major features may be known in outline in advance, the final connectivity has yet to emerge due to shifting light, clouds, shadows, etc.

This implies that distributed organising is more appropriate in complex projects for coordinating the interplay of tacit rationality between 'knowing' knowledge and abstract 'known' knowledge than up-front centralised knowledge planning under traditional PM. However, once distributed organising is accepted as a complement to centralised planning, a coordinating mechanism is needed to achieve the mutual purpose of the organisation. When approached under a framework of mutual interest, distributed organising is no less rational than centralised planning under traditional PM or less rational than neo-classical economics under Adam Smith's (1776/1981) 'invisible hand' of self-interest. Indeed, when knowledge is recognised as inseparable from the knowing subject, the potential for knowledge synergy is greater, because contextual 'knowing' knowledge is now included, as well as conventional 'known' knowledge.

7.5.4.1 A Common Will as a Distributed Tacit Dimension

The tacit dimension of knowledge is particularly relevant for the generation of new knowledge and is the basis of Polanyi's (1967) resolution of the *Meno* paradox in Plato's Dialogues. The paradox refers to the difficulty in rationalising the search for knowledge or truth: if knowledge is already known, there is no need to search for it; and, if knowledge is

[325] Project Evaluation and Review Technique (PERT)

not already known, it will not be recognised when encountered. Polanyi's response to the *Meno* paradox is based on his concept of "tacit foreknowledge", which is "the intimation of something hidden, which we may yet discover" (Polanyi, 1967, pp. 22-23), that is, a kind of 'tacit knowing'. This is the same kind of 'tacit knowing' that is involved in holding knowledge and seeing a problem, which leads to the growth of knowledge by seeing an undiscovered reality beyond the gaps in existing knowledge. In this way, it can fill the 'missing gaps' in existing knowledge.

Because the acquisition and holding of knowledge and also seeing a problem are largely unspecifiable by the knowing subject, this runs counter to the tradition of Positivism and, yet, remains an 'unaccountable element' of scientific knowledge and of all knowledge (Polanyi, 1961). This resonates with Popper's (1935/2007) "creative intuition" (p. 8) and Peirce's (1931-1958) 'abduction' regarding the growth of knowledge. Using the lens of foreknowledge, a complex problem is a problem that is unspecifiable, except in outline or in part, which is held in common by a group of people. Its solution is generally not known in advance but, rather, relies on a distributed tacit foreknowledge that is marshalled by a common will of mutual interest as an emergent and distributed tacit dimension of 'tacit foreknowledge' (Polanyi, 1967).

7.5.4.2 Fostering and Pacing a Common Will of Mutual Interest

Unlike Adam Smith's (1776/1981) 'invisible hand', which promotes the common good through uncoordinated self-interest, a 'common will of mutual interest' is more like a team spirit that promotes a mutual interest through coordinated actions. The mutual purpose is reflected in the pulse of the PLC-entrainment that is engendered by the project life cycle and permeates the problem-solving activities of the project team (Lindkvist *et al*., 1998; Söderlund, 2010). As a consequence, the PMC developmental cycle of goals, practice, learning, and development, at all levels of the organisation, is underpinned by the PLC-entrainment as a tacit pace-setting heuristic, a distributed tacit dimension (Polanyi, 1967; Kreiner, 2002; Enberg *et al*., 2006). It represents the hidden reality of the project as an entity that is better characterised as 'becoming' than 'being', better 'actor' than 'object', respectively (Engwall, 1998; Linehan & Kavanagh, 2006). In so far as delivering a project is partly about discovering its hidden reality, because project plans and designs can never be complete, "project execution is seldom a process of implementation; rather it is a journey of *knowledge creation*" (Engwall, 2002, p. 277, italics added).

A common will is understood as a distributed tacit dimension (Polanyi, 1967) for coordinating the interplay of tacit rationality between 'knowing' and 'known' knowledge towards achieving a mutual group objective. A key aspect of a common will lies in its *mutual* character rather than in a 'shared' or 'collective' characterisation. If the idea of a common will is informed by 'bottom-up' mutuality, or heterarchy, the idea of a 'collective will' is informed by 'top-down' hierarchy. This can assume a logical sequence from family to clan to society, where the individual can become subservient to the transcendent 'will' of the collective with ethical implications of an institutional nature (Berger & Luckmann, 1967; Giddens, 1984/2007). In a game of football, the players have a 'mutual interest' in the result of the game, which rewards active participation, whereas the spectators have a 'shared interest' that allows a more passive engagement in the same endeavour. And like PLC-entrainment over a project life cycle, the pacing of a common will in a football game is entrained by the time on the game clock, which focuses the creation of contextual football 'know-how' on achieving a mutual goal!

Thus, fostering a common will around a mutual goal that is challenging and pacing a common will towards achieving the mutual objective are two separate but crucial ingredients for overall project success in complex organisational settings. A good example of fostering and pacing a common will from the historical record is President Kennedy's exhortation to the American people in 1962[326] to commit themselves to the tasks of sending a man to the Moon and back safely by the end of the decade, 'not because they are easy tasks but because they are hard'. This challenging complex project goal was achieved in 1969. In both IE and the ESB, the development of a PMC was an organisational challenge whose realisation was grounded in a common will that was fostered and paced around project goals through strong communal leadership and teamworking. In addition, ongoing project team meetings served to maintain the entrainment of a common will of mutual interest in project goals by participants re-enacting their experience of delivering projects for others to absorb the information as a virtual experience (Czarniawska-Joerges, 1989, 1992). This idea of fostering and pacing a common will of mutual interest is exemplified by management informants in IE and ESB Networks:

> Generically, you have to get clarity about what the goals are and translate that to the guys who're going to deliver them. You must empower them and support them ... With the core team, you have to have teamwork and ... find a collective solution.[327]

> Your job is almost to create the atmosphere where people are empowered to make decisions and move forward and to create the energy in the team and ... creating a level of harmony and common purpose in the team as a whole ... [X] did that very well, where, as a team as a whole, we had a common goal.[328]

[326] Speech delivered at Rice University, Houston, Texas, USA, on 12 September 1962
[327] IE interview No. 7, Jul 2008
[328] ESB interview No. 12, May 2011

7.5.4.3 Distributed Organising and a Common Will of Mutual Interest

A common will of mutual interest is indispensible for the distributed organising of the PMC's contextual 'knowing' knowledge (know-how, etc.) that complements the abstract 'known' knowledge of the project (designs, plans, etc.). It achieves this partly through what Polanyi (1967) calls "mutual control" (p. 72) for the growth of knowledge across the organisational levels of the PMC, which involves self-discipline through the mutual authority of participating in the governance structure of the project and self-coordination through mutual adjustment (Polanyi, 1969). Like Adam Smith's (1776/1981) 'invisible hand' of self-interest in market economics, the key aspect of a 'common will of mutual interest' in complex problem-solving (CPS) is that it does not require any single person to comprehend either the problem or its solution in its entirety. What is crucial is that the complexity of the problem in space/time is understood in its entirety by the project team as an emergent entity with every actor understanding and contributing their own part of the solution in space/time in a bottom-up way. This does not preclude a high-level appreciation of the complex problem by a single individual but prevents the comprehension of its complex entirety by a single individual in a top-down fashion (Swinth, 1971; Weinberg, 2001; Snowden, 2002).

This study makes a distinction between Adam Smith's (1776/1981) 'invisible hand' of self-interest in market economics and a 'common will' based on a mutual interest in a shared goal. Both are a kind of distributed tacit dimension of 'tacit foreknowledge' (Polanyi, 1967) but, as Hayek (1945) points out, the actor has no overall sight of the common goal in market economics, whereas, in delivering complex projects, the project team is very aware of the overall goals around which a common will is fostered. Crucially, in both cases, the total complexity is not 'given' to a single individual nor can it be, because it is emergent with incomplete knowledge. Both mechanisms coordinate the complementary interplay of tacit rationality between distributed 'knowing' knowledge, which is contextual, and abstract 'known' knowledge that can be more centralised. In relation to the 'invisible hand' of self-interest, what is less commented upon is the 'common will' of society on which it depends, which is the intersection of economics and politics and beyond this study. Briefly, the 'invisible hand' approach to market economics is permitted to operate in order to fulfil the broader aspirations of society and is constrained when it is perceived to be inimical to the interests of society. In other words, the 'invisible hand' is the servant of the implicit 'common will' of society. This means that the 'invisible hand' is alive and well in

developing organisational capabilities, such as a PMC in IE and the ESB, but as a servant of a 'common will' of delivering complex projects, which is explicit rather than implicit.

In IE and the ESB, documented PM procedures did not exist to the same extent before the development of their PMCs. The real value of the new documented procedures was their role as 'scaffolding' for establishing a consensus among project team members for the effective implementation of PMC by coordinating the behaviour of project team members as a distributed organisational practice (Nightingale & Brady, 2011). This facilitated the synthesis of abstract 'known' knowledge with contextual 'knowing' knowledge (Bruner, 1986; Orlikowski, 2002, 2006) through a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967), as remarked:

> Yes, and the wonderful thing about that [PMI Procedures] was that it started us, as a group, as both managers and supervisors particularly, speaking a common language. Prior to that, if you spoke to any of our staff about scope, or bills of quantities, or schedules of rates, they were an alien language. /.../ After this was rolled out ... it became the common language and it supported the interchange of information.[329]

Nevertheless, experienced project managers in both organisations appreciate the limitations of documented procedures and understand that expert knowledge is embodied in expert practitioners whose expertise is on display but largely undocumented.[330] Such individuals fill the missing gaps in documented procedures for new practitioners, because they understand the 'why' behind the 'what' and the 'how' of the procedure.[331] What remains invisible to the naked eye is the communication of the tacit dimension of 'expert' knowledge between practitioners at different levels of expertise, which is driven by a common will to commune their experiences (Polanyi, 1967; Czarniawska-Joerges, 1989, 1992).

7.5.4.4 Complex PM as Bounded Planning

The idea of a common will of mutual interest in CPS does not mean that complex projects cannot, or should not, be planned but that complex projects cannot be *completely* planned in advance of their delivery (Geraldi *et al*., 2011; Nightingale & Brady, 2011). Paraphrasing Simon (1945/1997), this study suggests that complex projects can only be 'boundedly' planned. For example, not every element of the space mission to the Moon and back was planned in advance nor could it be, because its total complexity could not be *completely* specified or comprehended in advance by a single individual, except in outline or in part (Smith, 1776/1981; Hayek, 1945). The total complexity was not 'given' to a single individual nor could it be, because it is like an emergent prototype with incomplete Lego

[329] ESB interview No. 12, May 2011
[330] IE interview No. 26, May 2011
[331] IE interview No. 17, Aug 2010

blocks of knowledge. Nor was the voyage of Columbus to the New World completely planned in advance nor could it be.

However, in both cases, when the abstract 'known' knowledge of the preparatory planning was coupled with a common will of mutual interest of the entire team as a mechanism of mutual control, this ensured a tacit convergence on the mission goals at all times and the generation of the unspecifiable 'knowing' knowledge, or missing knowledge, when required (Nightingale & Brady, 2011). Nevertheless, as with the development of the US Polaris submarine project in the 1950s, the sensibilities of Western attitudes to knowledge based on technical rationality require an emphasis on abstract 'known' knowledge at the outset of a project that is detached from the knowing subject (Sapolsky, 1972; Spinardi, 1994). This is to the detriment of a more realistic socio-technical perspective, which is supported by this study (Lenfle & Loch, 2010). It is not a choice between 'objectivity' based on abstract 'known' knowledge and 'subjectivity' based on 'knowing' knowledge but, rather, a necessary synthesis of both over the project life cycle, which is largely absent from the business and PM literatures (Cook & Brown, 1999). The bounded nature of complex projects may require more exploratory mini-projects before undertaking major projects, as remarked:

> [In project X], if the company had undertaken pre-tender shutdowns for a month to completely flesh-out the design ... it would have been better for the project. In [Project Y], they did better pre-tender site investigations and were able to move services out of the way, so that, when the contractor hit the site, there were less surprises, delay, disruption, and cost.[332]

If complex projects are limited to bounded planning, this recalls Eisenhower's aphorism that "plans are nothing, planning is everything", which suggests that Eisenhower felt that military projects were modes of planning, or modes of organising. More subtly, it suggests that the abstract 'known' knowledge of plans may not be capable of mapping complex military environments or adequate for coordinating a response to a changing complex environment, both of which are better achieved through the 'knowing' knowledge of the lived planning process. In this, Eisenhower implicitly acknowledges that knowledgeability of a complex military environment is difficult to separate from knowing subjects. Borrowing from Eisenhower for organisations, this study suggests that '*organisations are nothing, organising is everything*'. And because organisations are about organising and sense-making (Weick, 1979, 1995), projects as modes of organising are essentially about knowledge-making, or knowledge-creating. In project settings, this study supports a view that sense-making occurs largely through problem-solving.

[332] IE interview No. 7, Jul 2008

7.5.4.5 PM Theory Development and a Common Will of Mutual Interest

This study is aware of the epistemological issues for PM research that are raised by the idea of a common will of mutual interest. As a form of knowledge, it does not conform either to propositional 'known' knowledge or to procedural 'knowing' knowledge (Ryle, 1949). However, its presence and absence is clearly recognisable as 'team spirit', 'morale', etc., which is beyond the norms of technical rationality. This study proposes that a 'common will of mutual interest' is a kind of distributed tacit dimension (Polanyi, 1962/1974, 1967) that is akin to Hayek's (1945) interpretation of Adam Smith's (1981/1776) 'invisible hand' of self-interest for coordinating the interplay of tacit rationality between contextual 'knowing' knowledge and abstract 'known' knowledge. This study conjectures that beehives, as complex organisational settings, operate with a 'common will' that is motivated by mutual interest rather than an 'invisible hand' of self-interest. Neo-classical economics is grounded in a 'rational actor' model and Adam Smith's 'invisible hand' of self-interest within a pragmatic Positivist perspective. In the same way, traditional PM can enhance its Positivist perspective as pragmatic Positivism by viewing PMC as a 'complex organisational practice' comprised of rational actors that participate in forging a 'common will of mutual interest' to achieve project goals.

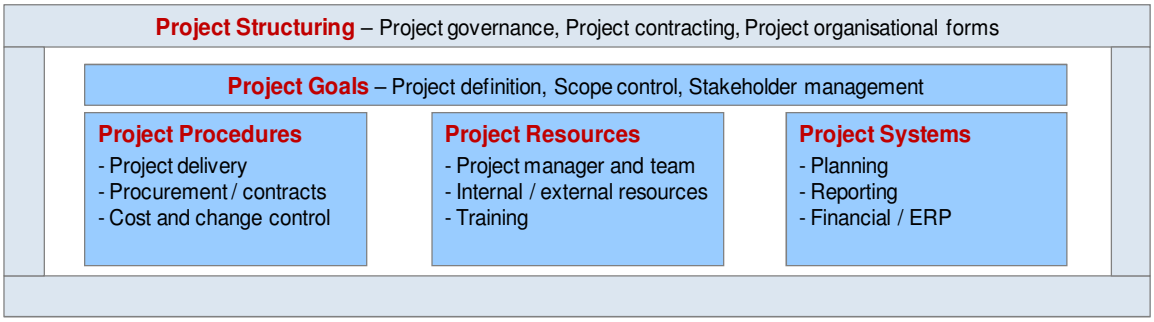
7.6 PMC DEVELOPMENT - LEARNING PROCESSES

This section highlights learning as a key aspect of PM. In this view, projects and PM/PMC are viewed as modes of organising or modes of 'learning-organising' when allied to problem-solving. However, as this study emphasises 'learning-organising' as a synonymous duality, practice and learning are combined in the updated process model in this chapter summary, Fig. 7.6. Accordingly, the discussion in this short section is of a general nature that complements the previous section (7.5) on Process Groups.

The capability development literature is inclined towards a practitioner approach to capability practices, in terms of routines (Nelson & Winter, 1982), learning (Zollo & Winter, 2002), and resources (Helfat, 2007). Where learning is acknowledged as an integral part of capability development, it is often viewed as a means to an end (Zollo & Winter, 2002; Winter, 2003) rather than the *sine qua non* of practice (Brown & Duguid, 1991; Wenger, 2001). The main Research Question inquires how learning processes underpin PMC development in complex organisational settings. The previous section discussed the organisational learning processes that are integral to the development of organisational capabilities as manifestations of the two-stage problem-solving process of differentiation and integration activities. This was discussed in relation to PMC and DC, Table 7.3, p. 187. Essentially, complex learning processes are integral to the development of PMC, because, as a strategic organisational competence in organising to accomplish complex temporary undertakings, PMC is a mode of learning through organisational CPS. In this view, PMC is a 'complex organisational practice', which is based on a view of a project as a mode of organising to accomplish a temporary undertaking. Because knowledge-creating and organising forms are mutually constituted, a project can be viewed as a temporary learning organisation or *a mode of learning-organising* that learns by organising and *vice versa*. It is not surprising, then, that organisations respond to change (problems), either internal or external, by the need to generate new requisite knowledge (learning) to match the change by changing their mode of 'learning-organising' from planned/deliberate to organic/emergent (Burns & Stalker, 1961; Mintzberg, 1987, 1990; Ansoff, 1991; Chandler, 1992).

7.7 PMC DEVELOPMENT - DIMENSIONS

This section will discuss the main dimensions of PMC in IE and the ESB - goals, structuring, procedures, resources, systems - using IE's PMC dimensions as a reference, Fig. 7.5. The dimensions of PMC were discussed in detail in each case study. As the complex learning processes in PMC development in IE and the ESB have been found to be equilogical, Table 7.3, p. 187, it will be shown that the PMC dimensions were comparable in purpose while contrasting in contextual approach. The development approach of IE was more emergent compared to the ESB's more planned approach, although each approach was emergent and planned on its own terms. The contrasting development approaches are viewed as a balance between the equilogical requirements of learning processes (differentiation-integration) together with the requirements of different project life cycles and organisational environments rather than driven primarily by the dynamics of the environment (Burns & Stalker, 1961). The ESB's more planned approach is viewed as similar to learning-before-doing (Pisano, 1994), while IE's more emergent approach is similar to learning-by-doing (Arrow, 1962).



