

**Variations on a Routine: How selection-
adaptation-retention dynamics create variety
in organisational routines**

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STATEMENT OF ORIGINAL AUTHORSHIP

The work contained in this thesis has not previously been submitted to meet requirements for an award at this or any other higher education institution. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made.

Signature

Date: 8 May 2012

ABSTRACT

The question “what causes variety in organisational routines” is of considerable interest to organisational scholars, and one to which this thesis seeks to answer. To this end an evolutionary theory of change is advanced which holds that the dynamics of selection, adaptation and retention explain the creation of variety in organisational routines. A longitudinal, multi-level, multi-case analysis is undertaken in this thesis, using multiple data collection strategies. In each case, different types of variety were identified, according to a typology, together with how selection, adaptation and retention contribute to variety in a positive or negative sense. Methodologically, the thesis makes a contribution to our understanding of variety, as certain types of variety only become evident when examined by specific types of research design. The research also makes a theoretical contribution by explaining how selection, adaptation and retention individually and collectively contribute to variety in organisational routines. Moreover, showing that routines could be stable, diverse, adaptive and dynamic at the same time; is a significant, and novel, theoretical contribution.

KEY WORDS

Organisational routines; variation; selection, adaptation, retention; organisational theory; procurement; engineering assets;

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TABLE OF CONTENTS

1) Introduction and context	17
2) Theoretical Framework	32
3) Methodology	68
4) Case Study Findings	107
5) Cross Case Analysis	212
6) Discussion	244
7) Appendices	269
8) Reference List	283

LIST OF TABLES

Table 1 – Summary of Key Elements of Definitions of Routines	20
Table 2 – Demonstrating Variety in organisational routines.....	47
Table 3 – Example of routine varieties created due to selection of different options.....	52
Table 4 – Example of how adaptation increases variety due to the increase in different options for selection.....	56
Table 5 – Demonstrating variety in organisational routines	64
Table 6 – Summary of central constructs in this thesis	65
Table 7 – Examples of the number of routines and number of cases	70
Table 8 – Summary of Case Studies (by volume, value and variety of assets purchased).....	74
Table 9 – Number of Data Source by Case and Source	75
Table 10 – Direct and indirect evidence of the elements of routines from each data source	77
Table 11 – Data Handling Process	78
Table 12 – Data handling process for the database	83
Table 13 – Summary of Data collection methods and how these answer the research questions:.....	83
Table 14 – Initial data for total number of options for Procurement Routines.....	84
Table 15 – Incident Matrix (Correlation) of Scope Items.....	86
Table 16 – Number of occurrences of scope items in the contracts	89
Table 17 – K-means cluster analysis – Final Cluster Centres	90
Table 18 – Number of Cases in each Cluster – k-means cluster of binary scope of works.....	90
Table 19 – Comparison of Log of Number of Tenders Received (mean difference).....	91
Table 20 - Comparison of [log] Time taken between Tender and Contract (mean difference)	92
Table 21 - Comparison of [log]of Value of the Contract (mean difference).....	92
Table 22 – Percentage of Missing Quantitative Variables	93

Table 23 – Univariate analysis of missing data	94
Table 24 – Separate Variance t Tests for correlation between quantitative variables.	94
Table 25 – EM Correlations and Little’s MCAR test	94
Table 26 – Comparison of Original raw data and revised data with EM estimation	95
Table 27 – Number of Times Sole Invitee, Closed Tender and Prequalification Occurred in same procurement event.....	96
Table 28 – Coding of Qualitative Data and Examples	97
Table 29 – Quantitative analysis method and reason for using the statistical method	100
Table 30 – Post-Hoc analysis of differences between values of contracts between case studies	110
Table 31 – Time Periods for Data Analysis.....	112
Table 32 – Total Set of Options Available for Each Sub-Routine across all cases.....	114
Table 33 – Examples of two variants of procurement routines in Prolific Projects.....	114
Table 34 – Variants of Routines in Use by Alpha over Three Time Periods.....	117
Table 35 – Sub-Routine Options in Use – Alpha	122
Table 36 – Total Variance Explained in components identified by PCA analysis of sub-routine options – Alpha study	124
Table 37 – Structure Matrix for rescaled component loadings of PCA Analysis.....	125
Table 38 – Recombination of routines over time – Alpha	127
Table 39 – Number of New Routines due to adaptive processes (Alpha case)	130
Table 40 – Number of new Sub-Routine Options Over Time – Alpha	130
Table 41 – Number of Routine Variants Retained (continued) in organisational memory - Alpha....	133
Table 42 – Number of sub-routine options retained in organisational memory - Alpha	134
Table 43 – Varieties of Routines in Use – Beta	137
Table 44 – Sub-Routine Options in Use – Beta	140
Table 45 – Total Variance Explained.....	141

Table 46 – Principal Component Analysis – Beta – 2000 to 2009.....	142
Table 47 – Change in Routine Variants Over Time – Beta Case Study.....	144
Table 48 – Approach to Market for Asset #1.....	144
Table 49 – Number of New Routine Variants due to adaptive processes (Beta case)	146
Table 50 – New Sub-Routine Options due to adaptation – Beta Case study.....	147
Table 51 – Number of Routine Variants Retained (Continued) - Beta	151
Table 52 – Number of sub-routines options retained - Beta.....	152
Table 53 – Routine variants Implemented by Gamma in a 10 Year Period	155
Table 54 – Sub-Routine Options in Use – Gamma.....	157
Table 55 – Total Variance Explained –Gamma PCA.....	158
Table 56 – Structure Matrix of the Rescaled Component –Gamma PCA	159
Table 57 – Number of routines in each time period – Gamma study	161
Table 58 – Number of New Routines due to adaptive processes (Gamma case).....	163
Table 59 – Change in Sub-Routine options over time – Gamma Case.....	163
Table 60 – Number of Routines variants Retained (continued) in organisational memory- Gamma	165
Table 61 – Number of sub-routines retained in organisational memory - Gamma	166
Table 62 – Varieties in Use – Delta – 2000 to 2009.....	169
Table 63 – Sub-Routine Options in Use – Delta.....	174
Table 64 – Total variance Explained – Delta	175
Table 65 – Principal Component Analysis – Delta	176
Table 66 – Number of Routine Variants due to recombination processes – Delta	178
Table 67 – Number of New Variants due to adaptive processes (Delta case).....	182
Table 68 – Change in Sub-Routine Options Over Time – Delta Case.....	182
Table 69 – Use of Various Forms of Contract – Delta – 2000 to 2009.....	183

Table 70 – Number of Routines Retained (continued) in organisational memory - Delta	187
Table 71 – Number of sub-routines retained in organisational memory – Delta.....	188
Table 72 – Varieties in Use – Epsilon	192
Table 73 – Sub-Routine Options in Use – Epsilon.....	200
Table 74 – Principal Component Analysis of Sub-Routine Options – Epsilon.....	201
Table 75 – Structure Matrix.....	201
Table 76 – Number of New Routines Due to Recombination Over Time – Epsilon Case Study	203
Table 77 – Summary of Contracts and Their Average Values.....	205
Table 78 – Logic of choice behind selection of specific tender and approach to market options	206
Table 79 – Variants in use due to adaptation	206
Table 80 – New Sub-Routine options due to adaptation – Epsilon	207
Table 81 – Number of Routines Retained (continued) in organisational memory – Epsilon	208
Table 82 – Number of sub-routine options retained in organisational memory – Epsilon	209
Table 83 – Overall pattern of action in each case study.....	214
Table 84 – Stable variants of the routine – Each Case.....	214
Table 85 – Summary of Findings – Types of variety in organisational routines (by level of analysis)	225
Table 86 – Comparison of the proportion of Scope of Works used by each of the Cases.....	227
Table 87 – Comparison of the proportion of Contracts Used by each of the Cases.....	228
Table 88 – Comparison of the proportion of tendering used by each of the Cases.....	229
Table 89 – Comparison of the proportion of Approach to Market used by each of the Cases	230
Table 90 – Evaluation of methodological issues in relation to variation in organisational routines..	253
Table 91 – Summary of Contracts used by Epsilon, and the reasons for selection (based on interviews 1,2, 14,15,and 16)	279

LIST OF FIGURES

Figure 1 – Summary of the value and type assets purchased by Prolific Projects over time	23
Figure 2 – Percentage of Asset being purchased in each division	24
Figure 3 – Procurement in relation to other organisational activities.....	25
Figure 4 – Typology of variation in routines	41
Figure 5 – Core research objective – how does selection, adaptation and retention affect variety....	48
Figure 6 – Incidence of Scope Items in Contracts.....	85
Figure 7 – Results of the Hierarchical Cluster Analysis	89
Figure 8 – Approach to Market – percentage of recoded data.	96
Figure 9 – Triangulation of data and method	102
Figure 10 – Overview of Embedded Case studies.....	107
Figure 11 – Value and Volume of Projects per Case Study.....	109
Figure 12 - Variety in Assets Purchased and the Routines Variants and Sub-Routine Options used to effect such purchases.....	111
Figure 13 – Alpha – Number and value of Projects per Time Period.....	115
Figure 14 – Number of Times Individual Variants of Procurement Routines Were Used	118
Figure 15 – Number of Times each Sub-Routine was used by Alpha over a ten year period.....	119
Figure 16 – Plot of Principal Component Analysis of Sub-Routines Options Used by Alpha – with Oblimax Rotation.....	126
Figure 17 – Number and Value of Projects per Time Period - Beta	136
Figure 18 – Number of Times Individual Routines Variants Were Used – Beta Case	138
Figure 19 – Number of Times each Sub-Routine was used by Beta over a ten year period - Beta ...	139
Figure 20 – Principal Component Analysis – Beta – 2000 to 2009	142
Figure 21 – Number and Value of Projects per Time Period - Gamma.....	153

Figure 22 – Number of Times Individual Routine variants Were Used – Gamma Case.....	155
Figure 23 - Number of Times each Sub-Routine Option was Used- Gamma.....	156
Figure 24 – Plot of Sub-Routine Options in Rotated Space – Gamma.....	160
Figure 25 – Number and Value of Projects per Time Period – Delta.....	167
Figure 26 – Number of Times Individual Routine variants Were Used - Delta.....	171
Figure 27 – Number of times each sub-routine option was used by Delta.....	171
Figure 28 – Plot of principal components in rotated space - Delta.....	177
Figure 29 – Original and extended values of projects.....	184
Figure 30 – Changes to tendering processes over time - Delta.....	186
Figure 31 – Number and value of Projects per Time Period for Epsilon.....	190
Figure 32 – Number of Times each Variant of the routine was used - Epsilon.....	195
Figure 33 – Number of times each sub-routine option was implemented - Epsilon.....	195
Figure 34 – Principal Component Analysis of Sub-routines in Oblimax Rotation - Epsilon.....	202
Figure 35 – Number of Time Periods Each Sub-routine was used – Comparison across case studies.....	216
Figure 36 – Comparison of number of times each variant of the routine was used.....	218
Figure 37 – Comparison of number of times each sub-routine option was used.....	219
Figure 38 – Make Buy decision for procurement.....	220
Figure 39 – Revised procurement process.....	222
Figure 40 – Source of Variance in Routines in each time period – Each Case Study.....	223
Figure 41 – Adaptation in Sub-Routine Options in each time period – Each Case Study.....	224
Figure 42 – New routine varieties through recombination, as a percentage of all routine variants.....	231
Figure 43 – Number of New Variants of the Routine, due to introduction of a new sub-routine into the repertoire.....	232
Figure 44 – Diffusion of Tendering Methods Across Case Studies.....	233

Figure 45 – Diffusion of New forms of Contract across Case Studies..... 234

Figure 46 – Diffusion of Approach to Market across Case Studies..... 235

Figure 47 - Number of Routine Variants Continued and Discontinued (all cases) 237

Figure 48 – Number of Sub-routine options continued and discontinued (all cases) 238

Figure 49 – Contribution of selection, adaptation and retention to the total number of variants.... 240

Figure 50 - Relationship between the number of sub-routines options (the repertoire) and the number of routines..... 241

Figure 51 – Relationship between the number of sub-routines and routines (all cases – all years combined data)..... 241

Figure 52 – The process of selection, and how it creates variety in organisational routines..... 255

Figure 53 – How Adaptation increases variety in the repertoire of sub-routines 258

Figure 54 – How retention affects variety in organisational routines 260

Figure 55 – Selection, adaptation and retention dynamics in relation to the elements of organisational routines..... 262

CHAPTER ONE

1) INTRODUCTION AND CONTEXT

In recent years there has been a burgeoning interest in organisational routines, and considerable empirical progress has been made concerning the nature and function of routines in organisations (Becker 2008; Feldman and Pentland 2003; Pentland 2011; Pentland and Feldman 2005). As with many other fields of endeavour though, there is still considerable scope for empirical studies which build on and extend the existing understanding of organisational routines. One question which this thesis seeks to contribute is to explore how variety is created in organisational routines, which has been identified as an area needing particular attention (Becker 2005a).

This thesis will contribute to a better understanding of organisational routines by advancing and testing a theory of dynamic change based on the work of Campbell (1965, 1974). Campbell (1965) argued that selection, adaptation and retention are key dynamics which create variety in organisations, concepts which will be explored in more detail in the theory section. I extend Campbell's evolutionary change theory and apply it to the study of change in organisational routines. Specifically I argue that selection, adaptation and retention dynamics explain the creation of variety in organisational routines. Before progressing to this wider research agenda however, it is necessary to firstly discuss the phenomena under examination: organisational routines.

1.1 THE CONCEPT OF AN ORGANISATIONAL ROUTINE

In their seminal work, Nelson and Winter (1982) highlight the importance of routines as units of analysis in organisations, as these phenomena provide a theoretical framework for understanding and analysing organisational change. Nelson and Winter (1982, 128) even go so far as to argue that one can only understand organisations, by gaining an understanding of routines and how they change over time.

The potential for routines to undergo incremental change has significant implications for empirical work, as routines provide a highly useful unit of analysis to examine and explain how change occurs within organisations (Becker 2004). Moreover, research which examines how change occurs in organisational activities requires a theory which can explain what are the precursors to the change (Van de Ven and Poole 2002). Such a theory is clearly advanced in the organisational routines literature, as changes in the external environment can force companies to vary their routines, often at considerable risk (Nelson and Winter 1982, 400). Thus routines, while providing for stability in organisations, as their name suggests, can also be adapted and modified by organisations in response to changes in their environments. This propensity for variation in routines – their capacity to change – is a central focus of this thesis, particularly the dynamics which create such variation. However, before progressing further and outlining the thesis proper, some orientation is needed to the study through the provision of a clear definition of what an organisational ‘routine’ is.

1.2 DEFINITION OF ORGANISATIONAL ROUTINES

Routines are not a new concept, as over time, multiple authors have helped to refine our understanding of routines. While Nelson and Winter (1982) are seen as the seminal authors of organisational routines, they were not the first to document their existence.

One of earliest reference to routines appears in the work of Schumpeter (Becker,Knudsen and March 2006) who noted that most of organisational life “consists of routine work based on well tried experience” (Schumpeter 1927, 297), although Schumpeter’s language used to describe routines varies over time (Becker,Knudsen and March 2006), particularly once translated from German to English. One of the earliest actual *definitions* of organisational routines was advanced by Stene (1940, 1129) who argued that an organisational routine was “that part of any organization’s activities which has become habitual because of repetition and which is followed regularly without specific directions” and involved multiple individuals. Other authors such as Simon (1947) discussed the relationship between decision making and organisational routines, particularly when rationality is bounded, while March and Simon (1958) focus on the ability of organisations to change their routines in response to the external environment, and the rules which guide routine implementation. These elements of adaptation to external environments, repetitive patterns of behaviour involving multiple individuals, and the guidance to such behaviour provided by organisational rules, have all become understood as essential to organisational routines (Cyert and March 1963).

Building on this foundation, Nelson and Winter (1982, 1997; 2002) provide an extended examination of organisational routines. In their seminal book, Nelson and Winter (1982, 14) argue that routines are “regular and predictable behaviour patterns of firms”. This definition was supported with research which found routines were repetitive and stable (Gersick and Hackman 1990), with an

implication that they needed little thought in order to implement. Thus routines become widely understood as stable patterns of action within firms.

However, other authors found that organisations needed to choose between a repertoire of options in their routines (Pentland 1995; 1994), which showed that routines were not ‘mindless’, but required intentional effort to implement. A conference was convened to work through some of these differences, and published an agreed definition of routines as: “repeated performance in some context that has been learned by an organisation in response to selective pressures” (Cohen et al. 1996, 683). While absent from the definition, the detail of this article retains the concepts of both ‘decision making’ and ‘habitual patterns’, although the role of individual agents within the organisation in enacting the routine were notably absent (Johnson and Onwuegbuzie 2004). Thus routines were still seen to involve patterns, learning and decision making.

In more recent times, two definitions predominate the organisational theory literature at the moment: that developed by Feldman and Pentland (2003; 2005), and that developed in conjunction with handbooks on routines (both edited by Becker (2008)). While slightly different, these definitions represent what Parmigiani and Howard-Grenville (2011) term the practice perspective. Other definitions exist, representing what Parmigiani and Howard-Grenville (2011) term the capabilities perspective (Hodgson 2008; Narduzzo, Rocco and Warglien 2002; Zollo, Reur and Singh 2002). The ‘capabilities’ approach to routines tends to see routines as “black boxes” (Parmigiani and Howard-Grenville 2011), and place the focus on what routines do in relation to firm performance, rather than the internal dynamics of routines themselves. As the dynamics of change which creates variety is the focus of this thesis, the practice perspective will be followed.