(Source: This Study)

Fig. 7.5 IE PMC Dimensions (copy Fig. 5.4)

7.7.1 PMC DIMENSIONS - GOALS

As purposeful endeavours, projects are driven by goals, the absence of which is a harbinger of unsatisfactory outcomes for major project stakeholders, which is well documented in the literature (Avots, 1969). In both the IE and the ESB case studies, clear goals were established for the PMC programmes using Customer Requirement Specifications (CRS) and other means, which contributed to the development of PMC and this finding is consistent with the PM capability literature (Söderlund, 2005; Winch, 2002). The traditional PM

assumption underpinning project goals is that the required knowledge for delivering project goals is available up-front, at the outset, before the project is executed.

However, a central finding in this study is that PMC developed in an unstructured, non-linear, complex problem space/time (CPS), which is characterised by a difficulty of practical importance. While an appreciation of the overall problem can be available to the comprehension of a single mind, like the outline of a cloud of water molecules, the solution of the complex problem in all its detail is not available to the comprehension of a single mind. This requires distributed organising to coordinate the interplay of tacit rationality between the 'knowing' knowledge of individuals and the 'known' knowledge of project plans through a common will of mutual interest that is paced by PLC-entrainment or other means. In addition, as PSOs, IE and the ESB had to deal with more external public stakeholders than a private sector organisation delivering a project of similar magnitude. This requires pro-active public relations and an awareness of the political context of delivering infrastructure projects in the public sector, which is weighted towards informal 'knowing' knowledge rather than formal 'known' knowledge, towards 'soft' knowledge rather than 'hard' knowledge, respectively.

7.7.2 PMC DIMENSIONS - STRUCTURING

As the competence level of the PMCs in IE and the ESB grew and matured, each incremental change in CPS caused less entropy amplitude change (ΔS) in the PMC entropy envelope. However, the pace of entropy change (dS/dt) continued to increase for IE compared to the ESB, due mainly to the changing scope of their project portfolio under the NDPs and the uncertainty relating to programme funding and duration since 2008. In contrast, the Networks PMC in the ESB, though comparable in terms of entropy amplitude change (ΔS) with IE, was assessed lower in this study in terms of pace of entropy change (dS/dt), due mainly to more certainty around its scope. These differences in problem space/time between IE and the ESB influenced their respective needs to generate ongoing project knowledge to support their PMCs and the organising forms that reflected this requirement. Overall, because of their different problem space/time contexts, the development of IE's PMC needed to be more organic that ESB Network's PMC, which was more amenable to being planned.

As part of its PMC development, IE adopted a flexible function-cum-experience approach to project organisational arrangements. This allowed the project management office (PMO) approach to metamorphose in accordance with the ongoing availability of managerial

expertise and the requirements of the projects portfolio to be delivered. Many PMOs had a core team of IE staff that was supplemented by a peripheral team of temporary non-IE staff. As part of the development of its PMC, IE adopted a secondment approach to consultants, which involved the direction of consultants by IE management.

Before the NRP project, ESB Networks had been a geographical regional model, which was now redesigned as a functional model. This involved designing the organisational form and filling the positions rather than building organisations around existing personnel capability. Although function-led, the resulting organisational capability was 'function-cum-experience', which was designed to emerge over time around the NRP project goals rather than emerging in response to contingent events. Because of the scale of EU-wide contractor participation under Contracting Partners, the Networks PMC in the ESB had to develop a supply-chain expertise to coordinate multiple external contractors in delivering modules of the NRP project under ESB supervision (Nightingale & Brady, 2011). However, ESB Networks were keenly aware that programmes such as the NRP project had not been successful in other countries. As part of the Networks PMC approach, ESB personnel were embedded with the contractor companies to ensure good liaison with the 'live' network, which was equivalent to a distributed PMO, an approach also adopted by IE's PMC. As part of the Networks PMC supply-chain expertise, Contracting Partners enabled the diversification of ESB Networks' skill base rather than supplementing it on a one-for-one basis by contractors.

7.7.3 PMC DIMENSIONS - PROCEDURES

Under technical rationality, traditional PM assumes that knowledge is detached from the knowing subject and can be assembled like a toolkit by a competent PM practitioner. In this view, problem-solving revolves around finding the right tools to assemble in a given situation. However, under a knowledge-based view that acknowledges three kinds of knowledge, 'knowing' knowledge, 'known' knowledge, and tacit knowledge, discovering the solution to a problem involves discovering a hidden reality that is echoed in the *Meno* paradox (Polanyi, 1967). The latter is the apparent contradiction involved in searching for new knowledge as a solution to a problem: if the solution is known, there is no need to search; and, if the solution is not known, it will not be recognized when encountered. A solution to this paradox is offered by Polanyi (1967) in terms of "tacit foreknowledge" (p. 23) and by Dewey (1916/1966) in terms of "*coming* to know" (p. 148, original italics), both

of which resonate with Popper's (1935/2007) "creative intuition" (p. 8) and Peirce's (1931-1958) 'abduction' regarding the growth of knowledge.

For both IE and the ESB, documented PM procedures served as a 'scaffolding' for the growth of knowledge, where narrative 'knowing' knowledge is constructed around paradigmatic 'known' knowledge by a dynamic interplay between the two that is guided by a distributed tacit dimension as a common will of mutual interest (Polanyi, 1967; Bruner, 1986; Orlikowski, 2002, 2006). In terms of 'scaffolding' in the form of documented PM procedures, both the IE and the ESB case studies demonstrate the importance that both organisations placed on documented procedures around which PMC learning took place (Prencipe & Tell, 2001). Both organisations also testify to the integrated aspect of PMC knowledgeability, in terms of formal 'known' knowledge, informal 'knowing' knowledge, and the tacit dimension of knowledge associated with experienced personnel. In both organisations, the relative ineffability of 'knowing' knowledge compared to 'known' knowledge often proved to be an impediment to the transfer of PMC expertise without transferring personnel (von Hippel, 1994; Szulanski, 1996).

7.7.4 PMC DIMENSIONS - RESOURCES

Most informants in IE and the ESB agree that a good team is a combination of a good leader and good team members. Many views emphasise the importance of leadership that is grounded in people-skills that promote a team climate based on trust, confidence, mutual support and accountability, and team spirit. Like an Archimedean lever, it seems that a good project manager has the ability to leverage performance beyond the ostensible resources at his/her disposal by configuring the available team resources around a tacit fulcrum point of the team. In this way, the configuration of a synergised team is both lever and fulcrum at the same time, like the dancer being synonymous with the dance.[333] Project managers are also viewed as having a pre-disposition to act rather than deliberate and to have an appetite for calculated risks rather than being risk averse. In both IE and the ESB, key heavyweight managers were key to the development of PM as an organisational capability (PMC).

Organisational resource arrangements for the development of PMC in IE and the ESB share many similarities. They revolved around PMOs, which co-developed with the PMCs during the 2000s, with a core team of IE/ESB staff and a periphery of temporary non-IE/ESB contractor staff. The core IE/ESB staff in the PMOs tended to work together as a team over

[333] "How can we know the dancer from the dance?" Last line of '*Among School Children*' by W.B. Yeats

several years. This is analogous to what Lindkvist (2005) calls a 'collectivity of practice' in contrast to 'communities of practice' (CoP) (Lave & Wenger, 1991/2003; Wenger, 2001). There is an extensive literature on CoP but a salient difference between a CoP and a team is that a CoP is more open-ended in the generation of new knowledge, whereas project teams are characterised by goals and project life cycles (Katzenbach & Smith, 1993, 2001; DeFillippi, 2001; Sense, 2003).

From N-Synergy to N^2-Synergy

The resource arrangements in the PMCs of both IE and the ESB resemble Hedlund's (1994) 'N-form' organisational approach, which emphasises heterarchy, temporary constellations of people, lateral communication, combining knowledge elements, and management as a catalyst. This is consistent with the view proposed in this study for distributed organising in situations of CPS, such as the development of PMC as an organisational capability. Using a practice-oriented approach to knowledge that is inseparable from the knower, an N-form approach to organising allows potential synergy to develop that is proportional to N^2 rather than N by using a toolkit approach to knowledge. When knowledge is embedded in people, there are two knowledge links between every two people, not one. Someone can be inspired by a writer but the writer may be unaware of their existence but, if there is mutual inspiration, there are two knowledge links. Overall, there are four potential knowledge elements between two people - two individuals and two links. The knowledge elements build up like a numerical series based on geometric shapes between people represented as point dots - 1 dot, 2 dots (line), 3 dots (triangle), 4 dots (square), 5 dots (pentagon), etc.

Persons (N)	A	1	2	3	4	5	... N
Knowledge Link Pairs	B	0	1	3	6	10	...
Knowledge Links	C (= Bx2)	0	2	6	12	20	...
Knowledge Elements	(A+C)	1	4	9	16	25	... N^2

7.7.5 PMC DIMENSIONS - SYSTEMS

As with documented procedures, systems act as a 'scaffolding' that facilitated the development of PMC as an organisational capability in IE and the ESB. Throughout the 2000s, IE continually upgraded the IT systems that were available for project delivery. This was manifest in areas such as planning, procurement, financial reporting, and project reporting. ESB Networks uses various management systems, such as its internal safety system, the ISO-9000 quality system, and the PAS-55 asset management system. In addition, it uses IT systems such as SAP for finance and MS Project for project planning. From a practice-oriented approach, good systems enable project performance to the level of the system but experienced project personnel often have a level of expertise that goes beyond the rules of formal-based systems (Dreyfus & Dreyfus, 1986). For such experienced personnel, new systems may inhibit their performance rather than enhance it, during their introduction.

7.8 CHAPTER SUMMARY

Based on the case data presented, this chapter set out to develop further the initial concepts in Chapter 3, Initial Conceptual Development - Capability Development as Organisational Complex Problem-Solving, and to discuss the study findings in relation to the data, literature, and conceptual development. The findings revolve around the development of PMC as an organisational practice through complex learning processes based on problem-solving, the central research theme of this study. The development of a multi-level PMC from a relatively low-level activity to a strategic supporting competence in both IE and the ESB was triggered by radical and rapid change in the external environment during the 2000s. IE's approach was more emergent than ESB's planned approach, even though each approach was planned and emergent on its own terms. Accordingly, in order to facilitate the nature of equilogical complex learning processes, together with the requirements of the project life cycle and a dynamic environment, IE and ESB developed 'PMC Dimensions' that were comparable in purpose while contrasting in contextual approach.

This study of PMC development in two PSOs also contributes to the empirical literature in four respects. Firstly, PSOs are under-researched in the PM literature. Secondly, the development of PMC has been largely researched in PBOs in the private sector, where PMC is a 'core competence', rather than in organisations as a 'core supporting competence'. Thirdly, little research is available on PMC development in either PBOs or PSOs subject to

radical and rapid environmental change. Fourthly, little research is available on PMC development as a multi-level PM ecology that encompasses project level, project organisation level, and external level.

An overall synthesis of the process findings of the study for PMC development is shown in Fig. 7.6. In this updated process model, organisational practice and learning are conjoined as 'practice-learning', a manifestation of the synonymous duality of 'learning-organising'. In effect, this study views practice as a mode of 'learning-organising' that is synonymously a mode of organising/ordering *and* a mode of learning. This builds upon and extends Gherardi's (2006) definition of practice given earlier as "*a mode ... of ordering* heterogeneous items into a coherent set" (p. 34, italics added).

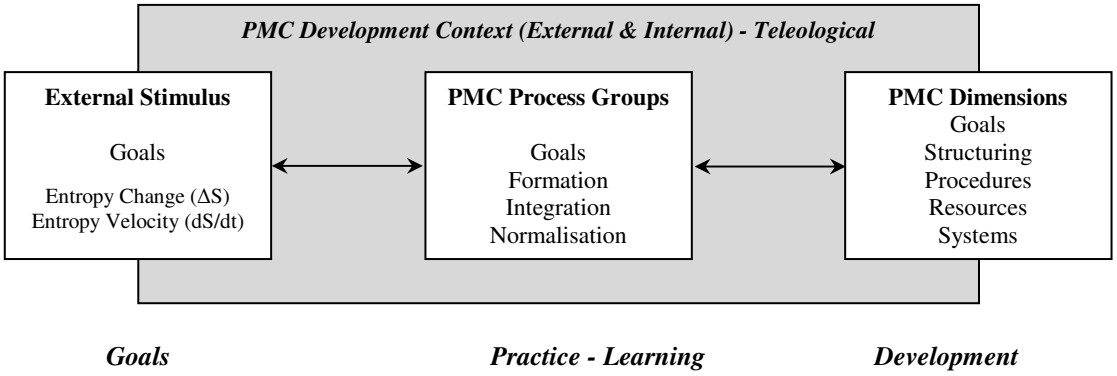


Fig. 7.6 Updated Process Model – PMC Development

Organisational complex learning processes are integral to PMC development because projects are viewed as a process rather than a task, as an active verb rather than a passive noun. In this view, project organising (projectising), like partnering, is a means-end mode of organising physical and social resources, which is an organisational practice that involves learning (Schön, 1983; Bresnen & Marshall, 2000; Wenger, 2001). In this integrated knowledge-based view of projects as process and PM/PMC as organisational practice, the following tentative definitions are proposed by this study:

> A project is a mode of organising to accomplish a temporary undertaking.
>
> Project management is an organisational competence in organising to accomplish temporary undertakings.
>
> Project management capability is a strategic organisational competence in organising to accomplish complex temporary undertakings.

In response to the main Research Question,[334] the principal process insight is that PMC is seen to be developed as a dynamic organisational capability in complex PM settings through organisational complex problem-solving (CPS). This builds upon and extends the emerging PMC literature with implications for traditional PM research and practice in three main areas. Firstly, PMC is honed as a practice through goal-directed organisational CPS. This builds upon and extends the work of Popper (1972/1979) on the evolutionary growth of knowledge by revealing problem-solving as a two-stage process of differentiation-integration, or disorder-order. In contrast to traditional PM which follows a path from 'order to order', the development of PMC as an organisational capability is a process of 'dissipative organising' from 'order to *disorder* to order'. Secondly, in contrast to the mechanistic view of traditional PM, this study supports an integrated knowledge-based view of projects as process and PM/PMC as practice.

Thirdly, traditional PM treats complex projects under a general systems approach of centralised 'total planning', which assumes that knowledge is manifest in pre-given plans that are executed with little organisational learning expected beyond the application of prior knowledge. However, an unexpected consequence of viewing PMC development as organisational CPS is that complex projects seem limited to bounded planning, as they cannot be *completely* specified in advance. Thus, a distributed organising approach is suggested for coordinating the formation of 'complex knowledge' under organisational CPS, which is inherently emergent and dynamic. This is underpinned by what this study terms a 'common will of mutual interest' as a distributed tacit dimension (Polanyi, 1967), which is fostered around the challenge of project goals and paced by the project life cycle.

These three finding areas of PM research and practice are now discussed in the three sub-sections that follow next - (1) organisational problem-solving as 'learning-organising', (2) projects as process and PM/PMC as organisational practice, and (3) complex PM as bounded planning. These finding sub-sections address the three sub-sections of the main Research Question, respectively: (i) What role does problem-solving play in learning processes for developing PMC?; (ii) How does a practice-oriented approach facilitate the development of PMC?; and (iii) How is project knowledge coordinated in complex PM settings?

[334] How do learning processes underpin the development of PMC in complex organisational settings?

7.8.1 ORGANISATIONAL PROBLEM-SOLVING AS LEARNING & ORGANISING

As discussed in Chapter 3, Initial Conceptual Development - Capability Development as Organisational Complex Problem-Solving, this study proposes that knowledge-creating and organising forms are a mutually constituted duality process within the entropy envelope that is constituted by problem-solving. In effect, like breaking eggshells to make omelettes, problem-solving is a synonymous process of 'learning-organising' that follows a path from 'order-to-*disorder*-to-order' rather than from 'order-to-order'. In extending the work of Popper (1972/1979) on the evolutionary growth of knowledge through problem-solving, CPS is revealed as a process of order-differentiation-integration, or old order-disorder-new order. This is a process of 'dissipative organising' that follows a path from 'order to *disorder* to order' rather than 'order to order' using traditional PM.

The term 'dissipative organising' also highlights the tension in knowledge-creating, because of the need to organise 'order' *and* 'disorder' with potential dissipation (entropy) (Prigogine, 1980). This tension is brought into sharp relief at the transitional bifurcation points between the differentiation (disorder) and integration (order) activities, point '*B*' of Fig. 3.1, p. 60. This is reflected in cascade form in the development of capabilities as increasing net order, or reducing net disorder, in Fig. 7.2, p. 174. This has implications for judgment, timing, and transition capability, which are beyond the scope of this study.

7.8.2 PROJECTS AS PROCESS & PM / PMC AS ORGANISATIONAL PRACTICE

As discussed, PM can be viewed more holistically as an organisational practice rather than an applied science, in which *a project is a mode of organising to accomplish a temporary undertaking* and PMC is a strategic organisational competence in organising to accomplish complex temporary undertakings, a practice honed through organisational CPS. This implies that projects are learning organisations or *modes of learning-organising* that learn by organising and *vice versa*. This reflects an integrated knowledge-based view of projects as process and PM/PMC as organisational practice. From the Literature Review, the main influences on this evolution in thinking include research on projects as temporary organisations (Lundin & Söderholm, 1995; Packendorff, 1995) and the conceptualisation of projects as 'actors/becoming' rather than as 'objects/being' (Engwall, 1998; Engwall *et al*., 2003; Linehan & Kavanagh, 2006).