Feldman and Pentland define routines as “Repetitive recognisable patterns of interdependent actions, carried out by multiple actors” (Feldman and Pentland 2003, 95; Pentland and Feldman 2005)¹. Notably this definition does include the role of individual actors in the enactment of the routine, but leaves aside notions of learning, change, stability, or choice. This may be due to the fact that empirical research had found that routines could be stable (Howard-Grenville 2005), could change (Feldman 2000, 2003) or could exhibit multiple variations requiring choice (Pentland 2003a, 2003b). Thus the definition differentiates between what a routine actually is (repetitive pattern of action), and the current status or condition of the routine (stable, changing and varied). Thus, while

¹ Recent authors such as Parmigiani and Howard Grenville (2011, 417) choose only the first part of this definition ‘repetitive patterns of interdependent organizational actions’, leaving aside the focus on the role of organisational actors. Given the importance of agency (Emirbayer and Mische 1998), the fuller definition will be used here.

routines are repetitive patterns of action, involving multiple actors, there are perceived differences in relation to the extent of variety which they exhibit (Pentland and Feldman 2005).

Becker (2004 p.645; 2005b, 818) defines routines as: “recurrent interaction patterns involving multiple actors working to achieve a particular outcome“. This is close to that advanced by Feldman and Pentland, with the inclusion of recurrent (similar to repetitive), and acknowledging the role of actors. The ‘interaction patterns’ posited by Becker (2004) however, is not quite the same as ‘patterns of interdependent actions’ (Feldman and Pentland 2003) as the ‘interaction patterns’ could focus on the interactions themselves, where as the second ‘patterns of interdependent actions’ clearly focuses on the patterns of action, and how they are interdependent. As will be explained in detail later, given the focus herein on the creation of variety, the notion of patterns becomes very important for the purposes of this thesis. However, the final part of Becker’s (2004) definition ‘working to achieve a particular outcome’ has merit as this differentiates one routine from another, and brings back in the purpose of the routine, a point considered important by Pentland (2004).

A comparison of the various elements of the definitions can be summarised in Table 1 below

Table 1 – Summary of Key Elements of Definitions of Routines

	Multiple agents / interaction	Repetition / Recurrent	Patterns	Specific Outcome	Learning / adaptation / change	Habitual / stable	Decision making / rules / choice
Schumpeter (1927)		X			(implied)	X	
Stene (1940)	X	X				X	
Simon (1947)	X					X	X
March and Simon (1958)					X		X
Nelson and Winter (1982)		X	X			X	
Pentland (1995)	X						X
Cohen et al. (1996)		X	X		X	X	X
Pentland and Feldman (2005)	X	X	X				
Becker (2004)	X	X	X	X			

The layout of Table 1, follows the differentiation made by Feldman and Pentland (2005) between what a routine is (shown on the left hand side of the table), and what agents do (learn from experience, make decisions based on rules) or the extent of variety the routine demonstrates

(stable/changeable). Consequently the definition of what a routine is should be drawn from the left hand side of the table. The right hand side of the table becomes important once in discussions on the behaviour of agents when enacting routines, or in relation to the outcomes of repeated enactments of a routine.

Drawing all of this together, a definition is advanced here drawing on the latest work of Feldman and Pentland (2008) which reflects previous research well, together with the final element advanced by Becker (2004). Routines are defined in this thesis as:

“repetitive patterns of interdependent actions carried out by multiple actors working to achieve a particular outcome”.

This definition of routines is unpacked in some detail below.

1.2.1 ROUTINES ARE REPETITIVE PATTERNS

That routines are repetitive patterns has been noted by authors other than Pentland and Feldman (2005). For example, Cohen (1996, 683) argues that a routine is a capability for repeated performance which has been learned by an organisation. An organisational activity which is not recurrent, but instead occurs in a random or haphazard fashion, or occurs only once, could hardly be considered ‘routine’ – as the name itself implies repeated, or recurrent implementations (Becker 2004).

1.2.2 ROUTINES ARE REPETITIVE PATTERNS OF INTERDEPENDANT ACTIONS

Routines are not just recurrent activities which involve interaction, but also involve patterns of behaviour (Nelson and Winter 1982). For something to be considered a routine, implies that there are patterns of organisational action which remain relatively stable, and which are followed repeatedly (Becker 2004), as opposed to simple random acts. Indeed a pattern of action which occurs once, could hardly be considered a routine (Vromen 2011), as it is not a pattern or blue print which can be imitated by the organisation for further behaviour.

1.2.3 ROUTINES ARE REPETITIVE PATTERNS OF INTERDEPENDENT ACTIONS CARRIED OUT BY MULTIPLE ACTORS

Feldman and Rafaeli (2002) have argued that routines are collective in nature and involve multiple individuals in their implementation. As they involve multiple actors, routines can be distributed across different organisational units, or occur in different places, although they are linked together in interaction while carrying out the routine (Becker 2004). A routine can occur within a hierarchical unit – which are relatively homogenous and share a common profession (Cohendet and Llerena

2003). Alternatively routines can occur across disciplinary boundaries – such as epistemic communities and communities of practice (Cohendet and Llerena 2003). However they occur, routines involve recurrent interactions within an organisation, between various actors. In other words, routines are not the habitual behaviour of an individual actor (Nelson and Winter 1982), but rather involve multiple actors.

1.2.4 ROUTINES ARE REPETITIVE PATTERNS OF INTERDEPENDANT ACTIONS, CARRIED OUT BY MULTIPLE ACTORS WORKING TO ACHIEVE A PARTICULAR OUTCOME FOR AN ORGANISATION

Organisations exhibit many examples of behaviour which is regular and involves interaction, such as coming to work, or talking around the water cooler; however, these are not routines. Routines must also achieve a specific outcome for an organisation – they have a specific purpose and intent. Empirical examples include activities such as budgeting, hiring, training student resident staff; moving students in at the beginning of term and closing the halls at the end of the year (Feldman 2000, 2003). Other examples are maintenance (Reynaud 1996), and software support call centre operations (Pentland 1992). All of these activities relate to achievement of a specific outcome for the organisation. Even when there is variation in the way an outcome was achieved, all of these can still be considered a routine, provided that they still achieve a the same particular outcome for an organisation (Pentland 2004). Having defined organisational routines, the specific context and routine being examined are detailed next. As with any field of research, context is important. For routines this is especially true, as there is a certain uniqueness in the way organisations implement their routines, and consequently, the analysis of organisational routines needs to pay attention to the specific context in which the routines are implemented (Pentland 2011).

1.3 CONTEXT OF THE STUDY

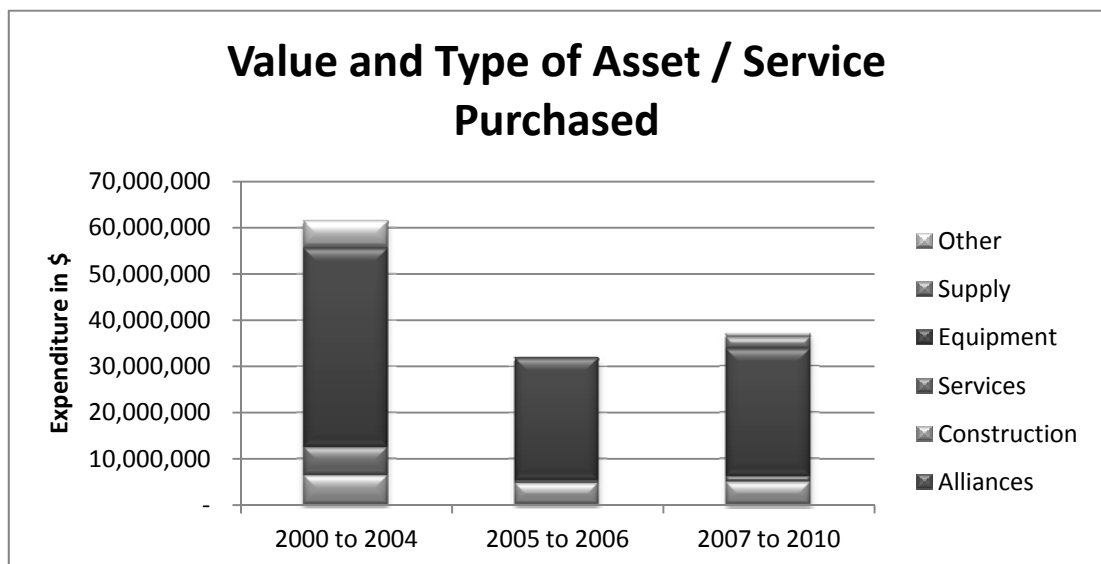
Context is important to establish as it is highly likely that the specific organisation and routine being examined, will have a significant influence on the findings. This is partly due to the endogeneity which needs to be acknowledged in organisational routines (Nelson and Winter 1982), as the same organisational routine is unlikely to be implemented in an identical fashion in different organisations, as each organisation develops its own way of undertaking a particular repetitive activity. Additionally, it is likely that the specific routine being examined might impact the empirical findings. Studying how a budgeting routine changes over time in an organisation (Feldman 2000), for example, may yield a slightly different perspective on variation, compared to the examination of call centre operations (Pentland 1992), simply because the number of times these routines occur in an organisation each year is considerably different.

The context for this study is an engineering asset intensive firm, which is referred to throughout the study by the pseudonym of “Prolific Projects”. Normally, an extended discussion of the organisation, its industry contexts, and types of activities undertaken would be provided in order to provide an explanation of the context of the study and the role of the organisation within this context.

However, this is not possible for this study as a condition of access to the data study was that the organisation, its divisions, industry and location, and detailed specifics of the asset being purchased could not be identified.

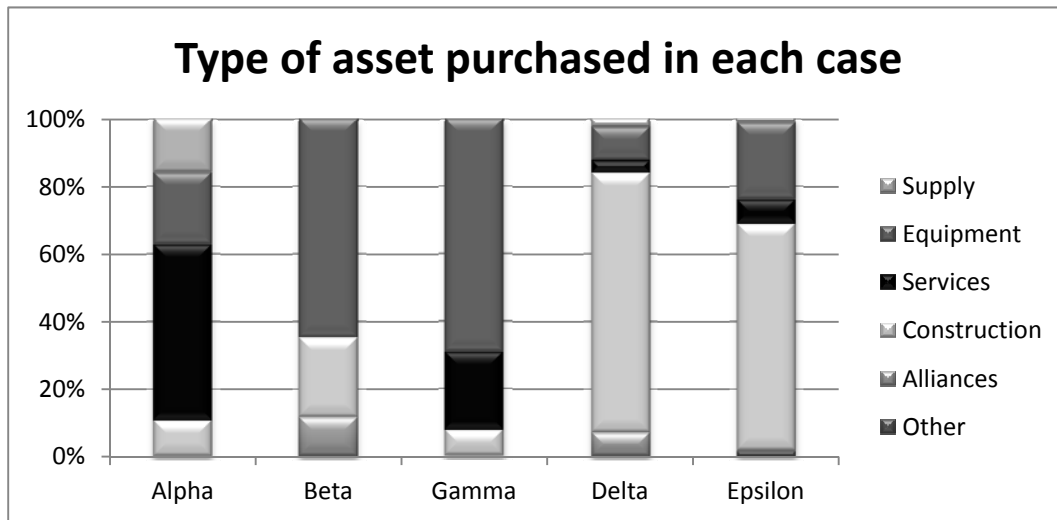
What I can disclose is that Prolific Projects has been in operation for over 50 years, and is comprised of a number of major divisions, referred to in this thesis by the pseudonyms of Alpha, Beta, Gamma, Delta and Epsilon. As an engineering asset intensive company, Prolific projects is a significant purchaser of engineering assets. As Figure 1 shows, between \$30 million and \$60 million dollars was spent in each time period on a range of different types of assets, although equipment was the largest expenditure in each time period.

Figure 1 – Summary of the value and type assets purchased by Prolific Projects over time



Thus the context of the study is a single organisation (Prolific Projects), which is comprised of multiple divisions (Alpha, Beta, Gamma, Delta and Epsilon). A single routine “engineering asset procurement” is examined across each of these divisions. As will be discussed in the methods and findings sections, each case is different in terms of the different types of assets being purchased. In other words, while procurement of engineering assets is examined in each of the cases, what is being purchased is different. This is shown in Figure 2 below, and will be explored further in the cross case analysis chapter which follows.

Figure 2 – Percentage of Asset being purchased in each division



This context is important as a single routine is studied over time across multiple cases within a single organisation, where there are differences between the cases in terms of what is being purchased. There is no other known empirical example of a longitudinal multi-embedded case examination of a single routine.

Thus, the context of the study provides a rather unique opportunity to examine a single routine across multiple cases. As will be explained in detail in the chapters that follow, access to this context enables the collection of data which provides both an empirical and methodological contribution.

In order to provide more context, the nature of the specific routine being examined will be discussed next.

1.3.1 PROCUREMENT – THE SPECIFIC ROUTINE BEING INVESTIGATED

Procurement involves “the acquisition of consumables (goods); real property; capital equipment such as computers; built assets such as hospitals, schools, roads and major facilities; and services such as office accommodation, cleaning and security (Australian Procurement and Construction Council 2003, 2). The focus of this thesis is not on purchasing of consumables, but rather on the procurement of engineering assets, such as machinery and buildings, and services, such as maintenance². Engineering asset procurement involves a set of decisions about: how to approach

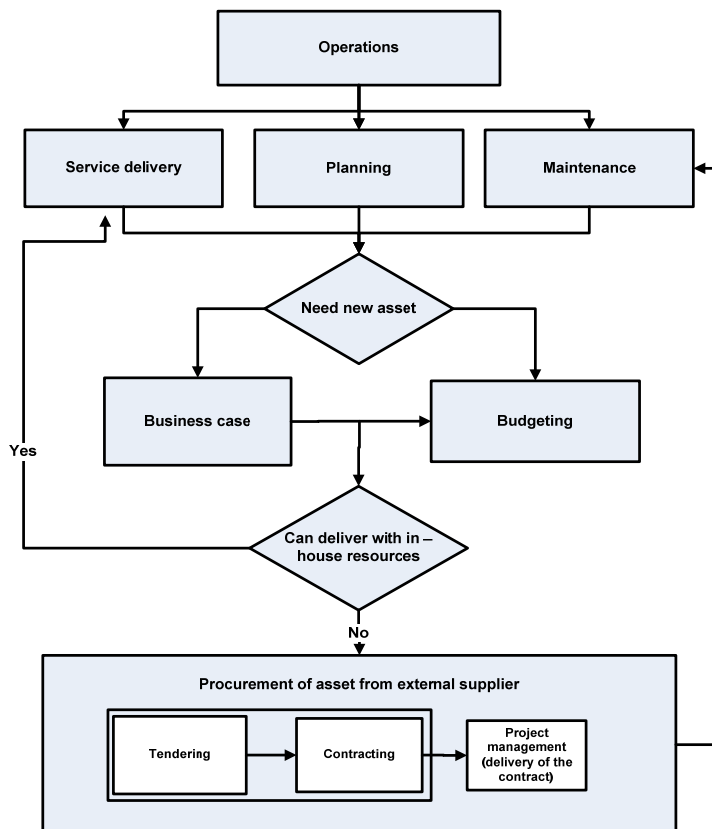
² This delineation was primarily data driven as information on the other types of procurement was not available. However, engineering assets are different type of artefact to consumables, as consumables tend not to need maintenance for example.

organisations to invite them to tender for projects, contractual arrangements, form of compensation, and how to maintain the asset over time (Lædre et al. 2006).

When considering the acquisition of engineering assets, such as machinery, companies must consider whether the delivery of the asset or service will be achieved by the firm itself with its own internal resources, or whether the asset or services will be purchased from the market. This has been termed elsewhere as the ‘make-or-buy’ decision (Tadelis 2002). Once a firm decides that it will not deliver the asset or service with internal resources, but instead will arrange for an external firm to deliver the asset or service, then procurement activities commence.

A diagram which sets out how procurement might relate to other organisational activities (such as maintenance) is provided below (see Figure 3).

Figure 3 – Procurement in relation to other organisational activities



What Figure 3 demonstrates is that routines are not isolated occurrences, but there are in fact “ecologies of routines” (Pentland 2011, 290). While each of the activities noted in Figure 3 are worthy of research (Feldman (2000) examines budgeting routines for example), in order to bound the scope of the thesis into a coherent, definable topic and deliver the project within the space available in the thesis, only the tendering and contracting phases of the procurement are the focus of the study. Additionally, the context for the study is the procurement of *engineering assets*, rather

than purchasing of consumables such as stationery. The purchasing of consumables would be a different study, as consumables tend not to need maintenance.

It should be noted that there is a considerable body of literature, both in management and engineering disciplines, most of which seeks to associate specific procurement approaches with specific variables – such as cost, quality and time (e.g. Ive and Chang 2007). While quite rich, this body of literature shall not be drawn upon. A key reason for this is that the research focus of this thesis is not on the relationship between procurement and specific project variables (such as cost, quality and time), but rather on the dynamics which create variety in procurement routines. The intent is thus not to examine correlations between specific variables, but rather to explore and explain the organisational dynamics which create variety. Consequently, procurement routines are not viewed as variables per se, but rather different organisational practices (Van de Ven and Poole 2005).

While much research has been conducted on the practice of contracting out of services (Wilson and Zhang 2002), there is little empirical work which has focused exclusively on procurement as a routine. This is important as exploratory empirical research into the nature, operations and dynamics of routines has been called for (Becker 2005a).