In this study, Winter *et al*. (2006) was a key influence from the PM literature in advocating a practice-oriented approach to PM to enrich the traditional PM perspective of technical rationality based on Positivism. This paper resulted from the UK government-sponsored initiative on *Rethinking Project Management*. From the practice literature, seminal influences include Weick (1979, 1995) on organisations as arenas of organising, sense-making, and knowledge-making rather than entities that are organised, in addition to Schön (1983) on practice as a process of problem-solving knowledge creation based on reflection-in-action. This thinking is echoed in the PM literature by Engwall (2002) on knowledge-creating over the project life cycle based on an interactive view of knowledge with dual aspects, experiential and abstract. This contrasts with the traditional PM view of abstract project knowledge that is pre-given at the outset of the project in designs, plans, etc.

Capability Development as Organisational CPS

As an exercise in organisational CPS, the development of organisational capabilities was shown to occur through knowledge-creating cycles of differentiation activities (disorder) and integration activities (order) associated with problem-solving. Over time, this involves a net increase in order or a net decrease in disorder (entropy). This pattern is observed in both dynamic capabilities and PMC, where the latter is developed through cycles of goals, formation, integration, and normalisation, Table 7.3, p. 187. In project settings, goals are pre-set and distributed over the project life cycle (PLC). The resulting PLC-entrainment underpins the PMC developmental cycle of goals, practice, and learning at all interrelated levels of PMC in IE and the ESB. A common will of mutual interest for the project team is fostered around project goals that are challenging and paced over the project life cycle by PLC-entrainment to create project knowledge through problem-solving to deliver the project goals. In this, organisational CPS is more tacit rationality than explicit rationality or technical rationality.

In IE and the ESB, their respective PMCs revolved around five main dimensions - goals, structuring, procedures, resources, and systems. The procedures and systems acted like 'scaffolding' that facilitated the complex learning processes that synthesised contextual 'knowing' knowledge (know-how, etc.) with formal 'known' knowledge (designs, plans, etc.), underpinned by a distributed common will of mutual interest. The latter was promoted by strong communal leadership and a heterarchical approach to organising arrangements that engendered trust, mutual accountability, and team spirit. Using a view that knowledge is inseparable from knowing subjects, this yields a knowledge-creating potential of N^2-synergy between individuals rather than N-synergy by using knowledge like detached Lego blocks.

As further replication between the two case studies, the process groups in the PMC in IE and the ESB were elaborated as a mode of organisational CPS at multiple interrelated levels - external level, board level, organisation level, project supervision level, and project works staff level. These process groups were variations of goals, formation (differentiation/entropy), integration (order), and normalisation. As a 'core supporting competence', PMC in IE and the ESB can be regarded as a strategic capability or as a dynamic resource capability or as a dynamic organisational capability.

7.8.3 COMPLEX PM AS BOUNDED PLANNING

Limitations of Traditional PM

In this study, PMC is viewed as a strategic organisational competence in organising to accomplish complex temporary undertakings that is developed through learning processes based on organisational CPS. This perspective on PMC builds on the work of Lindkvist *et al*. (1998), Davies and Brady (2000), Brady and Davies (2004), Davies and Hobday (2005), Söderlund (2005, 2008), and Söderlund and Tell (2009). In this way, PMC is a 'complex organisational practice' that complements PM as an 'organisational practice'. The key demarcation characteristic of CPS in complex PM settings is the inability of a complex project to be *completely* specified or comprehended in advance by a single individual, except in outline or in part (Hayek, 1945). The total complexity is not 'given' to a single individual nor can it be, because it is like an emergent prototype with incomplete knowledge. This is a logical problem of practical significance in complex PM settings (Lenfle & Loch, 2010; Geraldi *et al*., 2011; Nightingale & Brady, 2011). This is like a spectrum of uncertainty and risk that varies from the 'known knowns' of individual projects to the 'known unknowns' of team projects as organisational practice (PM) (Cleden, 2009). Beyond these are found the 'unknown knowns' of complex projects as 'complex organisational practice' (PMC) for accomplishing complex temporary undertakings and, at the extreme, the 'unknown unknowns' as intractable problems.

For successful delivery of complex projects, a 'total planning' approach under traditional PM is untenable and, instead, a distributed approach to the coordination of project knowledge is proposed by this study. This requires a coordinating mechanism, such as a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967), in order to coordinate the interplay of tacit rationality between different knowledge types (Kolb, 1984). This includes

local contextual 'knowing' knowledge (know-how, etc.) as an indispensable complement to the centralised bounded planning of abstract 'known' knowledge (designs, plans, etc.). By viewing PMC as a 'complex organisational practice' comprised of rational actors as participants in a 'common will of mutual interest', PM can enhance its Positivist perspective in the same way as in neo-classical economics, which is based on the 'rational actor' model and the 'invisible hand' of self-interest as a form of extended-Pragmatism.

PM in Complex Organisational Settings

Thompson (1967) describes complex organisations as "open systems, hence indeterminate and faced with uncertainty, but at the same time as subject to criteria of rationality and hence needing determinateness and certainty" (p. 10). Both IE and ESB represent complex organisational settings within a wider public sector that is subject to government/EU policy and ongoing change initiatives under the agenda of New Public Management (Dunleavy & Hood, 1994; Pollitt, 2001). The launch of the Euro, the NDPs (2000, 2007), and the deregulation of the EU electricity market provided the stimulus for IE and the ESB to develop a PMC in response to radical and rapid change in their external environments.

However, because of different business environments and initial conditions, the contextual approach to PMC development was different in IE and the ESB. The data indicates that the ESB set a planned course to develop their Networks PMC, because their dynamic environment was more predictable. In contrast, IE developed their PMC as an emergent organisational capability, because their dynamic environment was more uncertain. Nevertheless, the ESB's Networks PMC was also emergent on its own terms and IE's PMC was planned on its own terms. In traditional PM, the project life cycle is pre-given and little learning is expected beyond the application of prior knowledge. In complex PM, the project life cycle cannot be completely specified in advance (Swinth, 1971), even though its logical structure is known beforehand. In a similar way, the organisational complex learning processes involved in PMC development cannot be completely specified in advance, even though their logical structure can be known beforehand from the findings of this study. Even in the case of ESB Networks PMC, which was more planned than IE's emergent PMC, the learning-before-doing in ESB Networks was partially learning-by-doing, as it was tightly coupled to the feedback from the emerging installation processes during the rollout of the new documented procedures for the NRP project - see Sect. 6.4.3.2. By knowing in advance the logical structures for the project life cycle and the learning processes involved in PMC development, management effort can focus on facilitating their emergence relative to the

constraints of the environment rather than as a contingency reaction to the environment whose logic is unclear.

As highlighted in the Literature Review, PMC development is under-researched in respect of three important conceptual themes that revolve around organisational learning processes and inform the Research Questions - see Sect. 2.5.4, p. 51. In developing PMC as a 'core supporting competence' from a near-zero base, IE and the ESB needed to learn to change in a way that is rapid rather than incremental. This means that organisational learning processes are a crucial aspect of PMC development, which is under-researched in the literature. This dynamic environment contrasts with PMC development in project-based organisations in the private sector, the focus of much PMC research, for which PMC is a mainstream 'core competence' and PMC development can be more 'planned' than 'emergent'.

Chapter 8

Study Conclusions & Future Research

8.1 INTRODUCTION [335]

As discussed in the previous chapters, this exploratory research has investigated the development of project management as an organisational capability in two complex organisations in the public sector (PSO) during a period of rapid environmental change in the 2000s. Within the PM literature, the concept of PMC and how it develops over time is still an emerging tradition, in which the development of PMC in complex organisational settings revolves around various forms of organisational learning based on problem-solving, the central research theme of this study. This study locates itself within this emerging tradition and represents a unique empirical opportunity to study the complex learning processes involved in PMC development in a setting that shows these processes in greater relief. In both PSOs, the development of PMC from a relatively low-level activity to a strategic supporting competence was triggered by radical and rapid change in the external environment during the 2000s.

The main purpose of this chapter is to discuss the implications of the main process insight for theory, research, and practice, which is that PMC is seen to be developed as a dynamic organisational capability in complex PM settings through organisational complex problem-solving (CPS). This builds upon and extends the emerging PMC literature with implications for traditional PM research and practice in three main areas: (1) organisational problem-solving as 'learning-organising'; (2) projects as process and PM/PMC as organisational practice; and (3) complex PM as bounded planning.

By viewing PM as organisational practice rather than applied science, this has led to a tentative reformulation of projects and PM/PMC around the central research theme of

[335] Frequent acronyms: Project Management (PM), Project Management Capability (PMC), Public Sector Organisation (PSO), Project-Based Organisation (PBO)

organisational complex learning processes based on problem-solving - see Sect. 7.8, p. 212. In this view, problem-solving is a synonymous duality of knowledge-creating and organising forms, i.e., *a mode of learning-organising*. Resulting from the ongoing interaction between data and conceptual development, the reformulations have become both output and input of the main Research Question[336] reflecting an integrated knowledge-based view of projects as process and PM/PMC as organisational practice.

8.2 PMC DEVELOPMENT IN THE CASE STUDY ORGANISATIONS

For both IE and the ESB, developing a PMC as a new organisational capability in response to a radical change in their external environment was a successful endeavour. As their PMCs were developed from a near-zero base, this required rapid organisational learning that was goal-directed and multi-level across the organisation. As a form of organisational CPS, this was facilitated by fostering and pacing a common will of mutual interest in each organisation. Because of their different business environments, IE developed its PMC using a largely 'emergent' approach in contrast to the ESB's largely 'planned' approach, because IE's external environment was more complex than that of the ESB, Tables 7.2, 7.3. This suggests that isomorphism in approaches to PMC development in public sector organisations may be long-term rather than short-term, if at all (DiMaggio & Powell, 1983). If PMC development approaches are non-isomorphic, this implies that isomorphism may be more related to single/double-loop learning environments than to CPS environments. This study shows that the latter are contextual and multi-path, while based on equilogical complex learning processes of differentiation-integration.

8.2.1 IARNRÓD ÉIREANN - IRISH RAIL (IE)

As a public sector organisation (PSO), IE's PMC was successful on at least two counts. Firstly, it enabled the achievement of internal and external outcomes based on 'hard' KPIs such as scope, budget, and timescale, in addition to 'soft' KPIs such as an enhanced public train service and legitimacy. Because of the hundreds of capital projects that IE delivered during the 2000s, its PMC varies in scale and scope from small projects to medium, to large, to major projects (>€100m). Both IE informants and external IE consultants attest to the

[336] How do learning processes underpin the development of PMC in complex organisational settings?

progressive development of IE's PMC during the 2000s, both in respect of IE's pre-2000 PM capability and external PM benchmarks.

Secondly, as a newly developed organisational capability, IE's PMC is a strategic business process that will support the achievement of IE business goals into the future by synergising with other related strategic business processes, e.g., lean management systems, supply chain management, and total quality management.

8.2.2 ELECTRICITY SUPPLY BOARD (ESB)

For the ESB, the development of its Networks PMC was also successful on a number of counts. Firstly, the NRP Project was delivered successfully for project stakeholders. Secondly, the ESB had a new organisational PM capability in ESB Networks, which was strategically key to its future business and on a par with its pre-existing Generation PMC. The Networks PMC can also be viewed as an extended organisational capability that integrates part of ESB's supply chain for certain contractor services.

As the ESB views knowledge as 'embedded in people', they appreciate that an organisational capability such as Networks PMC is enacted as a distributed practice by people who are 'embedded in the organisation' with their knowledgeability, which is a combination of experiential knowledge and informational knowledge. Using this approach, the ESB integrates strategic HRM and organisational design around the common objective of managing organisational knowledge as a human resource rather than as a commodity resource. This enables the ESB to progress as a 'learning organisation', where the organisation learns through increasing the knowledge that is embedded in its people, who are embedded in the organisation (Senge, 1994).

8.3 STUDY PERSPECTIVES ON THEORY, RESEARCH, & PRACTICE

The main purpose of this section is to summarise and discuss the implications of the main process insight of the study for theory, research, and practice. This is that PMC is seen to be developed as a dynamic organisational capability in complex PM settings through learning processes based on organisational complex problem-solving (CPS). This builds upon and develops the PMC literature with implications for traditional PM research and practice. These finding areas will now be summarised and discussed in the next three main sub-sections (Sects. 8.3.1, 8.3.2, & 8.3.3), in terms of contributions that support, extend/develop, and advance the literature (Farndale, 2004). The three finding areas correspond to the three sub-sections of the main Research Question, namely: (i) What role does problem-solving play in learning processes for developing PMC?; (ii) How does a practice-oriented approach facilitate the development of PMC?; and (iii) How is project knowledge coordinated in complex PM settings?

8.3.1 STUDY PERSPECTIVES ON PROBLEM-SOLVING & KNOWLEDGE CREATION

A summary of the study perspectives on organisational knowledge theory and PM theory in this sub-section is shown in Table 8.1.

8.3.1.1 Organisational Knowledge Theory: Problem-Solving as Knowledge Creation

Popper's (1972/1979) evolutionary model for the growth of knowledge is re-interpreted as a teleological model based on differentiation and integration processes, disorder and order, respectively. Order is proportional to the reciprocal of disorder (entropy). Problem-solving is presented as an organising activity that creates an entropy envelope wherein knowledge-creating and organising forms are mutually constituted. In effect, knowledge-creating and organising are a synonymous duality process of 'learning-organising'. This is an emergent process of 'dissipative organising' that involves stimulus (problem), inquiry (differentiation-integration), and form (organising), where inquiry and form are a synonymous duality of 'learning-organising' (Prigogine, 1980). In addition, by providing a knowledge-based underpinning, this perspective extends and develops Lawrence and Lorsch's (1967) differentiation/integration, Schumpeter's (1942/1976) creative destruction, Guilford's (1956) divergent/convergent, and Lewin's (1947/2008) unfreeze/refreeze.

Organisational Knowledge Theory	Supported	Extended / Developed	Advanced / New
Problem-Solving as Knowledge Creation (Sect. 8.3.1.1)	Traditional approach to problem-solving based on problem-alternatives-solution (Popper, 1972/1979; Dewey, 1916/1966).	Greek dialectic of 'antithesis and synthesis' is reformulated as 'differentiation and integration' (Popper, 1972/1979) This extends and develops Lawrence & Lorsch's (1967) differentiation / integration, Schumpeter's (1942/1976) creative destruction, Guildford's (1956) divergent / convergent, and Lewin's (1947/2008) unfreeze / refreeze.	Introduction of 'entropy' as a covering concept for disorder and order. In the 'entropy envelope' of problem-solving, differentiation (disorder) increases entropy and integration (order) reduces entropy. Problem-solving as an emergent process of 'dissipative organising' that involves stimulus (problem), inquiry (differentiation-integration), and form (organising), where function and form are a synonymous duality of 'learning-organising' (Prigogine, 1980). The path from 'order to order' is from 'order to *disorder* to order', which represents an overall net increase in order and a net reduction in disorder (entropy).
A Duality View of Learning-Organising (Sect. 8.3.1.2)	Synonymous duality of 'agency-structure' (Giddens, 1984/2007).	This complements and extends the 'agency-structure' duality of Giddens (1984/2007) as a combined knowledge formation perspective.	Problem-solving as a synonymous duality of 'learning-organising' through the logical structure of differentiation and integration. Both 'learning organisations' and individuals adhere to the same logical structure of knowledge creation based on differentiation and integration (Fig. 3.1 & Table 7.3).
Organisations as Modes of Organising for Permanent Undertakings (Sect. 8.3.1.3)	Organisations as primarily about sense-making (Weick, 1979, 1995).	Sense-making as knowledge-making. Organisations as non-equilibrium / becoming rather than equilibrium / being (Whitehead, 1929/1978).	An organisation is a mode of organising to accomplish an undertaking, permanent or temporary, which is a mode of 'learning-organising' when allied to problem-solving (Weick, 1979, 1995).
A 'Common Will of Mutual Interest' (Sect. 8.3.1.4)	The 'invisible hand' of self-interest (Smith, 1776/1981).	The 'invisible hand' of self-interest as a distributed 'tacit dimension' (Polanyi, 1967). Project entrainment as a 'common will of mutual interest'. Fostering and pacing a 'common will' around goals and the project life cycle (Lindkvist et al., 1998; Söderlund, 2010).	A 'common will of mutual interest' as a distributed 'tacit dimension' for coordinating an interplay of tacit rationality between local 'knowing' knowledge (know how, etc.) and centralised 'known' knowledge (designs, plans, etc.) (Kolb, 1984; Tsoukas, 1996; Orlikowski, 2002, 2006).
PM Theory			
Complex PM as Bounded Planning (Sect. 8.3.1.5)		For complex projects, Hayek's (1945) 'specification problem' implies that the total complexity is not 'given' to a single individual, nor can it be. Fostering and pacing a 'common will' around goals and the project life cycle (Lindkvist et al., 1998; Söderlund, 2010).	Complex projects are limited to 'bounded planning' rather than 'total planning' under conventional PM. For coordinating project knowledge, distributed organising is proposed based on a 'common will of mutual interest', which is a distributed 'tacit dimension'. Like the 'invisible hand' in neo-classical economics, a 'common will of mutual interest' in PM is pragmatic social science.
PM Root Metaphors (Sect. 8.3.1.6)	Conventional PM as Positivism (Smyth & Morris, 2007).	Using Pepper's (1942) root metaphors, conventional PM as Mechanism (Positivism) and the Scandinavian descriptive-form approach as Contextualism (Pragmatism).	Projects as complex entities that are synthetic-dispersive, favouring Contextualism (Pragmatism), rather than generic entities that are analytic-integrative, favouring Mechanism (Positivism).

Table 8.1 Study Perspectives on Problem-Solving & Knowledge Creation

When problem-solving knowledge creation is viewed as a non-equilibrium two-stage process of 'dissipative organising', this highlights the tension underlying knowledge-creating between differentiation activities (entropy/dissipation) and integration activities (order), Fig. 3.3, p. 63. Even stable organisations that have reached a single-loop state of near-equilibrium seem to reflect this two-stage process in their modes of organising. Thus, a stable manufacturing organisation disaggregates to component level raw material that was in an ordered state in the warehouse before aggregating the transformed material into finished products at a higher level of order than before. In kitchens, food is often prepared in a similar way, e.g., breaking eggshells to make omelettes. This highlights single-loop learning as an act of knowledge creation for 'another first time' (Garfinkel, 1967), where the activities of disordering differentiation and ordering integration are pre-organised as well as their mutually constituted organising forms. Again, the path from 'order to order' is from 'order to *disorder* to order', which represents an overall net increase in order through a net reduction in disorder.