Having defined what a routine is, an argument needs to be made for how procurement could be construed as an organisational routine. As procurement involves the recurrent pattern of action in order to purchase assets, it will be argued below that procurement fits within the definition of a routine – or a recurrent interaction pattern.

1.4 PROCUREMENT AS A ROUTINE

The decision to make or buy (or procure) is a core strategic decision for organisations (Coase 1937; Furneaux and Brown 2007; Lædre et al. 2006; Walker and Hampson 2003). In other words, organisations make strategic decisions about those activities which the organisation will undertake, and what services, products, and assets will be purchased from other organisations. In this context, procurement is a core activity which nearly every organisation undertakes. Importantly, procurement routines are one of the few routines, which by their nature, specifically involve interaction with external companies.

1.4.1 PROCUREMENT IS INTER-ORGANISATIONAL

Much of the empirical examination of routines to date has focused on routines which operate purely within an organisation. For example, Feldman's (2000, 2003) work focuses on a number of routines which operate solely within a single organisation (such as budgeting). Nelson (1994) also notes the existence of what he terms 'interface routines' – those routines which govern the interaction of an

organisation with its customers, suppliers and other external parties. Zollo, Reur and Singh (2002) refer to these sorts of routines as inter-organisational routines, as does Pentland (2004). Inter-organisational routines standardise the interface between firms, and greatly reduce transaction costs (Williamson 1985). While important, not been many studies have been undertaken of inter-organisational routines to date (Zollo, Reur and Singh 2002).

As noted earlier, engineering asset procurement is a core process within organisations, which arises from a decision about whether to deliver a service or product with internal resources, or whether to purchase the asset or service from an external company (see Figure 3). Once the decision is made to not deliver the service, asset or commodity internally, then procurement begins as an organisation seeks to purchase the asset, commodity or service from another organisation. Pentland (2004) specifically argues that purchasing, another term for procurement, is an example of an inter-organisational routine. However, to the best of my knowledge such examination has not occurred empirically to date, although contractual choices in manufacturing (Wilson and Zhang 2002), and learning in organisational alliances (Zollo, Reur and Singh 2002) have been explored.

Thus, procurement is an inter-organisational routine. However, routines are specific within an organisation. Thus while procurement involves the engagement with other organisations, in both calling for tenders and contracting, these activities occur within a single organisation, and are undertaken by a single organisation. Other research might focus on the detailed and specific discourse of such interactions or their relative effectiveness. However the focus here is on the procurement routine of a specific organisation, although these activities involve choices about how to interact with other organisations. Consequently, no inter-organisational analysis has been undertaken.

1.4.2 PROCUREMENT AS AN INTERDEPENDANT PATTERN OF ACTION

Pentland (2011) notes that routines tend to form a interdependent pattern of action, with one stage of the process needing to be complete before the organisation moves to the next stage³. While there does not appear to be a previous study of procurement of engineering assets from the perspective of organisational routines, previous research into contracting has noted that procurement involves at least two related stages – tendering and contracting (Industry Commission 1996; Samuelson 1986). In tendering, organisations invite another organisation(s) to place an offer

³ Pentland uses the term ‘pattern’ to include each of the various sub-routines, which I would term a specific variety of a routine. I am viewing the ‘pattern’ at the overall level of the routine. While a minor point it does affect how heterogeneity is viewed.

bid to deliver a particular asset or service (King 1994). Having selected a firm to deliver an asset or service, a contract is signed by both parties which established the legal relationships between the two firms, and specifies the rights and responsibilities of each organisation (Cullen 2000; Gransberg et al. 2007; Steane and Walker 2000). Thus engineering asset procurement would appear to be an interdependent pattern of action involving at least two stages. In other words there is a pattern of action involved, which again indicates that it is suitable for examination as a routine.

The last consideration is the potential relationship between procurement routines and variation.

1.4.3 PROCUREMENT ROUTINES AND VARIETY

As noted in the previous section, procurement is the particular routine which is being focussed on in the thesis. One of the unique attributes of procurement routines, is the high degree of variety available to organisations when undertaking procurement (Cartlidge 2004; Chan 2007; Lædre et al. 2006). In fact Tookey et al. (2001, 28) refer to the ‘salad bar’ of options available to organisations when undertaking procurement activities. Other researcher profess exasperation when examining procurement – due to the high number of varieties involved (Chan 2007). This high degree of variety involved in procurement observed by multiple authors presents a clear opportunity to examine variety in organisational routines. Undertaking research on a routine which demonstrates less variety would provide less data on the dynamic processes which create variety in the first place, and therefore it would not be possible to answer the research question. Consequently, a deliberate choice was made to examine procurement as a routine in order to examine the causes of variety.

Interestingly, Pentland (2004) gives the specific example of purchasing, or procurement, when arguing that the function of the routine determines whether variants of a routine are in fact the same routine. Accepting that this is true, then two instances, or variants, of a procurement routine which are different in some way, may still be considered the same routine, as long as they achieve the same outcome. In other words, procurement is a special type of routine which exhibits considerable variety, and yet despite this variety, delivers the same outcome for an organisation, and can therefore still be considered the same routine. Procurement routines therefore demonstrate a key property which is the focus of the research of this thesis – variety. As a focus of research, the examination of procurement routines will yield data that can be used to examine how variety is developed. Examination of other routines may not yield the necessary data to examine the dynamics of variety creation. For example, Feldman’s (2000) examination of moving students in at the beginning of a year is well able to provide data on how the routine changes over time, as the single routine is examined over time. However as there is a single variety of a routine involved at a time, such routines do not yield data on variety.

Procurement thus sits well within the definition of routines as recurrent interaction patterns, as this phenomena occurs with regularity (is recurrent), involves interaction between various elements in

an organisation, as well as between an organisation and other organisations (interaction), involves tendering and contracting (is a pattern of action) and results in the purchasing of a specific asset (achieves a particular outcome). Additionally, as the focus of the thesis is an exploration of the causes of variety in routines, then procurement is a most appropriate routine to examine, due to the variety observed by other researchers.

Having defined routines proper, and provided the context of the study, together with the specific routine being examined, it is appropriate to outline the remainder of the thesis.

1.5 OVERVIEW OF THE THESIS

As noted in the introduction, the focus of this thesis is on the creation of variety in organisational routines. Campbell (1965) famously argued that an evolutionary perspective could assist in understanding how change occurs in organisations. Specifically, Campbell argued that selection, variation and retention within an organisation could create variety. This thesis contributes to a better understanding of organisational routines by extending and operationalising Campbell's (1965) initial theoretical framework, in order to explore the creation of variety, in all of its forms. This responds to calls in the literature for research which can explain the causes of variety (Becker 2004), together with the causes of stability and change in organisational routines (Pentland 2011).

Specifically, the thesis undertakes an exploratory and explanatory analysis of how selection, adaptation and retention dynamics create variety in organisational routines. To this end a longitudinal, multi-level, multi-case analysis was undertaken, using multiple data collection strategies. By examining the nature of variety at multiple levels over time, and across case studies, a better understanding of variety in organisational routines was developed, together with the dynamics which created this variety.

These findings enabled a number of theoretical contributions. Firstly the multi-level longitudinal analysis showed that four types of variety existed across all the cases, although there were differences between the different levels of a routine. This finding has methodological implications for the examination of variety in routines, as it is evident that certain types of research design are better suited to examining different types of variety in organisational routines. Secondly, if a single routine can be stable, varied and adaptive at the same time, then this suggests that stability and heterogeneity are properties of a routine, not a particular state. Thirdly, selection was found to increase variety through the recombination of sub-routine options, and decrease variety through recurrent selection of the same variant. The introduction of new sub-routine options through adaptation increases the number of options available for selection, which in turn increases the number of variants of a routine. Through choices about how many sub-routine options to keep in organisational memory, retention increases or decreases variety. And finally, there is a dynamic

interplay between selection, adaptation and retention in the creation of variety in organisational routines.

These findings are important as they show that the typology advanced in the literature review has merit as a theoretical lens for examining variety in organisational routines. Secondly, different types of variety can only be determined through specific methodologies. Arguments about whether routines are stable, varied, adaptive or dynamic need to consider and acknowledge the methodological and level of analysis issues as part of the analysis process. Additionally, the contention by Campbell (1965) that selection, adaptation and retention provide a way of explaining change, in organisations has been shown to hold true. In extension to this theory though, the specific ways in which selection, adaptation and retention affect variety have been advanced. Finally, a model is advanced that captures the dynamic process of the creation of variety, and takes into account the multifaceted nature of organisational routines.