8.3.1.2 Organisational Knowledge Theory: A Duality View of Learning-Organising

In this study, the entropy envelope of problem space/time has been characterised by amplitude change (ΔS) and pace of change (dS/dt). In conjunction with the organisation's prior PMC history, these two parameters influence the type of problem-solving learning that is required in order to respond to changes the organisation's environment, e.g., single-loop, double-loop, or complex problem-solving (CPS). Regardless of the learning mode, it seems that learning as knowledge-creating is an equilogical process that involves the organising activities of differentiation (disorder) and integration (order).

This study presents 'learning-organising' as a synonymous duality of knowledge creation through the problem-solving process of differentiation and integration, which complements and advances the 'agency-structure' duality of Giddens (1984/2007) as a combined knowledge formation perspective. This 'learning-organising' approach is echoed in a recent empirical study by Miron-Spektor, Gino, and Argote (2011) that uses cognitive theory to highlight the links between 'paradoxical frames' and creativity. This is based on a 'sense of conflict' and 'integrative complexity', where the latter emphasises "evaluative *differentiation* and conceptual *integration*" (*ibid*., p. 231, italics added). The 'learning-organising' approach also adds theoretical support to Weick and Westley (1996/2002) in affirming the concept of the 'learning organisation' against its perception as an oxymoron, because of the association of learning with disorder and organisation with order. By viewing 'learning-organising' as a

synonymous duality, both learning and organising involve order *and* disorder together at the same time. This view contributes to the development of theory that is suggested by Lam (2004) "to account for how ... organizational learning is connected to the emergence of new organizational forms" (p. 138), under a view that "Organizational creation is fundamental to the process of innovation" (p. 115). In addition, this study has outlined a logical structure of knowledge-creating based on differentiation-integration, which was developed at individual level, Fig. 3.1, p. 60, and was also found to be operative at organisational level, Table, 7.3, p. 187. This adds theoretical and empirical support for the idea that organisations learn in the same way as individuals by observing an equilogical structure of knowledge-creating based on differentiation-integration, Fig. 3.1, p. 60.

8.3.1.3 Organisational Knowledge Theory: Organisations as Modes of Organising

The project mode of organising (projectising) is distinguished from organising in permanent organisations by the temporary nature of project undertakings. Nevertheless, viewing organisations holistically as entities that are more 'becoming' than 'being', this study proposes that an organisation can be viewed as a mode of organising to accomplish an undertaking, permanent or temporary, which is a mode of 'learning-organising' when allied to problem-solving (Weick, 1979, 1995). Accordingly, the organisational undertaking is an instantiated 'being' on the trajectory of its indeterminate 'becoming' (Whitehead, 1929/1978), where 'becoming' is a state of permanent non-equilibrium that can vary in degree. In this view, sense-making is enacted as 'learning-organising', which is driven by problem-solving and progresses from 'order to *disorder* to order'.

8.3.1.4 Organisational Knowledge Theory: A Common Will of Mutual Interest

The rediscovery of Hayek's (1945) 'specification problem' in a PM setting implies that complex projects are only amenable to bounded planning rather than total planning under traditional PM. Like Simon's (1945/1997) bounded rationality, this finding of bounded planning poses many research challenges and opportunities for PM and for organisations in general. In response to the limitation of bounded planning in developing a PMC through organisational CPS in IE and the ESB, a distributed organising approach was used to coordinate the integration of project knowledge, which was based on what this study terms a 'common will of mutual interest' as a distributed tacit dimension (Polanyi, 1967). This common will was fostered around overall project goals that were challenging for both organisations. In addition, the common will was paced towards achieving the mutual goals of project delivery and PMC development through the project life cycle as an entrainment

heuristic (Lindkvist *et al*., 1998; Kreiner, 2002; Enberg *et al*., 2006; Söderlund, 2010). In this way, a distributed organising approach was adopted for coordinating an interplay of tacit rationality between local 'knowing' knowledge (know-how, etc.) and centralised 'known' knowledge (designs, plans, etc.) from bounded planning (Kolb, 1984; Tsoukas, 1996; Orlikowski, 2002, 2006). Other research areas where the idea of bounded planning may be relevant include strategy development, organisational capabilities, dynamic capabilities, and organisation studies, because they can be considered complex problems that require complex problem-solving (CPS) for their resolution. In this regard, Daft and Weick (1984) remind us that Boulding (1956) regarded organisations as among the most complex systems imaginable!

8.3.1.5 PM Theory: Complex PM as Bounded Planning

By acknowledging that complex problems cannot be *completely* specified or comprehended in advance by a single individual, except in outline or in part, this implies that complex organisational activities such as major projects may only be 'boundedly planned'. This is because for complex projects the total complexity is not 'given' to a single individual nor can it be, because it is like an emergent prototype with incomplete knowledge. To address this practical difficulty for coordinating project knowledge, this study proposes a distributed organising approach and key to this approach is the agency of a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967). In delivering complex projects, a common will can be fostered around project goals and paced by the project life cycle (Lindkvist *et al*., 1998; Söderlund, 2010). However, it is readily acknowledged that more research is warranted in this area. By adopting a 'common will of mutual interest' based on the 'rational actor' model, PM can embrace a pragmatic Positivism in the same way as neo-classical economics, which is based on rational actors and the 'invisible hand' of self-interest of Adam Smith (1776/1981). This is more tacit rationality than explicit rationality or technical rationality.

8.3.1.6 PM Theory: PM Root Metaphors

In the Research Methodology, the root metaphors of Pepper (1942) were contrasted with the typology of Engwall *et al*. (2003). This implies a correspondence between Mechanism (analytic-integrative) and the traditional PM approach of normative-content and a correspondence between Contextualism (synthetic-dispersive) and the Scandinavian descriptive-form approach, based on projects as temporary organisations. In this way, the root metaphors provide a theoretical underpinning for the traditional PM approach (PMI, 2004; APM, 2006; Smyth & Morris, 2007) and for contrasting socio-technical approaches.

8.3.2 STUDY PERSPECTIVES ON PROJECTS AS PROCESS AND PM / PMC AS PRACTICE

A summary of the study perspectives on projects as process and PM/PMC as practice in this sub-section is shown in Table 8.2.

8.3.2.1 PM Theory: Projects as Process

By viewing projects as *modes of organising to accomplish temporary undertakings*, this represents an ontological commitment that influences how we obtain knowledge about projects. This tentative formulation of projects is new in the literature and builds on viewing projects as temporary organisations (Lundin & Söderholm, 1995; Packendorff, 1995; Brady & Söderlund, 2008) and viewing organisations as primarily about 'organising', sense-making, and knowledge-making (Weick, 1979, 1995). In this, it privileges form over content (Engwall *et al*., 2003), where form is mutually constituted with knowledge-creating through the two-stage problem-solving activities of differentiation (disorder) and integration (order). In effect, a project is a mode of 'learning-organising' for a temporary undertaking.

This also advances the view of a project as an 'actor/becoming' rather than an 'object/being' (Engwall, 1998; Linehan & Kavanagh, 2006). The distinction between these two perspectives hinges on the difference between viewing knowledge as detached from the knower (object/being) and viewing knowledge as a process of knowing that is inseparable from the knower (actor/becoming). When a project is viewed as an 'object/being', the PM professional is a coordinator that ensures that the right tools are used to successfully deliver the project - *homo habilis projectus*. Viewing a project as an 'actor/becoming', the PM professional is a knowledgeable agent, who organises project activities that deploy the communal knowledgeability of the project team to successfully deliver the project over its life cycle - *homo sapiens projectus*.

PM Theory	Supported	Extended / Developed	Advanced / New
Projects as Process (Sect. 8.3.2.1)	Projects as temporary organisations (Lundin & Söderholm, 1995; Packendorff, 1995).	Organisations primarily about 'organising', sense-making, and knowledge-making (Weick, 1979, 1995). Projects as modes of problem-solving or modes of learning and organising (Engwall et al., 2003).	A project is a mode of organising to accomplish a temporary undertaking (Brady & Söderlund, 2008). A project is a mode of 'learning-organising', a synonymous duality of knowledge-creating and organising forms. Advances the view of a project as an 'actor/becoming' rather than an 'object/being' (Engwall, 1998; Linehan & Kavanagh, 2006). This is a difference between viewing knowledge as detached from the knower (object/being) and viewing knowledge as a process of knowing that is inseparable from the knower (actor/becoming).
PM / PMC as Organisational Practice (Sect. 8.3.2.2)	PMI (2004) process heuristic of initiating, planning, executing, and closing.	Viewing problem-solving as a two-stage process of differentiation-integration provides a theoretical underpinning for the PMI's (2004) process heuristic of initiating, planning (differentiation), executing (integration), and closing.	Advances an integrated knowledge-based view of projects as process and PM/PMC as organisational practice (Davies & Brady, 2000; Davies & Hobday, 2005). PM is an organisational competence in organising to accomplish temporary undertakings. PMC is a strategic organisational competence in organising to accomplish complex temporary undertakings.
PM Empirical Research			
Projects as Process & PM / PMC as Organisational Practice (Sect. 8.3.2.3)	Rethinking Project Management (Winter et al., 2006).	PM as an 'organisational practice' and PMC as a 'complex organisational practice', where project learning '*is*' the practice (Wenger, 2001).	Advances an integrated knowledge-based view of projects as process and PM/PMC as organisational practice.
PM Practice			
Projects as Process & PM / PMC as Organisational Practice (Sect. 8.3.2.4)		Projects as modes of problem-solving or modes of learning and organising (Weick, 1979, 1995). PM/PMC as organisational practice, where project learning is integral with PM/PMC practice (Engwall et al., 2003).	Projects as modes of organising to accomplish temporary undertakings and PM/PMC as organisational competences in organising projects / complex projects (Brady & Söderlund, 2008). Projects as modes of 'learning-organising', a synonymous duality.

Table 8.2 Study Perspectives on Projects as Process & PM/PMC as Practice

8.3.2.2 PM Theory: PM / PMC as Organisational Practice

This study views projects as modes of organising to accomplish temporary undertakings and PM/PMC as organisational competences in organising projects/complex projects. This advances an integrated knowledge-based view of projects as process and PM/PMC as organisational practice (Davies & Brady, 2000; Davies & Hobday, 2005). By viewing problem-solving as a two-stage process of knowledge creation based on differentiation (disorder) and integration (order), this provides a theoretical underpinning for the PMI's (2004) process heuristic of initiating, planning (differentiation), executing (integration), and closing, with monitoring and controlling throughout. However, this requires a complementary shift in thinking to view projects as a process rather than an object/tool under traditional PM.

8.3.2.3 PM Research: Projects as Process & PM / PMC as Organisational Practice

In the Literature Review, Winter *et al*. (2006) present the main findings of a UK government sponsored review of PM entitled *Rethinking Project Management* in terms of five directions aimed at developing PM theory and practice. These are categorised in three groups around PM as practice: (1) theory ABOUT practice (project complexity); (2) theory FOR practice (projects as social processes, value creation, project conceptualisation); and (3) theory IN practice (practitioner development). This emerging research tradition is reflected in the work of IRNOP[337] scholars and recent publications by Blomquist *et al*. (2010) and Lalonde *et al*. (2010, 2012). This study is an empirical contribution to this emerging research tradition and views PM as an 'organisational practice' and PMC as a 'complex organisational practice', where project learning '*is*' the practice (Wenger, 2001).

8.3.2.4 PM Practice: Projects as Process & PM / PMC as Organisational Practice

This study views projects as modes of organising to accomplish temporary undertakings and PM/PMC as organisational competences in organising projects/complex projects. Accordingly, PM/PMC is viewed as an organisational practice rather than an applied science (Weick, 1979, 1995; Engwall *et al*., 2003). This is a change in perspective for traditional PM, because it requires a change in knowledge perspective from viewing knowledge a toolkit that can be assembled as an applied science to viewing knowledge as emergent in a PM practice setting (Brady & Söderlund, 2008). This requires a PM perspective that recognises knowledge creation as a key part of the journey through the project life cycle

[337] International Research Network on Organizing by Projects

rather than pre-given at the outset (Schön, 1983; Engwall, 2002). This involves an interplay of tacit rationality between different kinds of knowledge, abstract 'known' knowledge (designs, plans, etc.), contextual 'knowing' knowledge (know, etc.), and the 'tacit dimension' as a component of all knowledge (Polanyi, 1967).

8.3.3 STUDY PERSPECTIVES ON PMC DEVELOPMENT

A summary of the study perspectives on PMC development in this sub-section is shown in Table 8.3.

8.3.3.1 PM Research: Problem-Solving as Learning & Organising

Problem-solving is a non-equilibrium mode of 'learning-organising' that involves activities of disaggregation (disorder) and aggregation (order) (Popper, 1972/1979; PMI, 2004; APM, 2006). In both non-equilibrium and near-equilibrium scenarios, it seems that competitive advantage for organisations derives from organising both *order and disorder*. The trick seems to revolve around achieving a near-equilibrium generative balance between the two that avoids equilibrium, because the latter reduces coherence as it reduces interdependence. As previously discussed, the synonymous duality of 'learning-organising' is a non-equilibrium condition that is reflected in the entropy envelope of problem-solving. This can vary in degree from the complex problem-solving (CPS) of dynamic capabilities at 'far from equilibrium' to the single-loop learning of production at near-equilibrium, to organisational quiescence at equilibrium.

8.3.3.2 PM Research: Capability Development as Organisational CPS

Problem-solving learning modes have long been discussed in the literature as single-loop and double-loop learning (Argyris, 1977). What is less discussed is complex problem-solving (CPS), which this study has shown is integral to developing organisational capabilities, including PMC and dynamic capabilities (DC), Table 7.3, p. 187. Key aspects of CPS include the organisation-wide effects of CPS and the inability of a complex problem to be *completely* specified or comprehended in advance by a single individual (Hayek, 1945; Swinth, 1971; Weinberg, 2001; Snowden, 2002). In CPS settings, the entropy envelope is unstable and far from equilibrium in which problem-solving is a non-equilibrium process of extreme 'dissipative organising'. There are three interrelated aspects involved in 'dissipative organising' - stimulus, inquiry, and form (Prigogine, 1980). The problem to be solved represents the stimulus. The two-stage problem-solving activities of differentiation (disorder)

and integration (order) represent inquiry, which is a synonymous duality with its own organising forms.

In organisational CPS, extreme 'dissipative organising' involves resolving a complex problem on a scale that is simultaneously disruptive and creative across the organisation. This is like a spectrum of uncertainty and risk. At the low end, 'known knowns' (single-loop) and 'known unknowns' (double-loop) correspond to 'normal' individual and team problem-solving as an organisational practice. At the high end, 'unknown knowns' correspond to CPS as a strategic 'complex organisational practice' and 'unknown unknowns' as intractable problems. This suggests that the Positivist assumption of pre-given 'known' knowledge at the outset of a complex project is untenable and with it the normative assumption of 'total planning' for complex projects. This study supports an emergent approach and proposes distributed organising for the coordination of project knowledge based on a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967).

8.3.3.3 PM Research: PMC as a Dynamic Organisational Capability

This study has shown that organisational capability development, including PMC and dynamic capability (DC), is a form of organisational CPS, Table 7.3, p. 187. In this, PMC is a dynamic organisational capability on three counts. Firstly, its development in IE and the ESB was in response to a dynamic CPS context that was characterised by variable amplitude change (ΔS) and pace of change (dS/dt). Secondly, PMC development as organisational CPS is a non-equilibrium process of extreme 'dissipative organising' in scale and scope across the organisation that is inherently dynamical. Thirdly, as a 'core supporting competence' in the two PSOs under study, PMC is a dynamic capability (Winter, 2003). In addition, PMC is a multi-level PM ecology (Grabher, 2002, 2004).

The CPS entropy envelope of knowledge creation enables us to anticipate that dissipation (entropy increase) is likely to occur when the outcome is unsuccessful. This is the scenario of organisational projects that are started but not finished, which results in disorder (entropy). However, not undertaking projects in a changing environment can result in a pre-existing order that is no longer in the required order. In change-making, or knowledge-making, the key transition from differentiation activities to integration activities can be seen as a 'bifurcation point' with implications for leadership, judgement, timing, degree, etc. – see Fig. 3.1, p. 60, transition point '*B*'. Successive cycles of knowledge-making give rise to a cascade of bifurcation points, which, if successful, lead to a continuous reduction in net entropy (disorder) over time, or a continuous increase in net order.