The Thesis is structured as follows:

- Chapter One (this chapter) introduces the topic and structure of the thesis, together with the context of the study.
- Chapter Two provides a theoretical overview of the phenomena of routines, a theoretical gap in this literature, and advances a set of research questions which arise from this literature that the thesis will seek to answer.
- Chapter Three provides a review and justification of the methodology used to examine the research questions.
- Chapter Four provides the data analysis of each case, regarding each of the research questions.
- Chapter Five advances five findings as a result of the cross case analysis
- Chapter Six discusses the methodological and theoretical implications of the findings, and then summarises the theoretical contribution of the thesis.

A set of appendices are also provided for information which is important to the thesis, which if included in the main text would disrupt the overall flow of the text.

- Appendix A – Semi-Structured Interview Guide
- Appendix B – Process for assessing quality of interview transcriptions
- Appendix C – Full tabulation of each Variant of the Routine, by year and by case study
- Appendix D – Full description for each of the contracts used, including triangulation between interviews and data base

Readers are referred to the relevant appendices throughout the body of the thesis.

Having provided an overview of the thesis as a whole, the next chapter explores the academic literature of organisational routines, particularly the various types of variety found in organisational routines, and how selection, adaptation and retention might create such variety.

CHAPTER TWO

2) THEORETICAL FRAMEWORK

In order to determine how the dynamics of selection, adaptation and retention create variety in organisational routines, a theoretical framework is required in order to articulate specific research questions which are subsequently examined empirically. To achieve this outcome, this chapter firstly advances a definition of routines, and then clarifies the differences between the existence of a number of variants of a routine and the dynamics which might create such variety. Then the various types of variation are discussed and a typology advanced, (Figure 4) which is developed from an analysis of the extant literature on variation in organisational routines. The ways in which selection, adaptation and retention affect variety are then examined, and research questions advanced.

The aim then is to develop a theoretical model of how variety is created in routines, in the context of a specific and complex routine – procurement. Where appropriate, specific issues related to the methodological investigation of specific questions, or of routines in general, will be prefaced in this chapter, to assist linking the theoretical framework advanced in this chapter, with the methodological approach in the chapter following.

2.1 INTRODUCTION TO ORGANISATIONAL ROUTINES

Considerable gains have been made in the empirical examination of organisational routines in the past 20 years. There are a number of aspects of organisational routines which have been clearly established. In terms of function, routines are recurrent patterns of action which achieve a specific outcome in an organisation (Feldman and Pentland 2003; Pentland and Feldman 2005, 2008). In terms of behaviour, it would appear that some routines are stable (Howard-Grenville 2005), while others change over time (Feldman 2000, 2003), or exhibit considerable variety (Pentland, Haerem and Hillison 2009; Pentland and Rueter 1994). Despite their conceptual power – empirical examination of organisational routines are still relatively few (Becker 2004, 2005a, 2005b; Becker 2008), and examination of inter-organisational routines are even less prevalent (Zollo, Reur and Singh 2002).

Consequently there are a number of areas in which additional research on routines is needed. Specifically, Becker (2004) argued the causes of variety in routines should be pursued as a matter of priority. This call resonates with broader quests to understand feedback processes between search, experimentation and adoption of innovations in the evolutionary economic literatures (e.g. Witt 2008). As Aldrich states (2008, 584) “The general problem of the existence and replenishment of variety remains a vital question of evolutionary research in the social and technological domain”. More specifically, Pentland and Feldman (2008) argue that in order to “understand routines, we need to study and understand this variety”.

It is this gap in the literature that this thesis seeks to make a contribution. This is achieved firstly by exploring the notion of variation in organisational routines, and by differentiating between the causes of variety and the existence of variety. A thorough review of the literature develops a theoretical understanding of how variety might be created in organisational routines. Consequently, the overall aim of the thesis is to explore and explain how different types of variety are created in organisational routines.

Therefore the focus of this thesis is not on the structure or function of routines per se, although these will be noted, nor on their effectiveness at achieving specific outcomes for a firm, but on the dynamic processes which generate variety in organisational routines (Feldman 2000). A number of more specific research questions are advanced in the pages that follow, which together suggest how variety might be generated in organisational routines.

In summary, this thesis will explore the causes of variety in organisational routines. It is appropriate then to explore the notion of routines in some detail, as a prelude to examining how a methodological investigation might be undertaken (as discussed in Chapter 3).

Firstly, the particular function that routines have within organisations is examined.

2.1.1 THE FUNCTION OF ROUTINES IN ORGANISATIONS

Various authors have examined the function routines have within organisations. How routines function as memory, source of stability and source of change are each examined in the sections which follow.

Routine as organisational memory

Routines are seen to function as devices which enable an organisation to remember how to do certain things (Nelson and Winter 1997). From this perspective, routines at an organisational level are similar to skills at an individual level (Nelson and Winter 1982, 124-125). While individuals may well practise an activity consciously, over time the performance of this skill becomes automatic, which is the same process held to occur with routines within organisations (Nelson and Winter

1997). This knowledge involves both cognitive knowledge (knowledge that something is so) and procedural knowledge (knowledge of how to do something) (Cohen and Bacdayan 1994). Routines thus provide a way of remembering why and how to do certain things (Cohendet and Llerena 2003 p.272). Routines therefore provide a useful way of understanding how knowledge of firms, including tacit and procedural knowledge, is stored, used, lost and changed (Becker 2004).

Routines as source of stability

Once a routine has been established within an organisation, and is seen to equate to standard operating procedure, management can view the operation of the routine as the target for performance and will therefore seek to do what they can to ensure the routine continues (Nelson and Winter 1982). In other words, once the routine has demonstrated that it can achieve an acceptable level of performance, management will seek to ensure organisational activities are in line with the targeted procedures in this routine (Nelson 1994). In this sense, routines are used by management as a standard which is strived for. In highly complex environments, having already established routine ways of operating, can enable the reduction in complexity related to decision making (Egidi 1996; Hodgson and Knudsen 2004).

“... routines (as contrasted with more or less random behaviour, or highly deliberative behaviour) tends to come into existence when certain ways of doing things consistently give results that are at least satisfactory, in the sense of not triggering conscious cognitive problem solving to find something better to be doing” (Nelson 1994, 250).

It is important to note that routines as targets do not seek to optimise behaviour, but rather ‘satisfice’ (March and Simon 1993)⁴. That is, they do not necessarily seek optimal or perfect behaviour, as there is no way to calculate optimal performance before the routine is established. Thus, routines as targets evolve out of organisational processes, and are chosen according to the ‘logic of appropriateness’ (March and Olsen 1998; March and Simon 1993, 8).

As a repository of organisational memory, and as a standard operating procedure, routines enhance the stability of organisational procedures and processes (Becker 2004). From this perspective, routines were “repeated patterns of behaviour that are bound by rules and customs and do not change very much from one iteration to another” (Feldman 2000, 611). More recently however,

⁴ Throughout their work, March and Simon (1993) refer to repetitive organisational activities as programs. It is evident from their analysis that the phenomena they are discussing is the same as a routine.

Feldman and Pentland (2003) have recently argued that routines are also a source of flexibility and change and that routines can adapt over time (Feldman 2000).

Routine as a source of change

Routines were conceptualised originally by Nelson and Winter (1982) as a source of change within organisations, and note that the term ‘innovation’ necessarily involves change in a routine (Nelson and Winter 1982, 128). Feldman (2000, 2003), however, can be largely credited with showing empirically that organisational routines are in fact capable of changing over time. What is particularly interesting about Feldman’s work is that her studies commenced with the assumption that routines were stable, however empirical analysis instead found ongoing variation had occurred across each of the routines which were examined (Feldman 2000, 2003; Pentland and Feldman 2008).

This notion of change in routines has become widely accepted in both the empirical and theoretical literature (Becker, Knudsen and March 2006; Becker et al. 2005; Feldman 2000, 2003; Knudsen 2002; Pentland and Feldman 2005, 2008). As this theoretical perspective is central to the thesis the different approaches to examining change is examined in some detail in the next section.

2.1.2 THEORIES OF CHANGE

Various theoretical perspectives exist in which to examine change in organisations. Van de Ven (1992) argues that there are at least four perspectives which could be used to analyse change processes: an evolutionary perspective, where change in the natural environment is drawn upon by way of analogy; life cycle, where change occurs through a sequentially staged process; teleological where change occurs through deliberate pursuit by an organisation of a deliberate end state; and dialectic perspectives, where change occurs through competing agendas, life cycles or teleologies (Van de Ven 1992, 177-179). While it is not possible to examine validate each of these theoretical perspectives throughout the thesis *per se*, it is important to identify the most appropriate approach for examining change in organisational routines.

Evolutionary theories of change

Evolutionary theories of change look to nature for inspiration on how change might occur in organisations. Some authors would claim that such a view can be a literal application of evolutionary theory to organisations with change due to natural selection by the environment (Hodgson 2001). In terms of organisational routines, most of the who understand evolutionary change of routines (with the exception of Feldman 2000, 2003) embrace a *natural selection* approach, assuming that Darwin’s survival of the fittest can be understood in a literal sense for organisations (Felin and Foss 2011; Freudenburg 1986; Furneaux 2011; Hodgson 2001, 2008; Hodgson and Knudsen 2004; Hodgson and

Knudsen 2006; Knudsen 2002; Knudsen 2008). While change is predominantly examined from a natural selection approach, this has drawn some heavy criticism in the economic literature recently (Pentland 2011; Winter 2011).