PM Empirical Research	Supported	Extended / Developed	Advanced / New
Problem-Solving as Learning & Organising (Sect. 8.3.3.1)	Problem-solving as a key aspect of PM (PMI, 2004; APM, 2006).	Problem-solving as a non-equilibrium mode of learning and organising (Popper, 1972/1979).	Problem-solving as a non-equilibrium mode of 'learning-organising' that involves activities of disaggregation (disorder) and aggregation (order) (Popper, 1972/1979). Problem-solving as knowledge creation involves organising both *order and disorder*.
Capability Development as Organisational CPS (Sect. 8.3.3.2)		Developing organisational capabilities, including PMC and dynamic capabilities (DC), is a form of complex problem-solving (CPS) rather than single-loop or double-loop learning (Argyris, 1977).	Capability development as organisational CPS is a non-equilibrium process of extreme 'dissipative organising'. This involves three interrelated aspects - stimulus, inquiry, and form (Prigogine, 1980). Key aspects of CPS include the organisation-wide effects of CPS and the inability of a complex problem to be completely specified or comprehended in advance by a single individual (Hayek, 1945; Swinth, 1971). The Positivist assumption of 'total planning' for complex projects is untenable. This study supports an emergent approach and proposes distributed organising for the coordination of project knowledge, based on a 'common will of mutual interest' as a distributed 'tacit dimension'.
PMC as a Dynamic Organisational Capability (Sect. 8.3.3.3)	PM as an organisational capability (Lindkvist et al., 1998; Davies & Brady, 2000; Brady & Davies, 2004; Davies & Hobday, 2005; Söderlund, 2005, 2008; Söderlund & Tell, 2009). Case study approach to PMC research (Söderlund, 2005).	PMC development as organisational CPS. PMC as a multi-level PM ecology (Grabher, 2002, 2004).	Organisational CPS as extreme 'dissipative organising' with a 'bifurcation point' between differentiation and integration activities. PMC is a dynamic capability as a 'core supporting competence' (Winter, 2003).
PM Practice			
PMC Development as Organisational CPS (Sect. 8.3.3.4)	PM as an organisational capability.	PMC as organisational CPS. PMC as 'complex organisational practice. Fostering and pacing a 'common will' around goals and the project life cycle (Söderlund , 2010).	Complex projects can only be 'boundedly planned'. Distributed organising approach is proposed for integrating knowledge in complex PM settings (Hayek, 1945). A 'common will of mutual interest' for coordinating an interplay between local 'knowing' knowledge (know how, etc.) and abstract 'known' knowledge (designs, plans, etc.) (Smith, 1776/1981).

Table 8.3 Study Perspectives on PMC Development

8.3.3.4 PM Practice: PMC Development as Organisational CPS

In so far as PMC development is an exercise in organisational CPS, it is inherently dynamic and the reconfigured project resource-base becomes a measure of the performance of PMC, a measure of its 'dynamic performance' (Iansiti & Clark, 1994). This requires the development of PMC as a 'complex organisational practice' for accomplishing complex temporary undertakings. Because complex projects can only be 'boundedly planned', a distributed organising approach is proposed by this study for integrating knowledge in complex PM settings (Smith, 1776/1981; Hayek, 1945). This is based on a common will of mutual interest for coordinating an interplay of tacit rationality between local 'knowing' knowledge (know-how, etc.) and abstract 'known' knowledge (designs, plans, etc.) under centralised bounded planning (Kolb, 1984).

In developing PMC as a multi-level PM ecology through organisational CPS, this is a form of 'dissipative organising' that involves the activities of disaggregation/differentiation and aggregation/integration on a scale that is simultaneously creative and disruptive across the organisation. In IE and the ESB, the development of PMC progressed through recursive cycles of practice and learning, which was recognisable in the PMC process groups as variations of goals, formation (differentiation), integration, and normalisation, Table 7.3, p. 187 (Söderlund , 2010).

8.4 RESEARCH LIMITATIONS

This study was undertaken as exploratory research in the development of PM as an organisational capability (PMC) in public sector organisations (PSO), which is under-researched in the literature. Because of the importance of context and the processual nature of capability development, it was decided to adopt a Contextualist approach based on two case studies (Pepper, 1942). The empirical research findings are limited by the data from the two case study organisations but are corroborated in many instances by replication between the two cases (Yin, 2003) and by a critical evaluation with the existing literature. The perspectives on theory, research, and practice may have analytic generalisability beyond this study, subject to further research corroboration.

In this study of PMC development in complex organisational settings, various literatures have been synthesised in relation to the data, including organisational knowledge, organisational capabilities, and PM as a capability. While yielding some useful tentative findings, it was not possible to delve more deeply into all the findings in the current research, e.g., a common will of mutual interest. Furthermore, this study has explored knowledge creation as a key aspect of developing PMC but acknowledges that this is part of a broader process of knowledge formation that also includes knowledge utilisation, transfer, absorption, dissemination, etc., which were not explored in this study.

Finally, dialectic problem-solving as differentiation-integration activities and a common will of mutual interest highlight the need for a holistic view of organisational knowledge that includes contextual 'knowing' knowledge (know-how, etc.), abstract 'known' knowledge (design, plans, etc.), and the 'tacit dimension' (Polanyi, 1967). This study adopted an 'interplay' approach (Dewey, 1916/1966; Kolb, 1984), which is under-developed in the literature, rather than the mainstream 'conversion' approach of Nonaka and Takeuchi (1995). The latter approach is problematic because of Polanyi's view that the ideal of converting tacit knowledge into explicit knowledge and, thereby, eliminating the tacit component of knowledge would "aim at the destruction of all knowledge" (1967, p. 20), a point highlighted by Tsoukas (1996, 2005) and Cook and Brown (1999).

8.5 FUTURE RESEARCH

The findings and perspectives resulting from this study give rise to various research opportunities in PM empirical research and practice.

Projects as Process and PM / PMC as Practice

1) By viewing PM/PMC through the lenses of *organising* and *practice*, this can enrich PM research by drawing on insights from the practice and organisation literatures that reflect the processual nature of practice and organisations (Pettigrew, 1990, 1997). This includes insights from practice (Schön, 1983; Cook & Brown, 1999; Orlikowski, 2002; Nicolini *et al*., 2003; Gherardi, 2006; Feldman & Orlikowski, 2011) and enactment in organisations (Orlikowski, 1996; Weick, 1996; Tsoukas & Chia, 2002). It also includes insights from sense-making (Weick, 1979, 1993, 1995), knowledge creation (Nonaka & Takeuchi, 1995), and distributed knowledge (Weick & Roberts, 1993; Tsoukas, 1996).

Organisational Capability Development

2) In this study, the development of PMC has been explored as a multi-level construct and has identified the structure of learning as an equilogical process based on differentiation-integration. In responding to environmental change, this suggests that management needs to balance two sets of requirements, external environment and internal learning, rather than a contingency reaction that emphasises the environment (Burns & Stalker, 1961). Additional research is warranted to explore the balance between the need of the organisation to learn in a way that observes the logical structure of knowledge-creating and the need to adapt to environmental change.

For example: How do the dynamics of organisational learning processes affect adaptability to environmental change?

3) As an organisational capability, PMC development is honed as a practice through organisational CPS, which is based on the logical structure of problem-solving through activities of differentiation (disorder) and integration (order). In this study, this has been shown to be a learning process that is equilogical at individual level and organisational level, Fig. 3.1, p. 60 & Table 7.3, p. 187. In addition, PMC development through organisational CPS represents extreme 'dissipative organising' of disordering and ordering activities for developing capabilities on a path from 'order to *disorder* to order' rather than 'order to

order'. The transition from differentiation to integration activities can be viewed as a 'bifurcation point' with implications for judgment, timing, and transition capability, which requires further research elaboration (Gersick, 1988 ; Okhuysen & Eisenhardt, 2002).

For example: How does the timing of management intervention enhance organisational learning outcomes?

Complex Project Management as Bounded Planning & Distributed Organising

4) The need for a common will of mutual interest for coordinating project knowledge that is contextual (knowing) and abstract (known) gives rise to a concurrent need to foster and pace a project common will around goals and the project life cycle (Lindkvist *et al*., 1998; Söderlund, 2010). This offers a different perspective for investigating leadership and teamwork in PM research. Using the lens of a common will of mutual interest as a distributed tacit dimension (Polanyi, 1967), leadership in organisations and projects can be investigated holistically as a spectrum from heterarchy (Hedlund, 1994), such as a mass of flying birds using swarm intelligence, to hierarchy, such as beehives. Both extremes seem to rely on what Polanyi (1967, 1969) describes as 'mutual control', which is a distributed tacit dimension of 'tacit foreknowledge' based on the twin principles of self-discipline through mutual authority and self-coordination through mutual adjustment.

For example: Leadership in PM - from orchestra to jazz ensemble.

5) This study has encountered the perennial issue of knowledge transfer between projects, which flows directly from the Positivist ideal of detached 'known' knowledge that ignores 'knowing' knowledge and the 'tacit dimension' of knowledge. Using a view of knowledge that is inseparable from the knowing subject together with PM as organisational practice based on 'learning-organising', the idea of PM as a 'collectivity of practice' (Lindkvist, 2005) could be further researched for knowledge creation, utilisation, and transfer.

For example: How does a community of project practice (CoPP) contribute to the formation and utilisation of knowledge over the project life cycle?

Project Management as Social Science

6) The idea of bounded planning suggests that the PM spectrum can be divided into zones of knowledge complexity rather than systems complexity (Cleland & King, 1968; Shenhar 1998 *et seq*.). This spectrum has a linear part in the middle with a 'fuzzy' tail at each end. At

the fuzzy lower-end, simple projects are performed by individuals acting largely alone with project plans 'in their head'. In the middle linear area, medium to large projects are performed under traditional PM planning as technical rationality, because they can be comprehended in their entirety by a single individual and reflected in plans, designs, etc. At the fuzzy upper-end, complex projects are limited to bounded planning, because no single individual can comprehend the complexity in its entirety. Holistic PM research needs to encompass this entire spectrum from a knowledge-based view and other business perspectives rather than focusing on the linear part in the middle as a *quasi* applied science, which may turn out to be the exception rather than the rule.

7) In adopting Adam Smith's (1776/1981) idea of an 'invisible hand' of self-interest, neo-classical economics grounds itself in a 'rational actor' model of human behaviour, i.e., Positivist social science. By adopting a 'common will of mutual interest' for complex projects, PM can ground itself in a model of communal rationality that is socio-technical rather than purely technical and where projects are viewed as 'rational actors' rather than 'rational objects'. This is more tacit rationality than explicit rationality or technical rationality and can be viewed as extended-Pragmatism within a socio-technical perspective or pragmatic Positivism from a traditional PM perspective. If the 'invisible hand' is operative at the fuzzy lower-end of individual projects and a 'common will' at the fuzzy upper-end of complex projects, separated by nominal rationality in the middle, then, the PM spectrum can be approached as a rational domain when viewed as *social science rather than applied science.*

For example: Towards reconceptualising project management as pragmatic social science.

APPENDIX I CASE STUDY PROTOCOL

1. Process Model

Using the process model depicted in Fig. 9.1, this case study seeks to investigate the development of PM as an organisational capability (PMC) in two PSOs in response to the economic stimulus of the 2000s.

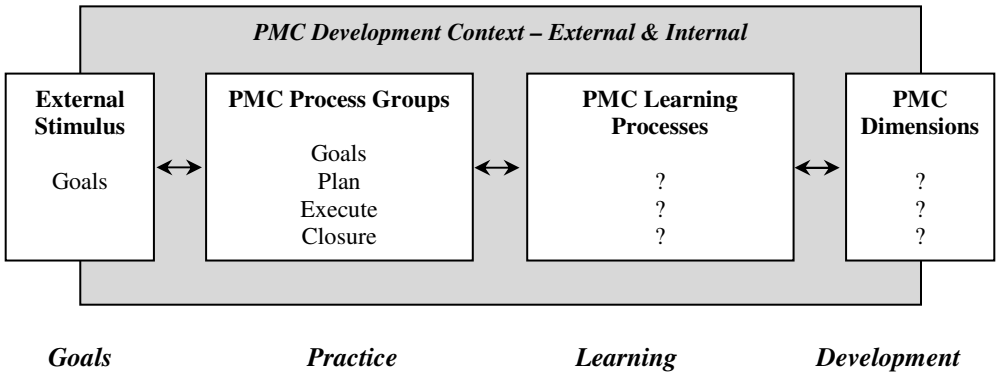


Fig. 9.1 Study Process Model – PMC Development (copy Fig. 4.3)

2. Research Questions

How do learning processes underpin the development of project management capability in complex organisational settings?

(i) What role does problem-solving play in learning processes for developing PMC?
(ii) How does a practice-oriented approach facilitate the development of PMC?
(iii) How is project knowledge coordinated in complex PM settings?

3. Ethical Guidelines

Under the ethical guidelines of Dublin City University for data confidentiality in conducting social science research, permission is sought from informants regarding the use of interview data in the study. With the consent of informants, interviews are electronically recorded and transcripts prepared for subsequent analysis for major themes and supporting themes. A copy of the interview transcript is sent to the informant for review. If it is not possible to record interviews, notes are taken during the interviews. In addition, a draft copy of the case study of IE and the ESB is sent to each respective organisation for review and comment.

4. Primary Data

Primary study data derives from semi-structured interviews with personnel from IE and ESB at external level, organisational level, and project level. In relation to IE's PMC development, it is hoped to interview personnel at the following organisational levels:

External Level

Department of Finance
PM Consultants to IE

Organisation Level

Executive Directors
Strategic Planning
Chief Safety & Security Office
Chief Signalling Engineer Office
Programme Management
Project Controls
Liaison - Operations

Project Level

Project Manager - Construction
Project Manager - Signalling
Project Manager - Track Installation
Project Manager - Track Protection
Project Planning
Project Task Leaders
Track Installation Coordination
Track Inspectors

In relation to ESB Network's PMC development, it is hoped to interview ESB personnel at the following organisational levels:

Organisation Level

Executive Directors
Contracting Partners
Contracts Management
Programme Management
Network Management
Project Controls

Project Level

Project Manager - Construction
Project Manager - Contracts Planning
Project Manager - Networks

5. Sample Questions in Semi-Structured Interviews

In general, questions to interviewees revolve around the six aspects of the low-resolution process model, Fig. 9.1, namely, external context, internal context, external stimulus, PMC process groups, PMC learning processes, and PMC dimensions. Sample questions under these headings are indicated as follows, where informants are allowed the flexibility to expand on areas they feel to be important.

External Context

- What are the external factors that contribute to the successful delivery of infrastructure projects?
- Do you think that the organisation's interface with the public sector and with the government has been important for developing project management capability?

Internal Context

- How does having an internal client customer influence what are considered project performance criteria?
- Regarding internal organisational factors, what do you think are the factors that are important in delivering successful infrastructure projects?

External Stimulus

- Does government strategy contribute to the successful delivery of infrastructure projects?
- Does the government's transport strategy, like 'Transport 21' or the NDPs, have an influence on the way infrastructure projects are done?

PMC Process Groups

- How does the company's internal implementation and control environment impinge on your ability to deliver a successful infrastructure project?
- What implementation approach was adopted to deliver Project X?
- Did the implementation process vary over the life cycle of the project?

PMC Learning Processes

- Did you start doing the infrastructure projects first and then the procedures later or do you draft the procedures first and take a formal approach?
- How has the new project management expertise been shared between different people - how does it get disseminated and diffused?

PMC Dimensions

- What do you believe are the key building blocks that are necessary in order to deliver capital projects, in order for an organisation to develop the capability to deliver capital projects on a sustained basis?
- In terms of the top 3 or 4 or 5 building blocks of the organisation's capability to do infrastructure projects, what would you say are the key building blocks?

6. Secondary Data

- IE/CIE and ESB Annual Reports and Financial Statements
- IE Newsletters (Stop Press; Rail Brief)
- IE/CIE Board approval papers
- IE and ESB procedures
- Journal of the Irish Railway Record Society
- IE and ESB Websites
- Academic literature
- Miscellaneous

APPENDIX II DATA CODING SCHEME

Count of No.	
Level 1	Total
PMC Dimensions	1,686
Knolwedge Creation	650
PMC Process	433
Context External	201
Context Internal	124
PMC Old	93
Outcomes Internal	88
Outcomes External	8
Context Technology	6
Grand Total	3,289

Count of No.	
Level 2	Total
Proj Structuring	548
Proj Goals	383
Proj Procedures	293
Proj Resources	240
Org Learning	231
Proj Systems	176
GFIN-Integrate	174
Org Knowledge	153
GFIN-Formation	106
Stimulus	97
GFIN	70
ISID-Disemminate	67
Lessons Learned	57
GFIN-Goals	49
Development	33
GFIN-Normalisation	33
Scale	32
ISID-Integrate	26
ISID-Sharing	23
ISID	22
Politics	20
Capital Expend	17
HRM	14
PMC-2	9
ISID-Initiate	2
Grand Total	2,875

Count of No.	
Level 3	Total
Contracting	269
Org Struct	262
PM & Team	253
Stake Mgmt	162
KPI	160
Planning	149
Formal	125
Experiential	124
Training	82
Consolidating	73
Meetings	51
Design	48
Reporting	41
Nat'l Dev Plans	33
Safety	26
Org Planning	26
Deregulation	24
Major	24
Dissemination	23
Resident Eng	22
Governance	20
Organic	19
Drafting	18
Procurement	17
Maintenance	14
Maturity	14
Small-Med	12
Systems	12
3 Pillars	12
Tacit Knowledge	12
Business Goals	11
PMI	11
EU	9
Quality	9
Configuring	7
Framework	7
Delivery	6
Goal Directed	6
4 Pillars	6
Marketing	5
Entrainment	5
Legal Docs	4
Compliance	4
Technology	4
Risk	4
Value Eng	4
Proj Journal	4
Executing	4
Publishing	4
ERP	3
Barrier	3
Business Case	3
Medium	3
Wind	3
Material	2
Forgetting	2
Legacy	2
New Pub Mgmt	2
Collective Tacit Knowledge	2
Weather	1
Rotation	1
Grand Total	2,268

Count of No.	
Level 4	Total
Building Blocks	442
Outsourcing	63
Documented	54
Duality	53
Proj Mgmt Office	50
Strategy	48
Undocumented	47
Customer Requirements Spec	46
Ganger	36
Innovation	34
Proj Life Cycle	31
Budget	28
Interface	26
Commercial	25
Teamwork	22
Leadership	22
Catalyst	19
Competencies	19
Trust	17
Success	15
Participation	14
Design & Build	13
Benchmark	13
Matrix	12
Contractors	11
Internal	11
Routine	11
Communicating	11
Local Authority	11
Proj Delivery Model	10
Comm of Proj Pract	10
IR	10
PR	10
Handover	9
Pub Priv Partnership	9
Confidence	7
IT Proj	7
PM Framework	7
Failure	7
Proj Engineering	7
Prob-Solving	7
Culture	6
Gov Const Contracts Comm	5
Civils	4
Work Inst	4
Validation	4
Power	4
Time	4
Mentor	4
Value For Money	3
Quantity Surveyor	3
Snr Mgmt	3
Dispersed	3
Remeasureable	3
Continuing Prof Devel	3
Legal	3
Technology	3
Education	3
Functional	3
Succession	3
Proj Adv Group	3
Audits	3
External	2
Operations	2
Doc Control	2
Gate Review	2
Ownership	2
Flexibility	2
Service Level	2
Transition	2
Intranet	2
Possessions	2
Challenge	2
Reliability	2
Fragmented	2
Practice	2
Proj Controls	1
Demographics	1
Consultant	1
Autonomy	1
Reassignment	1
Adversarial	1
People	1
Turnover	1
Competition	1
Res Loading	1
Consultants	1
PBO	1
Proj Control Office	1
Grand Total	1,419

Abbreviations
GFIN: Goals, Formation, Integration, Normalisation
ISID: Initiate, Sharing, Integrating, Disseminating

Table 10.1 Data Coding Scheme - Levels 1, 2, 3, 4

APPENDIX III ESB - PROJECT DELIVERY MODEL (PDM)

Table of Contents - Knowledge Areas

REFERENCES

Adams, J. & Barndt, S. (1983). Behavioral implications of the project life cycle. In D.I. Cleland & W.R. King (Eds.), *Project management handbook* (pp. 222-244). New York: Van Nostrand Reinhold.

Andersen, E.S. (2006). Toward a project management theory for renewal projects. *Project Management Journal*, 37(4), 15-30.

Ansoff, H.I. (1991). Critique of Henry Mintzberg's 'The design school: Reconsidering the basic premises of strategic management'. *Strategic Management Journal*, 12(6), 449-461.

Anumba, C.J., Egbu, C.O., & Carrillo, P.M. (Eds.) (2005). *Knowledge Management in Construction*. Oxford: Blackwell.

APM (2006). *APM body of knowledge (5th Ed.)*. Princes Risborough, Bucks., UK: Association for Project Management. (Orig. 1992)

Argyris, C. (1977). Double loop learning in organizations. *Harvard Business Review*, 55(5), 115-125.

Argyris, C. & Schön, D.A. (1996). *Organizational learning I: Theory, method, and practice*. Reading, MA: Addison-Wesley.

Arrow, K.J. (1962). The economic implications of learning by doing. *Review of Economic Studies*, 29(3), 155-173.

Ashby, W.R. (1956). *An introduction to cybernetics*. London: Chapman & Hall.

Atkinson, R. (1999). Project management: Cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria. *International Journal of Project Management*, 17(6), 337-342.

Avots, I. (1969). Why does project management fail? *California Management Review*, 12(1), 77-82.

Ayas, K. & Zeniuk, N. (2001). Project-based learning: Building communities of reflective practitioners. *Management Learning*, 32(1), 61-76.

Baker, B., Murphy, D., & Fisher, D. (1983). Factors affecting project success. In D.I. Cleland & W.R. King (Eds.), *Project management handbook* (pp. 669–685). New York: Van Nostrand Reinhold. See also: Murphy, D.C., Baker, B.N., & Fisher, D. (1974). Determinants of project success. Accession No. N-74-30392, National Technical Information Services, Virginia 22151, USA.

Barnard, C.I. (1938). *The functions of the executive*. Cambridge, MA: Harvard University Press.

Barney, J.B. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, 17(1), 99-120.

Beer, S. (1988). *Brain of the firm*. New York: Wiley.

Beer, S. (1994). *Decision and control: The meaning of operational research and management cybernetics*. New York: Wiley. (Orig. 1966)

Bellini, E. & Canonico, P. (2008). Knowing communities in project driven organizations: Analysing the strategic impact of socially constructed HRM practices. *International Journal of Project Management*, 26(1), 44-50.

Benton, T. & Craib, I. (2001). *Philosophy of social science. The philosophical foundations of social thought.* Basingstoke: Palgrave.

Berger, P.L. & Luckmann, T. (1967). *The social construction of reality: A treatise in the sociology of knowledge*. New York: Anchor Books.

Berggren, C., Järkvik, J., & Söderlund, J. (2008). Lagomizing, organic integration, and systems emergency wards: Innovative practices in managing complex systems development projects. *Project Management Journal*, 39(S), S111-S122.

Berggren, C., Söderlund, J., & Anderson, C. (2001). Clients, contractors and consultants: The consequences of organizational fragmentation in contemporary project environments. *Project Management Journal*, 32(3), 39-48.

Betts, M. & Lansley, P. (1995). International Journal of Project Management: A review of the first ten years. *International Journal of Project Management*, 13(4), 207-217.

Blomquist, T., Hällgren, M., Nilsson, A., & Söderholm, A. (2010). Project-as-practice: In search of project management research that matters. *Project Management Journal*, 41(1), 5-16.

Bogner, W.C. & Thomas, H. (1994). Core competence and competitive advantage: A model and illustrative evidence from the pharmaceutical industry. In G. Hamel & A. Heene (Eds.), *Competence-based competition* (pp. 111-144). Chichester, UK: Wiley.

Boisot, M.H. (1998). *Knowledge assets: Securing competitive advantage in the information economy*. Oxford: Oxford University Press.

Boulding, K.E. (1956). General systems theory: The skeleton of science. *Management Science*, 2(3), 197-208.

Bragd, A. (2002). *Knowing management: An ethnographic study of tinkering with a new car*. Göteborg, Sweden: Göteborg University, BAS Publisher.

Brady, T. & Davies, A. (2004). Building project capabilities: From exploratory to exploitative learning. *Organization Studies*, 25(9), 1601–1621.

Brady, T. & Hobday, M. (2011). Projects and innovation: Innovation and projects. In P. Morris, J. Pinto, & J. Söderlund (Eds.), *The Oxford handbook of project management* (pp. 273-294). Oxford: Oxford University Press.

Brady, T. & Söderlund, J. (2008). Projects in innovation, innovation in projects selected papers from the IRNOP VIII conference. *International Journal of Project Management*, 26(5), 465-468.

Bredillet, C.N. (2006). Making the Case… *Project Management Journal*, 37(2), 3-4.

Bredillet, C.N. (2007a). Exploring research in project management - nine schools of project management research (Part 1). *Project Management Journal*, 38(2), 3-4.

Bredillet, C.N. (2007b). Exploring research in project management - nine schools of project management research (Part 2). *Project Management Journal*, 38(3), 3-5.

Bredillet, C.N. (2007c). Exploring research in project management - nine schools of project management research (Part 3). *Project Management Journal*, 38(4), 3-4.

Bredillet, C.N. (2008a). Exploring research in project management - nine schools of project management research (Part 4). *Project Management Journal*, 39(1), 2-6.

Bredillet, C.N. (2008b). Exploring research in project management - nine schools of project management research (Part 5). *Project Management Journal*, 39(2), 2-4.

Bredillet, C.N. (2008c). Exploring research in project management - nine schools of project management research (Part 6). *Project Management Journal*, 39(3), 2-5.

Bresnen, M., Edelman, L., Newell, S., Scarbrough, H., & Swan, J. (2003). Social practices and the management of knowledge in project environments. *International Journal of Project Management*, 21(3), 157-166.

Bresnen, M. & Marshall, N. (2000). Partnering in construction: A critical review of issues, problems and dilemmas. *Construction Management & Economics*, 18(2), 229-237.

Brown, J.S. & Duguid, P. (1991). Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation. *Organization Science*, 2(1), 40-57.

Brown, S.L. & Eisenhardt, K.M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative Science Quarterly*, 42(1), 1-34.

Bruner, J. (1986). *Actual minds, possible worlds*. Cambridge, MA: Harvard University Press.

Burns, T. & Stalker, G.M. (1961). *The management of innovation*. London: Tavistock.

Campbell, D.T. (1960). Blind variation and selective retention in creative thought as in other knowledge processes. *Psychological Review*, 67(6), 380-400.

Carlile, P.R. (2002). A pragmatic view of knowledge and boundaries: Boundary objects in new product development. *Organization Science*, 13(4), 442-455.

Casserley, H. (1974). *Outline of Irish railway history*. London: David & Charles.

Chan, A. & Chan, A. (2004). Key performance indicators for measuring construction success. *Benchmarking: An International Journal,* 11(2), 203-221.

Chan, A., Ho, D., & Tam, C. (2001). Design and build project success factors: Multivariate analysis. *Journal of Construction Engineering & Management*, 127(2), 93-100.

Chandler, A.D. (1977). *The visible hand. The managerial revolution in American business.* Cambridge, MA: Harvard University Press.

Chandler, A.D. (1990). *Scale and scope: The dynamics of industrial capitalism*. Cambridge, MA: Belknap Press, Harvard University Press.

Chandler, A.D. (1992). Organizational capabilities and the economic history of the industrial enterprise. *Journal of Economic Perspectives*, 6(3), 79-100.

Cleden, D. (2009). *Managing project uncertainty*. Farnham, UK: Gower.

Cleland, D.I. & Ireland, L.R. (2007). *Project management: Strategic design and implementation* (5th Ed.). New York: McGraw-Hill.

Cleland, D.I. & King, W.R. (1968). *Systems analysis and project management.* New York: McGraw Hill.

Cleland, D.I. & King, W.R. (1983). *Project management handbook*. New York: Van Nostrand Reinhold.

Cook, S.D.N. & Brown, J.S. (1999). Bridging epistemologies: The generative dance between organizational knowledge and organizational knowing. *Organization Science*, 10(4), 381-400.

Cooke-Davies, T.J. (2002). Establishing the link between project management practices and project success. *Proceedings of PMI Research Conference* (pp. 15-25). Newton Square, PA: Project Management Institute (PMI).

Cooke-Davies, T.J., Cicmil, S., Crawford, L., & Richardson, K. (2007). We're not in Kansas anymore, Toto: Mapping the strange landscape of complexity theory, and its relationship to project management. *Project Management Journal*, 38(2), 50-61.

Crawford, L. (2006). Developing organizational project management capability: Theory and practice. *Project Management Journal*, 37(3), 74-86.

Crawford, L., Costello, K., Pollack, J., & Bentley, L. (2003). Managing soft change projects in the public sector. *International Journal of Project Management,* 21(6), 443-448.

Crawford, L., Pollack, J., & England, D. (2006). Uncovering the trends in project management: Journal emphases over the last 10 years. *International Journal of Project Management*, 24(2), 175-184.

Czarniawska-Joerges, B. (1989). Toward an anthropology of complex organizations. *International Studies of Management and Organization*, 19(3), 3-15.

Czarniawska-Joerges, B. (1992). *Exploring complex organizations: A cultural perspective*. Newbury Park, CA: Sage.

Daft, R.L. & Weick, K.E. (1984). Toward a model of organizations as interpretation systems. *Academy of Management Review*, 9(2), 284-295.

Daniel, R.D. (1961). Management information crisis. *Harvard Business Review*, 39(5), 111-121.

Davies, A. & Brady, T. (2000). Organisational capabilities and learning in complex product systems: Towards repeatable solutions. *Research Policy*, 29(7/8), 931–953.

Davies, A. & Hobday, M. (2005). *The business of projects: Managing innovation in complex products and systems*. Cambridge, UK: Cambridge University Press.

de Wit, A. (1986). Measuring project success: An illusion. *Proceedings of Project Management Institute Seminar / Symposium*, Montreal, Canada, Sept. 20-25, 13-21.

de Wit, A. (1988). Measurement of project success. *Project Management*, 6(3), 164-170.

DeFillippi, R.J. (2001). Project-based learning, reflective practices and learning. *Management Learning*, 32(1), 5-10.

DeFillippi, R.J. & Arthur, M.B. (1998). Paradox in project-based enterprise: The case of film making. *California Management Review*, 40(2), 125-139.

Dewey, J. (1966). *Democracy and education: An introduction to the philosophy of education*. New York: Free Press. (Orig. 1916)

Dewey, J. & Bentley, A.F. (1949). *Knowing and the known*. Boston: Beacon Press.

DiMaggio, P.J. & Powell, W.W. (1983). The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147-160.

Dosi, G., Hobday, M., & Marengo, L. (2003). Problem-solving behaviors, organizational forms, and the complexity of tasks. In C.E. Helfat (Ed.), *The SMS Blackwell handbook of organizational capabilities: Emergence, development, and change* (pp. 167-192). Oxford: Blackwell.

Dosi, G. & Marengo, L. (1993). Some elements of an evolutionary theory of organizational competences. In R.W. England (Ed.), *Evolutionary concepts in contemporary economics* (pp. 157-178). Ann Arbor, MI: University of Michigan Press.

Dosi, G., Nelson, R.R., & Winter, S.G. (2000). Introduction. In G. Dosi, R.R. Nelson, and S.G. Winter (Eds.), *The nature and dynamics of organizational capabilities* (pp. 1-22). New York: Oxford University Press.

Dougherty, D. (1992). Interpretive barriers to successful product innovation in large firms. *Organization Science*, 3(2), 179-202.

Dougherty, D. (2001). Reimagining the differentiation and integration of work for sustained product innovation. *Organization Science*, 12(5), 612–31.

Dreyfus, H. & Dreyfus, S. (1986). *Mind over machine*. Oxford: Blackwell.

Dunleavy, P. & Hood, C. (1994). From old public administration to new public management. *Public Money & Management*, 14(3), 9-16.

Dvir, D. & Lechler, T. (2004). Plans are nothing, changing plans is everything: The impact of changes on project success. *Research Policy*, 33(1), 1–15.

Easterby-Smith, M. & Prieto, I.M. (2008). Dynamic capabilities and knowledge management: An integrative role for learning? *British Journal of Management*, 19(3), 235-249.

Egbu, C.O. (2004). Managing knowledge and intellectual capital for improved organizational innovations in the construction industry: An examination of critical success factors. *Engineering, Construction and Architectural Management*, 11(5), 301–315.

Eisenhardt, K.M. (1989a). Building theories from case study research. *Academy of Management Review,* 14(4), 532-550.

Eisenhardt, K.M. (1989b). Making fast strategic decisions in high-velocity environments. *Academy of Management Journal*, 32(3), 543-576.

Eisenhardt, K.M. (1999). Strategy as strategic decision making. *Sloan Management Review*, 40(3), 65-72.

Eisenhardt, K.M. & Martin, J.A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, 21(10/11), 1105-1121.

Eisenhardt, K.M. & Tabrizi, B.N. (1995). Accelerating adaptive processes: Product innovation in the global computer industry. *Administrative Science Quarterly*, 40(1), 84–110.

Enberg, C., Lindkvist, L., & Tell, F. (2006). Exploring the dynamics of knowledge integration: Acting and interacting in project teams. *Management Learning*, 37(2), 143-165.

Enberg, C. (2007). *Knowledge integration in product development projects*. Doctoral dissertation, No. 106, IMIE, Linköping University, Sweden.

Enberg, C., Lindkvist, L., & Tell, F. (2010). Knowledge integration at the edge of technology: On teamwork and complexity in new turbine development. *International Journal of Project Management*, 28(8), 756-765.

Engwall, M. (1992). Project management and ambiguity: Findings from a comparative case study. In I. Hägg & E. Segelod (Eds.), *Issues in empirical investment research* (pp. 173-197). Amsterdam: Elsevier.

Engwall, M. (1998). The project concept(s): On the unit of analysis in the study of project management. In R.A. Lundin & C. Midler, *Projects as arenas for learning and renewal* (pp. 25-35). Boston: Kluwer.

Engwall, M. (2002). The futile dream of the perfect goal. In K. Sahlin-Andersson & A. Söderholm (Eds.). *Beyond project management: New perspectives on the temporary-permanent dilemma* (pp. 261-277). Copenhagen: Liber Abstrakt Copenhagen Business School Press.

Engwall, M. (2003). No project is an island: Linking projects to history and context. *Research Policy*, 32(5), 789-808.

Engwall, M., Steinthórsson, R.S., & Söderholm, A. (2003). Temporary organizing - a Viking approach to project management research. In B. Czarniawska & G. Sevon (Eds.), *The northern light organization theory in Scandinavia* (pp. 111-130). Copenhagen: Liber Abstrakt Copenhagen Business School Press.

Farndale, E. (2004). *The intra-organisational power of the personnel department in higher education in the UK*. Unpublished PhD Thesis, Cranfield University, UK.

Fayol, H. (1988). *General and industrial management*. London: Pitman. (Orig. 1916, trans. 1949). Fayol, H. (1916). *Administration industrielle et générale: Prévoyance, organisation, commandement, coordination, controle*. Paris: Dunod & Pinat.

Feldman, M.S. & Orlikowski, W.J. (2011). Theorizing practice and practicing theory. *Organization Science*, 22(5), 1240 - 1253.

Ferlie, E., Ashburner, L., Fitzgerald, L., & Pettigrew, A. (1996). *The new public management in action*. Oxford: Oxford University Press.

Flyvbjerg, B. (2004). Five misunderstandings about case study research. In C. Seale, G. Gobo, J. Gubrium, & D. Silverman, *Qualitative Research Practice* (pp. 420-434). London: Sage.

Flyvbjerg, B., Bruzelius, N., & Rothengatter, W. (2003). *Megaprojects and risk: An anatomy of ambition***.** Cambridge: Cambridge University Press

Freeman, M. & Beale, P. (1992). Measuring project success. *Project Management Journal*, 23(1), 8-17.

Gaddis, P. (1959). The project manager. *Harvard Business Review*, 37(3), 89-97.

Galbraith, J.R. (1971). Matrix organization designs. *Business Horizons*, 14(1), 29-40

Galbraith, J.R. (1977). *Organization design*. Reading, MA: Addison-Wesley.

Gareis, R. (1989). 'Management by projects': The management approach for the future. *International Journal of Project Management*, 7(4), 243-249.

Gareis, R. (2005). *Happy projects!* Vienna, Austria: Manz.

Garfinkel, H. (1967). *Studies in ethnomethodology*. Englewood Cliffs, NJ: Prentice Hall.

Geraldi, J., Maylor, H., & Williams, T. (2011). Now, let's make it really complex (complicated): A systematic review of the complexities of projects. *International Journal of Operations & Production Management,* 31(9), 966-990.