Others would argue that a literal application of *natural selection* evolution to organisations is not appropriate, as organisations can exercise agency, and exert influence on their environment (Miles and Huberman 1984b; Morgan 1997). In other words the influence of the external environment is mediated and mollified to a certain extent by agency (Miles and Huberman 1984b), and organisations are not at the mercy of their environment (Morgan 1997).

An alternative evolutionary approach is that proposed by Campbell (1965, 1974), who argued that the evolutionary view of change in organisations was useful, provided that this is undertaken by way of analogy, rather than literally. While well understood in the organisational literature (e.g. Miles and Huberman 1984b), Campbell's approach has not been applied empirically to studying routines, although it has been discussed theoretically (Miner, Ciuchta and Gong 2008; Miner and Raghavan 1999).

While the genesis of routines comes from an evolutionary economics (Nelson 1994; Nelson and Winter 1982) the recent criticism of a literal understanding of natural selection (Pentland 2011; Winter 2011), means that an alternative approach is needed. The obvious theoretical candidate for this is the work of Campbell (1965, 1974), particularly given the lack of an empirical examination of this approach.

Life-Cycle Theory of Change

Van de Ven (1992, 177-179) argues that the life cycle approach to change involves a sequential stage process. Existing research on routines has not shown that there is a staged process of change organisational routines (Feldman 2000, 2003). Instead there is evidence of adaptation over time, although the multiple reasons given for change, do not support a staged process approach.

Teleological Theory of Change

The Teleological theory of change (Van de Ven 1992) suggests that there is the deliberate pursuit of a desired end. While there is evidence to suggest that there is deliberation in decision making about routines (Child 1972; Teece and Pisano 1994), there is also bounded rationality, which may make the link between the desired end and the actual outcome unclear (Egidi 1996; Simon 1991). While there may well be intentionality in the way specific routines are selected in order to achieve a specific end, a teleological view is most suited to a high level approach in relation to how procurement fits into the overall business practices, rather than a micro-analysis of change in organisational routines themselves.

Dialectic Theory of Change

The final alternative theory advanced by Van de Ven (1992) is that of a dialectic theory of change. There is evidence of competing agendas in procurement and of conflict whenever change is being considered -- even organisational truces being made (Nelson and Winter 1982). However, conflict is more likely to inhibit change, rather than enabling change to occur in the first place. Again, it is possible that this view is better utilized in a whole of organisational sense, rather than for examining change of the routine itself.

Summary on theories of change

Thus, of the four views, the teleological view and the evolutionary views appear to have merit in examining change. Indeed, the view of selection advanced in this thesis, an intentional choice between alternatives, fits with a teleological view. Both the Dialectic and Teleological perspectives have value in the analysis of procurement at a fairly high strategic level inside the organisation. They both appear to have less value at the individual enactment of the routine however.

Thus alternative analytical and theoretical perspectives have some merit in examining procurement activities. However there is a clear opportunity to advance and test an evolutionary model of change, particularly one which embraces a metaphorical understanding of change, rather than a literal approach to change. This would acknowledge the evolutionary economic theoretical origins of routines, while utilising a theoretical perspective which has support in the organisational theory literature.

Campbell (1965) is largely credited with advancing an evolutionary theory of change which is appropriate for social systems. Essentially Campbell (1965) argued that social systems such as organisations undertake a set of interrelated processes: the creation of a set of variations, the selection process to choose between these variations, and mechanisms for ensuring that those variations which performed adequately were retained for future use. These three elements are discussed in some detail below, as they are central constructs in evolutionary theories of the firm (Knudsen 2008), and are vital to understanding the dynamics of change in organisational routines (Feldman and Pentland 2003; Knudsen 2008; Pentland and Feldman 2005). Indeed, Campbell's theories are the primary theoretical foundation for evolutionary change currently adopted in organisational theory (Romanelli 1999). However, firstly some clarity needs to be established concerning the specific construct of variation in organisational routines.

2.2 VARIATION AND VARIETY⁵

In his seminal work, Campbell (1965) discussed the creation, mutation rate and sources of variation (Campbell 1965, 28) and the existence of multiple variations, and the heterogeneity of variants. Campbell (1974) is thus careful to distinguish and differentiate between the existence of variety, and the factors which cause such variety. While some authors are careful to differentiate between heterogeneity of variants and change in variants (e.g. Madsen, Mosakowski and Zaheer 1999), for various reasons this careful distinction is not always maintained in the organisational theory literature, with the focus tending to be on one or another of these two phenomena.

For example, Zollo and Winter (2002, 343) argue that variation is “where individuals or groups of them generate a set of ideas on how to approach old problems in novel ways”. In other words, variation is seen as the generation of novel ways of doing things – the same as adaptation or change (Miner, Ciuchta and Gong 2008). Other authors, however, define variation in terms of differentiation - the existence of different varieties of a specific routine (Levitt and March 1988). Campbell (1974, 143) himself defines variation as “heterogeneity of alterations on existing forms”. These authors see variation as the degree of variety in a given set of routines at a given point of time.

Therefore the construct of variation has come to be articulated in the organisational theory literature as both the creation of variety, and the available pool of varieties which are the result of adaptive processes. Using the same term – variation – to label both the way variety is created, and the variety which is the outcome of such activity, can create considerable conceptual, methodological, and analytical difficulties.

Conceptually, a single construct with multiple meanings can cause lack of clarity and even confusion. To advance a theoretical model which uses the same construct (variation) to describe both the way variety is created and the outcome of such adaptive activity, also creates significant analytical difficulties. Suddaby (2010) recently argued that construct clarity requires clear conceptual distinctions between constructs, as a necessary precursor to effective consistency in the development of a consistent theoretical argument.

It would be possible in this thesis to retain the use of the term variation, but to define clearly what is meant by such a term, as some authors do (e.g. Miner, Ciuchta and Gong 2008). However, while the distinction between variation as an activity and variation as an outcome may well be implicitly

⁵ The basic structure of this argument was first advanced in (Furneaux, Tywoniak and Gudmundsson 2010).

understood, or explicitly stated by an author, for the purposes of conceptual, methodological and analytical clarity these two aspects of variation will be held separate in this thesis.

Here variation is understood to be the existence of a number of variants of a given routine, as I would argue this is the original intent of Campbell (1965). However, given the confusion driven by the duality of the meaning of this term noted earlier, the term *heterogeneity* will be used in order to ensure the construct denotes “heterogeneity of variants” (Campbell 1965, 28). When discussing specific varieties of a routine, the term *variant* will be used, with *variants* as the plural, in keeping with Campbell (1965). The creation of new variants of a routine cannot be covered by a single term, but instead a theoretical understanding of how selection, adaptation and retention dynamically create variety is discussed in detail in Section 2.5 below.

Even a term as simple as heterogeneity, indicating multiple variants of a routine, needs some further explanation. This is because there is a difference between heterogeneity over time, and heterogeneity at the same time (Feldman and Pentland 2008). This is explained in some detail in the next section (Section 2.3), and a typology of the different types of variety articulated.

2.3 DIFFERENT TYPES OF VARIETY IN ORGANISATIONAL ROUTINES

Having differentiated between the creation of variety and the existence of a number of variants as a result of this creative activity, the notion of heterogeneity needs some more exploration. This is because researchers have identified a number of different types of heterogeneity, or even a lack of heterogeneity, particularly when change is measured over time. The four different types of heterogeneity are discussed in turn below, and a typology will be advanced later in the section to demonstrate the differences between each.

2.3.1 TYPE I – STABLE (LOW HETEROGENEITY AND HIGH STABILITY)

For many years the notion of a routine was perceived as a source of stability to organisations (Cyert and March 1963; March and Simon 1993; Nelson and Winter 1982). From this perspective, routines promoted stability and inhibited change. In evolutionary biology, species with very low change or variety are seen to have adapted to the peak of fitness. In other words – there is a single genetic configuration which will enable an animal to be at that peak performance for a given landscape (Nowak 2006). This apparent stability in organisational routines has led various theorists to suggest that routines exert inertia on organisational innovation (Nelson and Winter 1982). Applying this to routines, there may well be a routine which, once found, alters little for a long period of time, even in the face of changes in the external environment (Pentland 2011), possibly because they are perceived to function well. This corresponds to the notion of routines as a target (Egidi 1996;

Hodgson and Knudsen 2004), as organisations which have found a high performing routine, would seek to ensure the routine did not change significantly. Additionally, some recent researchers (Howard-Grenville 2005) found that routines were in fact stable over time. Thus, based on existing research, there is potential for routines to remain stable, and thus exhibit stability (low heterogeneity and high stability) over time.