Gersick, C.J.G. (1988). Time and transition in work teams: Toward a new model of group development. *Academy of Management Journal*, 31(1), 9-41.

Giddens, A. (2007). *The constitution of society: Outline of the theory of structuration*. Cambridge: Polity Press. (Orig. 1984)

Gherardi, S. (2006). *Organizational knowledge: The texture of workplace learning*. Malden, MA: Blackwell.

Goodman, R.A. & Goodman, L.P. (1976). Some management issues in temporary systems: A study of professional development and manpower - the theater case. *Administrative Science Quarterly*, 21(3), 494-501.

Grabher, G. (2002). Cool projects, boring institutions: Temporary collaboration in social context. *Regional Studies*, 36(3), 205-214.

Grabher, G. (2004). Learning in projects, remembering in networks? Communality, sociality, and connectivity in project ecologies. *European Urban and Regional Studies*, 11(2), 103-123.

Grant, R.M. (1996a). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science*, 7(4), 375-387.

Grant, R.M. (1996b). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17(Winter), 109-122.

Guilford, J.P. (1956). The structure of intellect. *Psychological Bulletin*, 53(4), 267-293.

Hall, P. (1980). *Great planning disasters*. Berkeley, CA: Univ. of California Press.

Hällgren, M. & Wilson, T. (2007). Mini muddling: Learning from project plan deviations. *Journal of Workplace Learning*, 19(2), 92–107.

Hartman, F. (1998). Project management competence. *Proceedings of IRNOP III, The International Research Network on Organizing by Projects* (pp. 1–9), 6–8 July, University of Calgary, Alberta, Canada.

Hayek, F.A. (1945). The use of knowledge in society. *American Economic Review*, 35(4), 519-30.

Hedlund, G. (1994). A model of knowledge management and the N-form corporation. *Strategic Management Journal*, 15(Summer), 73-90.

Helfat, C.E. (2007). *Dynamic capabilities: Understanding strategic change in organizations*. Malden, MA: Blackwell.

Henderson, R.M. & Clark, K.B. (1990). Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. *Administrative Science Quarterly*, 35(1), 9-30.

Hobday, M. (2000). The project-based organization: An ideal form for management of complex products and systems? *Research Policy*, 29(7/8), 871-893.

Hodgson, D.E. (2004). Project work: The legacy of bureaucratic control in the post-bureaucratic organization. *Organization*, 11(1), 81–100.

Hood, C. (1998). *The art of the state: Culture, rhetoric, and public management*. Oxford: Oxford University Press.

Iansiti, M. & Clark, K.B. (1994). Integration and dynamic capability: Evidence from product development in automobiles and mainframe computers. *Industrial and Corporate Change*, 3(3), 557-605.

Institution of Civil Engineers (ICE) (1995). *The engineering and construction contract* (2nd Ed.). London: Thomas Telford.

Institution of Civil Engineers. (1999). *Conditions of contract: Measurement version* (7th Ed.). London: Thomas Telford.

Iyer, K.C. & Jha, K.N. (2005). Factors affecting cost performance: Evidence from Indian construction projects. *International Journal of Project Management*, 23(4), 283-295.

Jackson, P. & Klobas, J. (2008). Building knowledge in projects: A practical application of social constructivism to information systems development. *International Journal of Project Management*, 26(4), 329-337.

Jugdev, K. & Müller, R. (2005). A retrospective look at our evolving understanding of project success. *Project Management Journal*, 36(4), 19-31.

Katzenbach, J.R. & Smith, D.K. (1993). *The wisdom of teams: Creating the high-performance organization*. Boston, MA: Harvard Business School Press.

Katzenbach, J.R. & Smith, D.K. (2001). *The discipline of teams*. New York: Wiley.

Keegan, A. & Turner, J.R. (2001). Quantity versus quality in project-based learning practices. *Management Learning*, 32(1), 77-98.

Kerzner, H. (2006). *Project management: A systems approach to planning, scheduling, and controlling* (9th Ed.). Hoboken, NJ: Wiley. (Orig. 1979)

Killen, C.P., Hunt, R.A., & Kleinschmidt, E.J. (2008). Learning investments and organizational capabilities: Case studies on the development of project portfolio management capabilities. *International Journal of Managing Projects in Business*, 1(3), 334–351.

King, W.R. & Cleland, D.I. (1983). Life cycle management. In D.I. Cleland & W.R. King (Eds.), *Project management handbook* (pp. 209-221). New York: Van Nostrand Reinhold.

Kloppenborg, T.J. & Opfer, W.A. (2000). Forty years of project management research: Trends, interpretations, and predictions. *Proceedings of PMI Research Conference* (pp. 41-59). Newton Square, PA: Project Management Institute (PMI).

Knight, K. (1976). Matrix organization: A review. *Journal of Management Studies*, 13(2), 111-130.

Knorr-Cetina, K.D. (1981). *The manufacture of knowledge: An essay on the constructivist and contextual nature of science*. Oxford: Pergamon.

Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development*. Upper Saddle River, NJ: Prentice Hall.

Kolltveit, B.J., Karlsen, J.T., & Grønhaug, K. (2007). Perspectives on project management. *International Journal of Project Management*, 25(1), 3-9.

Koskinen, K.U. (2000). Tacit knowledge as a promoter of project success. *European Journal of Purchasing & Supply Management*, 6(1), 41-47.

Koskinen, K.U. (2004). Knowledge management to improve project communication and implementation. *Project Management Journal*, 35(2), 13-19.

Kreiner, K. (1992). The postmodern epoch of organization theory. *International Studies of Management & Organization*, 22(2), 37-52.

Kreiner, K. (1995). In search of relevance: Project management in drifting environments. *Scandinavian Journal of Management*, (11)4, 335-346.

Kreiner, K. (2002). Tacit knowledge management: The role of artifacts. *Journal of Knowledge Management*, 6(2), 112-123.

Kreyszig, E. (1972). *Advanced engineering mathematics*. New York: Wiley.

Kuhn, T.S. (1996). *The structure of scientific revolutions*. Chicago: The University of Chicago Press. (Orig. 1962)

Lalonde, P.L., Bourgault, M., & Findeli, A. (2010). Building pragmatist theories of PM practice: Theorizing the act of project management. *Project Management Journal*, 41(5), 21-36.

Lalonde, P.L., Bourgault, M., & Findeli, A. (2012). An empirical investigation of the project situation: PM practice as an inquiry process. *International Journal of Project Management*, 30(4), 418-431.

Lam, A. (2004). Organizational innovation. In J. Fagerberg, D. Mowery, & N. Richard (Eds.), *The Oxford handbook of innovation* (pp. 115-147). Oxford: Oxford University Press.

Laufer, A., Denker, G., & Shenhar, A.J. (1996). Simultaneous management: The key to excellence in capital projects. *International Journal of Project Management*, 14(4), 189-199.

Lave, J. & Wenger, E. (2003). *Situated learning: Legitimate peripheral participation*. Cambridge, UK: Cambridge University Press. (Orig. 1991)

Lawrence, P.R. & Lorsch, J.W. (1967). *Organization and environment: Managing differentiation and integration*. Boston: Harvard University.

Lawson, B. & Samson, D. (2001). Developing innovation capability in organisations: A dynamic capabilities approach. *International Journal of Innovation Management*, 5(3), 377-400.

Lechler, T. (1997). *Erfolgsfaktoren des projektmanagements*. Frankfurt: Lang.

Lechler, T. (1998). When it comes to project management, it's the people that matter: An empirical analysis of project management in Germany. In Hartman, Jergeas, & Thomas (Eds.), *IRNOP III (The International Research Network on Organizing by Projects), The nature and role of projects in the next 20 years: Research issues and problems* (pp. 205-215). Calgary: University of Calgary.

Lee, L.S. & Anderson, R.M. (2006). An exploratory investigation of the antecedents of the IT project management capability. *e-Service Journal*, 5(1), 27-42.

Legris, P. & Collerette, P. (2006). A roadmap for IT project implementation: Integrating stakeholders and change management issues. *Project Management Journal*, 37(5), 64–75.

Lenfle, S. & Loch, C. (2010). Lost roots: How project management came to emphasize control over flexibility and novelty. *California Management Review*, 53(1), 32-55.

Leonard-Barton, D. (1992). Core capabilities and core rigidities: A paradox in managing new product development. *Strategic Management Journal*, 13(Summer), 111-125.

Leonard-Barton, D. (1995). *Wellsprings of knowledge*. Boston: Harvard Business School Press.

Levinthal, D.A. (2000). Organizational capabilities in complex worlds. In G. Dosi, R.R. Nelson, & S.G. Winter (Eds.), *The nature and dynamics of organizational capabilities* (pp. 363-379). New York: Oxford University Press.

Lewin, K. (2008). Quasi-stationary social equilibria and the problem of permanent change. In W.W. Burke, D.G. Lake, & J.W. Paine (Eds.), *Organization change: A comprehensive reader* (pp. 73-77). New York: Wiley. (Orig. 1947)

Leybourne, S. & Sadler-Smith, E. (2006). The role of intuition and improvisation in project management. *International Journal of Project Management*, 24(6), 483-492.

Lim, C. & Mohamed, M. (1999). Criteria of project success: An exploratory re-examination. *International Journal of Project Management*, 17(4), 243–248.

Lindkvist, L. (2005). Knowledge communities and knowledge collectivities: A typology of knowledge work in groups. *Journal of Management Studies*, 42(6), 1189-1210.

Lindkvist, L. (2008). Project organization: Exploring its adaptation properties. *International Journal of Project Management*, 26(1), 13-20.

Lindkvist, L. & Söderlund, J. (2002). What goes on in projects? On goal-directed learning processes. In K. Sahlin-Andersson & A. Söderholm (Eds.). *Beyond project management: New perspectives on the temporary-permanent dilemma* (pp. 278-291). Copenhagen: Liber Abstrakt Copenhagen Business School Press.

Lindkvist, L., Söderlund, J., & Tell, F. (1998). Managing product development projects: On the significance of fountains and deadlines. *Organization Studies*, 19(6), 931-951.

Linehan, C. & Kavanagh, D. (2006). From project ontologies to communities of virtue. In D. Hodgson & S. Cicmil (Eds.), *Making projects critical* (pp. 51-67). Basingstoke, UK: Palgrave Macmillan.

Lovas, B. & Ghoshal, S. (2000). Strategy as guided evolution. *Strategic Management Journal*, 21(9), 875-896.

Lundin, R.A. & Midler, C. (Eds.) (1998). *Projects as arenas for learning and renewal*. Boston: Kluwer.

Lundin, R.A. & Söderholm, A. (1995). A theory of the temporary organization. *Scandinavian Journal of Management*, 11(4), 437-455.

Manning, M. & McDowell, M. (1984). *Electricity supply in Ireland: The history of the ESB*. Dublin: Gill & Macmillan.

March, J.G. (1991). Exploration and exploitation in organizational learning. *Organization Science*, 2(1), 71-87.

March, J.G. (1994). The evolution of evolution. In J.A.C. & J.V. Singh (Eds.), *Evolutionary dynamics of organizations* (pp. 39-49). New York: Oxford University Press.

March, J.G. & Simon, H.A. (1958). *Organizations*. New York: Wiley.

Mayo, E. (1945). *The social problems of an industrial civilization*. Boston: Harvard University.

Meyerson, D., Weick, K.E., & Kramer, R.M. (1996). Swift trust and temporary groups. In R.M. Kramer & T.R. Tyler (Eds.), *Trust in organizations* (pp. 166-195). Thousand Oaks, CA: Sage.

Middleton, C.J. (1967). How to set up a project organization. *Harvard Business Review*, 45(2), 73-82.

Miles, M.B. (1964). On temporary systems. In M.B. Miles (Ed.), *Innovation in education* (pp. 437-490). New York: Teachers College Press.

Mintzberg, H. (1979a). *The structuring of organizations: A synthesis of the research*. Englewood Cliffs, N.J.: Prentice-Hall.

Mintzberg, H. (1979b). An emerging strategy of "direct" research. *Administrative Science Quarterly*, 24(4), 582-589.

Mintzberg, H. (1987). Crafting strategy. *Harvard Business Review*, 65(4), 66-75.

Mintzberg, H. (1990). The design school: Reconsidering the basic premises of strategic management. *Strategic Management Journal*, 11(3), 171-195.

Mintzberg, H. & Waters, J. (1985). Of strategies, deliberate and emergent. *Strategic Management Journal*, 6(3), 257-272.

Miron-Spektor, E., Gino, F., & Argote, L. (2011). Paradoxical frames and creative sparks: Enhancing individual creativity through conflict and integration. *Organizational Behavior and Human Decision Processes*, 116(2), 229-240.

Morris, P.W.G. (1997). *The management of projects*. London: Telford. (Orig. 1994)

Morris, P.W.G. (2000). Researching the unanswered questions of project management. Indeco Management Solutions, Indeco Ltd., Apr-2000, pp. 1-24.

Morris, P.W.G. (2002). Science, objective knowledge and the theory of project management. *Proceedings of the Institution of Civil Engineers (ICE)*, UK, Civil Engineering, 150, 82–90.

Morris, P.W.G. & Hough, G. (1987). *The anatomy of major projects: A study of the reality of project management.* New York: Wiley.

Morris, P.W.G., Patel, M.B., & Wearne, S.H. (2000). Research into revising the APM project management body of knowledge. *International Journal of Project Management*, 18(3), 155-164.

Morris, P.W.G. & Pinto, J.K. (2007). *The Wiley guide to project control*. Hoboken, NJ: Wiley.

Mumford, E. (1998). Problems, knowledge, solutions: Solving complex problems. *Journal of Strategic Information Systems*, 7(4), 255-269.

Munns, A. & Bjeirmi, B. (1996). The role of project management in achieving project success. *International Journal of Project Management*, 14(2), 81-87.

NDP (2000). *National Development Plan 2000 – 2006*. Dublin: The Stationery Office.

NDP (2007). *National Development Plan 2007 – 2013*. Dublin: The Stationery Office.

Nelson, R.R. (1991). Why do firms differ, and how does it matter? *Strategic Management Journal*, 12(Winter), 61-73.

Nelson, R.R. & Winter, S.G. (1982). *An evolutionary theory of economic change*. Cambridge, MA: Belknap Press, Harvard University Press.

Newell, A. & Simon, H.A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.

Newell, S., Bresnen, M., Edelman, L., Scarbrough, H., & Swan, J. (2006). Sharing knowledge across projects: Limits to ICT-led project review practices. *Management Learning*, 37(2), 167–185.

Nicolini, D., Gherardi, S., & Yanow, D. (Eds.) (2003). Introduction: Toward a practice-based view of knowing and learning in organizations. In D. Nicolini, S. Gherardi, & D. Yanow (Eds.), *Knowing in organizations: A practice-based approach* (pp. 3-31). Armonk, NY: Sharpe.

Nightingale, P. & Brady, T. (2011). Projects, Paradigms and Predictability. In G. Cattani, S. Ferriani, L. Frederiksen, & F. Täube (Eds.), *Project-based organizing and strategic management* (*Advances in strategic management - Vol. 28)* (pp. 83-112). Bingley, UK: Emerald.

Nonaka, I. & Takeuchi, H. (1995). *The knowledge-creating company*. New York: Oxford University Press.

Okhuysen, G.A. & Eisenhardt, K.M. (2002). Integrating knowledge in groups: How formal interventions enable flexibility. *Organization Science*, 13(4), 370-386.

Orlikowski, W.J. (1996). Improvising organizational transformation over time: A situated change perspective. *Information Systems Research*, 7(1), 63-92.

Orlikowski, W.J. (2002). Knowing in practice: Enacting a collective capability in distributed organizing. *Organization Science*, 13(3), 249–273.

Orlikowski, W.J. (2006). Material knowing: The scaffolding of human knowledgeability. *European Journal of Information Systems*, 15(5), 460-466.

Packendorff, J. (1994). Temporary organizing: Integrating organization theory and project management. In R.A. Lundin & J. Packendorff (Eds.), *Proceedings of the IRNOP Conference on Temporary Organizations and Project Management* (pp. 207-226), 22-25 March 1994. Umeå Business School, Sweden: IRNOP.

Packendorff, J. (1995). Inquiring into the temporary organisation: New directions for project management research. *Scandinavian Journal of Management*, 11(4), 319-333.

Parkin, J. (1996). Organizational decision making and the project manager. *International Journal of Project Management,* 14(5), 257-263.

Peirce, C.S. (1931-1958). *Collected papers of Charles Sanders Peirce*. Cambridge, MA: Harvard University Press.

Penrose, E. (1995). *The theory of the growth of the firm (3rd Ed.)*. Oxford: Oxford University Press. (Orig. 1959)

Pepper, S.C. (1942). *World hypotheses: A study in evidence*. Berkeley, CA: University of California Press.

Petit, Y. & Hobbs, B. (2010). Project portfolios in dynamic environments: Sources of uncertainty and sensing mechanisms. *Project Management Journal*, 41(4), 46-58.

Pettigrew, A. (1990). Longitudinal field research on change: Theory and practice. *Organization Science*, 1(3), 267-292.

Pettigrew, A. (1997). What is processual analysis? *Scandinavian Journal of Management*, 13(4), 337-348.

Pinto, J.K. (1986). Project implementation: A determination of its critical success factors, moderators, and their relative importance across stages in the project life cycle. Unpublished doctoral dissertation, Univ. of Pittsburg, Pennsylvania, USA.

Pinto, J.K. & Covin, J. (1989). Critical factors in project implementation: A comparison of construction and R&D projects. *Technovation*, 9(1), 49-62.

Pinto, J.K. & Prescott, J.E. (1988). Variations in critical success factors over the stages in the project life cycle. *Journal of Management*, 14(1), 5-18.

Pinto, J.K. & Prescott, J.E. (1990). Planning and tactical factors in the project implementation process. *Journal of Management Studies,* 305-325

Pinto, J.K. & Slevin, D.P. (1987). Critical factors in successful project implementation. *IEEE Transactions on Engineering Management*, 34(1), 22–27.

Pinto, J.K. & Slevin, D.P. (1988). Critical success factors across the project life cycle. *Project Management Journal*, 19(3), 67–75.

Pinto, J.K. & Slevin, D.P. (1989). Critical success factors in R&D projects. *Research Technology Management*, 32(1), 31-35.

Pisano, G.P. (1994). Knowledge, integration, and the locus of learning: An empirical analysis of process development. *Strategic Management Journal*, 15(Winter), 85-100.

Pisano, G.P. (2000). In search of dynamic capabilities. In G. Dosi, R.R. Nelson, & S.G. Winter (Eds.), *The nature and dynamics of organizational capabilities* (pp. 129-154). New York: Oxford University Press.

PMI (2004). *A guide to the project management body of knowledge (PMBOK® Guide)(3rd Ed.)*. Newton Square, PA: Project Management Institute. (Orig. 1987)

Poggi, G. (1965). A main theme of contemporary sociological analysis: Its achievements and limitations. *British Journal of Sociology*, 16(4), 283-294.

Polanyi, M. (1961). Knowing and being. *Mind*, 70(280), 458-470.

Polanyi, M. (1967). *The tacit dimension*. Garden City, NY: Doubleday.

Polanyi, M. (1969). *Knowing and being: Essays by Michael Polanyi (M. Grene, Ed.).* Chicago, IL: University of Chicago Press.

Polanyi, M. (1974). *Personal knowledge: Towards a post-critical philosophy*. Chicago, IL: Univ. of Chicago Press. (Orig. 1962)

Pollitt, C. (2001). Clarifying convergence: Striking similarities and durable differences in public management reform. *Public Management Review*, 3(4), 471-492.

Pollitt, C. & Bouckaert, G. (2000). *Public management reform: A comparative analysis*. Oxford: Oxford University Press.

Popper, K.R. (1979). *Objective knowledge: An evolutionary approach*. London: Oxford University Press. (Orig. 1972)

Popper, K.R. (2006). *All life is problem solving*. London: Routledge. (Orig. 1999)

Popper, K.R. (2007). *The logic of scientific discovery*. New York: Routledge. (Orig. 1935)

Popper, K.R. (2007). *Conjectures and refutations: The growth of scientific knowledge*. New York: Routledge. (Orig. 1963)

Porter, M.E. (1980). *Competitive strategy: Techniques for analyzing industries and competitors*. New York: Free Press.

Porter, M.E. (2004). *Competitive advantage: Creating and sustaining superior performance*. New York: Free Press. (Orig. 1985)

Prahalad, C.K. & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review*, 68(3), 79-91.

Prencipe, A. & Tell, F. (2001). Inter-project learning: Processes and outcomes of knowledge codification in project-based firms. *Research Policy*, 30(9), 1373-1394.

Prieto, I.M., Revilla, E., Rodríguez-Prado, B. (2009). Building dynamic capabilities in product development. *Scandinavian Journal of Management*, 25(3), 313-326.

Prigogine, I. (1980). *From being to becoming*. San Francisco, CA: Freeman.

Raelin, J.A. (2001). Public reflection as the basis of learning. *Management Learning*, 32(1), 11-30.

Ramo, S. (1969). *The cure for chaos: Fresh solutions to social problems through the systems approach*. New York: McKay.

Richardson, G. (1972). The organization of industry. *The Economic Journal*, 82(327), 883-896.

Rockart, J. (1979). Chief executives define their own data needs. *Harvard Business Review*, Mar/Apr, 81-92.

Ruuska, I. & Brady, T. (2011). Implementing the replication strategy in uncertain and complex investment projects. *International Journal of Project Management*, 29(4), 422-431.

Ryle, G. (1949). *The concept of mind*. New York: Barnes & Noble.

Sadeh, A., Dvir, D., & Shenhar, A. (2000). The role of contract type in the success of R&D defence projects under increasing uncertainty. *Project Management Journal*, 31(3), 14-21.

Sanvido, V., Grobler, F., Parfitt, K., Guvenis, M., & Coyle, M. (1992). Critical success factors for construction projects. *Journal of Construction Engineering and Management*, 118(1), 94-111.

Sapolsky, H.M. (1972). *The Polaris system development: Bureaucratic and programmatic success in government*. Harvard, MA: Harvard University Press.

Saynisch, M. (2010a). Beyond frontiers of traditional project management: An approach to evolutionary, self-organizational principles and the complexity theory - results of the research program. *Project Management Journal*, 41(2), 21-37.

Saynisch, M. (2010b). Mastering complexity and changes in projects, economy, and society via project management second order (PM-2). *Project Management Journal*, 41(5), 4-20.

Scarbrough, H., Bresnen, M., Edelman, L.F., Laurent, S., Newell, S., & Swan, J. (2004). The processes of project-based learning: An exploratory study. *Management Learning*, 35(4) 491-506.

Schön, D.A. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Schultz, R.L., Slevin, D.P., & Pinto, J.K. (1987). Strategy and tactics in a process model of project implementation. *Interfaces*, 17(3), 34-46.

Schulze, A. & Hoegl, M. (2006). Knowledge creation in new product development projects. *Journal of Management*, 32(2), 210–236.

Schumpeter, J.A. (1976). *Capitalism, socialism and democracy.* New York: Harper & Row. (Orig. 1942)

Schrödinger, E. (1980). *What is life? & Mind and matter*. Cambridge: Cambridge University Press. (Origs. 1944 & 1958)

Scott, W.R. (1983). The organization of environments: Network, cultural, and historical elements. In J.W. Meyer & W.R. Scott (Eds.), *Organizational environments: Ritual and rationality* (pp. 155-175). Beverly Hills, CA: Sage.

Scott, W.R. (1998). *Organizations: Rational, natural, and open systems*. Upper Saddle River, N.J.: Prentice-Hall.

Selznick, P. (1957). *Leadership in administration: A sociological interpretation*. New York: Harper & Row.

Senge, P.M. (1994). *The fifth discipline: The art and practice of the learning organization.* New York: Currency Doubleday. (Orig. 1990)

Sense, A.J. (2003). Learning generators: Project teams re-conceptualized. *Project Management Journal*, 34(3), 4-12.

Shenhar, A.J. (1998). From theory to practice: Toward a typology of project-management styles. IEEE Transactions on Engineering Management, 45(1), 33-48.

Shenhar, A.J. (2001). One size does not fit all projects: Exploring classical contingency domains. Management Science, 47(3), 394-414.

Shenhar, A.J. & Dvir, D. (1996). Towards a typological theory of project management. *Research Policy*, 25(4), 607-632.

Shenhar, A., Dvir, D., Lechler, T., & Poli, M. (2002). One size does not fit all: True for projects, true for frameworks. PMI Research Conference, Seattle, Washington.

Shenhar, A.J., Dvir, D., & Shulman, 4. (1995). A two-dimensional taxonomy of products and innovations. *Journal of Engineering and Technology Management,* 12(3), 175-200.

Shenhar, A.J., Levy, O., & Dvir, D. (1997). Mapping the dimensions of project success. *Project Management Journal*, 28(2), 5-13.

Siggelkow, N. (2007). Persuasion with case studies. *Academy of Management Journal*, 50(1), 20-24.

Simon, H.A. (1997). *Administrative behavior.* New York: The Free Press. (Orig. 1945)

Simon, L. (2006). Managing creative projects: An empirical synthesis of activities. *International Journal of Project Management*, 24, 116–126.

Slevin, D. & Pinto, J. (1986). The project implementation profile: New tool for project managers. *Project Management Journal*, 17(4), 57-70.

Smith, A. (1981). *The wealth of nations*. Harmondsworth, UK: Penguin. (Orig. 1776)

Smyth, H. & Morris, P.W.G. (2007). An epistemological evaluation of research into projects and their management: Methodological issues. *International Journal of Project Management*, 25(4), 423-436.

Snowden, D. (2002). Complex acts of knowing: Paradox and descriptive self-awareness. *Journal of Knowledge Management*, 6(2), 100-111.

Söderlund, J. (2000). Temporary organizing – characteristics and control forms. In R.A. Lundin & F. Hartman (Eds.), Projects as business constituents and guiding motives (pp. 61–74). Boston, MA: Kluwer.

Söderlund, J. (2002). On the development of project management research: Schools of thought and critique. *International Project Management Journal*, 8(1), 20-31.

Söderlund, J. (2004a). Building theories of project management: Past research, questions for the future. *International Journal of Project Management*, 22(3), 183-191.

Söderlund, J. (2004b). On the broadening scope of the research on projects: A review and a model for analysis. *International Journal of Project Management*, 22(8), 655-667.

Söderlund, J. (2005). Developing project competence: Empirical regularities in competitive project operations. *International Journal of Innovation Management*, 9(4), 451-480.

Söderlund, J. (2008). Competence dynamics and learning processes in project-based firms: Shifting, adapting, and leveraging. *International Journal of Innovation Management*, 12(1), 41-67.

Söderlund, J. (2010). Knowledge entrainment and project management: The case of large-scale transformation projects. *International Journal of Project Management*, 28(2), 130-141.

Söderlund, J. & Tell, F. (2009). The P-form organization and the dynamics of project competence: Project epochs in Asea/ABB, 1950–2000. *International Journal of Project Management*, 27(2), 101-112.

Söderlund, J., Vaagaasar, A.L., & Andersen, E.S. (2008). Relating, reflecting and routinizing: Developing project competence in cooperation with others. *International Journal of Project Management*, 26(5), 517-526.

Songer, A. & Molenaar, K. (1997). Project characteristics for successful public-sector design build. *Journal of Construction Engineering & Management*, 123(1), 34-40.

Spinardi, G. (1994). *From Polaris to Trident: The development of US fleet ballistic missile technology*. Cambridge: Cambridge University Press.

Stake, R. (2000). Case studies. In N.K. Denzin & Y.S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 236-247). London: Sage.

Standish Group (2003). The CHAOS chronicles. Retrieved from http ://www.standishgroup.com/chaos/introduction.pdf, 07-Apr-2008.

Strauss, A. (1987). *Qualitative analysis for social scientists*. Cambridge, UK: Cambridge University Press.

Suchman, L. (2003). Organizing alignment: The case of bridge-building. In D. Nicolini, S. Gherardi, & D. Yanow (Eds.), *Knowing in organizations: A practice-based approach* (pp. 187-203). Armonk, NY: Sharpe.

Sutterfield, J.S., Friday-Stroud, S.S., & Shivers-Blackwell, S.L. (2006). A case study of project and stakeholder management failures: Lessons learned. *Project Management Journal*, 37(5), 26–35.

Strauss, A. & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* Thousand Oaks, CA: Sage.

Swinth, R.L. (1971). Organizational joint problem-solving. Management Science, 18(2), B68-B79.

Sydow, J., Lindkvist, L., & DeFillippi, R. (2004). Project-based organizations, embeddedness and repositories of knowledge. *Organization Studies*, 25(9), 1475-1489.

Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice with the firm. *Strategic Management Journal*, 17(Winter), 27-43.

Taylor, F.W. (1911). *Principles of scientific management*. New York: Harper.

Teece, D.J. (2007). Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, 28(13), 1319-1350.

Teece, D.J. & Pisano, G. (1994). The dynamic capabilities of firms: An introduction. *Industrial and Corporate Change*, 3(3), 537-556.

Teece, D.J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 18(7), 509-533.

Thamhain, H. & Wilemon, D. (1975). Conflict management in project life cycles. *Sloan Management Review*, 16(3), 31-50.

Themistocleous, C. & Wearne, S. H. (2000). Project management topic coverage in journals. *International Journal of Project Management*, 18(1), 7-11.

Thomas, J.L. (2000). Making sense of project management. In R.A. Lundin & F. Hartman (Eds.), *Projects as business constituents and guiding motives* (pp. 25-43). Boston, MA: Kluwer.

Thomas, J., Delisle, C., & Jugdev, K. (2002). *Selling project management to senior executives: Framing the moves that matter.* Newtown Square, PA: Project Management Institute.

Thompson, J.D. (1967). *Organizations in action: Social science bases of administrative theory*. New York: McGraw-Hill.

Tsoukas, H. (1996). The firm as a distributed knowledge system: A constructionist approach. *Strategic Management Journal*, 17(Winter), 11-25.

Tsoukas, H. (2005). *Complex knowledge: Studies in organizational epistemology*. Oxford: Oxford University Press.

Tsoukas, H. (2009). A dialogical approach to the creation of new knowledge in organizations. *Organization Science*, 20(6), 941–957.

Tsoukas, H. & Chia, R. (2002). On organizational becoming: Rethinking organizational change. *Organization Science*, 13(5), 567–82.

Turner, J.R. (2006a). Towards a theory of project management: The nature of the project. *International Journal of Project Management*, 24(1), 1-3.

Turner, J.R. (2006b). Towards a theory of project management: The nature of the project governance and project management. *International Journal of Project Management*, 24(2), 93-95.

Turner, J.R. (2006c). Towards a theory of project management: The functions of project management. *International Journal of Project Management*, 24(3), 187-189.

Turner, J.R. (2006d). Towards a theory of project management: The nature of the functions of project management. *International Journal of Project Management*, 24(4), 277-279.

Turner, J.R. (2009). *The handbook of project-based management*. New York: McGraw-Hill. (Orig. 1993)

Turner, J. R., Huemann, M., & Keegan, A. E. (2007). *Human resource management in the project-oriented organization*. Newtown Square, PA: Project Management Institute.

Turner, J.R. & Keegan, A.E. (2001). Mechanisms of governance in the project-based organization: Roles of the broker and steward. *European Management Journal*, 19(3), 254-267.

Turner, J.R. & Müller, R. (2003). On the nature of the project as a temporary organization. *International Journal of Project Management*, 21(1), 1-8.

Ulri, B. & Ulri, D. (2000). Project management in North America: Stability of the concepts. *Project Management Journal*, 31(3), 33-43.

Van de Ven, A.H. (1992). Suggestions for studying strategy process: A research note. *Strategic Management Journal*, 13(Summer), 169-188.

von Bertalanffy, L. (1950). An outline of general system theory. *British Journal for the Philosophy of Science*, 1(2), 134-165.

von Hippel, E. (1994). ''Sticky information'' and the locus of problem solving: Implications for innovation. *Management Science*, 40(4), 429-439.

von Hippel, E. & Tyre, M. (1996). The mechanisms of learning by doing: Problem discovery during process machine use. *Technology and Culture*, 37(2), 312-329.

Walker, A. & Wing, C. (1999). The relationship between construction project management theory and transaction cost economics. *Engineering, Construction and Architectural Management,* 6(2), 166-176.

Wallas, G. (1926). *The art of thought*. London: Jonathan Cape.

Weick, K.E. (1977). Organization design: Organizations as self-designing systems. *Organizational Dynamics*, 6(2), 30-46.

Weick, K.E. (1979). *The social psychology of organizing*. New York: McGraw-Hill. (Orig. 1969)

Weick, K.E. (1993). The collapse of sensemaking in organizations: The Mann Gulch disaster. *Administrative Science Quarterly*, 38(4), 628-652.

Weick, K.E. (1995). *Sensemaking in organizations*. Thousand Oaks, CA: Sage.

Weick, K.E. (1996). Enactment and the boundaryless career: Organizing as we work. In M.B. Arthur & D.M. Rousseau (Eds.), *The boundaryless career: A new employment principle for a new organizational era* (pp. 40-57). New York: Oxford University Press.

Weick, K.E. & Roberts, K.H. (1993). Collective mind in organizations: Heedful interrelating on flight decks. *Administrative Science Quarterly*, 38(3), 357-381.

Weick, K.E. & Westley, F. (2002). Organizational learning: Affirming an oxymoron. In S.R. Clegg, C. Hardy, & W.R. Nord (Eds.), *Handbook of organization studies* (pp. 440-458). London: Sage. (Orig. 1996)

Weinberg , G.M. (2001). *An introduction to general systems thinking*. New York, NY: Dorset House.

Wenger, E. (2001). *Communities of practice: Learning, meaning, and identity*. Cambridge, UK: Cambridge University Press. (Orig. 1998)

Whitehead, A.N. (1978). *Process and reality: An essay in cosmology*. New York: Free Press. (Orig. 1929)

Whitty, S.J. & Maylor, H. (2009). And then came complex project management (revised). *International Journal of Project Management*, 27(3), 304-310.

Williams, T. (2002). *Modelling complex projects*. Chichester, UK: Wiley

Williams, T. (2005). Assessing and moving on from the dominant project management discourse in the light of project overruns. *IEEE Transactions on Engineering Management*, 52(4), 497–508.

Williamson, O.E. (1975). *Markets and hierarchies: Analysis and anti-trust implications*. New York: Free Press.

Williamson, O.E. (1985). *The economic institutions of capitalism*. New York: Free Press.

Winch, G. (1989). The construction firm and the construction project: A transaction cost approach. *Construction Management and Economics***,** 7(4), 331-345.

Winch, G. (2002). *Managing construction projects: An information processing approach*. Oxford: Blackwell.

Winter, S.G. (2000). The satisficing principle in capability learning. *Strategic Management Journal*, 21(10/11), 981-996.

Winter, S.G. (2003). Understanding dynamic capabilities. *Strategic Management Journal*, 24(10), 991-995.

Winter, M., Smith, C., Morris, P., & Cicmil, S. (2006). Directions for future research in project management: The main findings of a UK government-funded research network. *International Journal of Project Management,* 24(8), 638–649.

Wittgenstein, L. (1988). *Philosophical investigations*. Oxford: Blackwell. (Orig. 1953)

Wittgenstein, L. (1989). *On certainty*. Oxford: Blackwell. (Orig. 1969)

Wittgenstein, L. (2010). *Tractatus logico-philosophicus*. London: Routledge. (Orig. 1922)

Yin, R.K. (2003). *Case study research: Design and methods (3rd Ed.).* Thousand Oaks, CA: Sage.

Zobel, A.M. & Wearne, S.H. (2000). Project management topic coverage in recent conferences. *Project Management Journal*, 31(2), 32-37.

Zollo, M. & Winter, S.G. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 13(3), 339-351.