2.3.2 TYPE II – DIVERSE (HIGH HETEROGENEITY AND HIGH STABILITY)

The work of Pentland (Pentland, Haerem and Hillison 2009; Pentland 1992; Pentland 1995; Pentland 1999b; Pentland 2003a, 2003b) has tended to focus on demonstrating variety with less focus on the adaptation of routines, although recent work is also beginning to focus on change over time (Pentland, Haerem and Hillison 2009; Pentland, Haerem and Hillison. 2010). Becker (2005b) argues that the more complex the task at hand, the greater the number of elements required to accomplish a task, and consequently the number of possible variants of a routine. This mirrors Boisot and Child's (1999) 'complexity absorption response', where complexity in the external environment causes a firm to generate internal variety in order to provide the necessary set of responses to external complexity.

Variety is important for organisations, as it allows an organisation to have more than one action which can be chosen for a specific situation – thus improving the flexibility of the organisation to various circumstances (Nelson and Winter 1982, 106). Thompson (1967) described how a repertoire of processes can shield an organisation from its environment. In other words, the variety enables a rapid response to changing environments. Thus some routines exhibit variety, but do not necessarily change.

2.3.3 TYPE III – ADAPTIVE (LOW HETEROGENEITY AND LOW STABILITY)

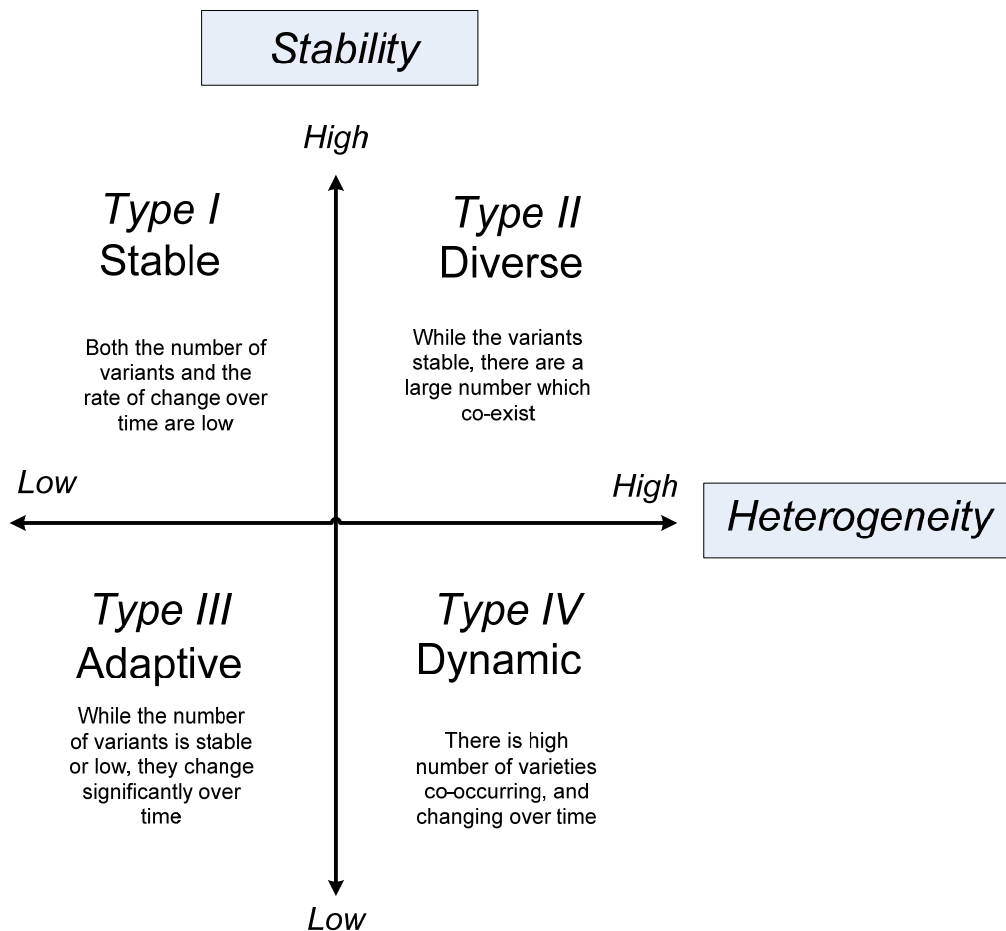
Martha Feldman can be largely credited with demonstrating that routines are not just a source of stability in organisations, but also a source of change (Feldman 2000, 2003; Feldman and Pentland 2003). Some routines are not stable over time, but are capable of changing even if external conditions stay the same (Pentland 2011). The types of routines examined by Feldman, such as budgeting (Feldman 2000), only occur once a year. Thus, at any given time, there is only one budget routine in operation. However, searching for improvements can lead the organisation to change the routine over time. This means that while the routines change, the number of variants does not increase, as there is only one in existence at any given point of time. This is not to diminish the importance of change, as it is held to improve the performance of routines over time, and is thus important to analyse (Nelson and Winter 1982, 130-131). Consequently, some routines may exhibit change over time (low stability), and yet exhibit low heterogeneity in the number of variants of a routine at the same time.

2.3.4 TYPE IV – DYNAMIC (HIGH HETEROGENEITY AND LOW STABILITY)

Very few authors have conducted research into both the heterogeneity and long term stability of in routines at the same time. As noted in the previous sections, the focus has been either on demonstrating the stability of routines over time (Type I), the change in organisational routines over time (Type II), or the existence of concurrent variants of a routine (Type III). In fact, only one paper was found which attempted to demonstrate both the existence of a heterogeneity of variants together with adaptation over time (Pentland, Haerem and Hillison 2009). This thesis will contribute to a better understanding of both heterogeneity and stability, which is the focus of Type IV Dynamic variety.

In reviewing each of the types, it is evident that each type is either high or low in stability and high or low in heterogeneity. If stability was viewed as an axis on a graph from low to high, and heterogeneity is also viewed as an axis on a graph from low to high, then it would be possible to create a typology which shows each of the types in relation to each other. Figure 4 below plots each of the types of variation on a graph against the two axes of stability and heterogeneity.

Figure 4 – Typology of variation in routines



As Figure 4 shows, it is possible to examine variety in routines, and use the axes of stability and heterogeneity in order to differentiate each from each other. This classification is not just an empirical exercise either, as the notion of stability and change has theoretical implications. In particular, this goes to core theoretical debates about the nature of routines.

Currently, there is debate about whether routines are either stable (Nelson and Winter 1982), change (Feldman 2000), or have a heterogeneity of variants (Pentland 2003b). What the typology suggests is that all routines do not necessarily exist in one of these states, but rather that stability and heterogeneity are *properties* that each routine has. Thus a routine could change over time, become stable, and increase or decrease in heterogeneity. This is a slight, but important shift in the understanding of routines, as the focus shifts from a debate over the essential characteristics of routines, to simply measuring the different properties of routines at a given time.

Once this shift is made, the challenge for a researcher is to identify the type of variety which the routine under examination exhibits, and then to determine how such variety came to be. The next section discusses how the determination of variation in a routine.

2.4 DETERMINING DIFFERENT VARIANTS OF A ROUTINE

The issue of variety in routines has been identified as a critical research area (Becker 2005a). Becker (2007, 254) has more recently asked how ‘alike’ variations of a routine have to be in order to be considered the ‘same’ routine? Such matters are essential to resolve in order to compare routines either concurrently, or over time. The issue of similarity and difference in variants of a routine are essential issues to resolve, as this is essential in order to examine the other aspects of routines for the purpose of this thesis – particularly their selection, adaptation and retention.

One way of resolving the dilemma posed by Becker (2005a, 2007) on the similarity and difference of routines is to start with the purpose of the routine itself. As noted in the introductory definition, routines are “‘recurrent interaction patterns’ involving multiple actors working to achieve a particular outcome” (Becker 2004 p.645; 2005b, 818). To establish whether or not a routine is a different routine or a variant of an existing routine, the starting point would be to consider the outcome the routine is attempting to achieve. For example, if the routine is to establish a budget, such as outlined in the work of Feldman (2000, 2003), then changes in the way that process was undertaken would be considered variants of the same routine, rather than a different routine, as the same outcome was sought – to establish a budget. Thus a variant of a routine can still be considered the same routine if it seeks to achieve the same outcome (Pentland 2004).

The variants of a routine then simply become a repertoire from which individual performances of a routine can be selected (Feldman 2000). Nelson and Winter (1982, 106) argued organisations

typically have a wide variety of specialised routine performances, each ‘customised’ for a particular configuration of the environment. In other words, there is not necessarily a single variety of a routine, but rather a number of different variants of the routine which can be performed, and the effectiveness of the variety needs to match the environment in which it is situated. Thus all the varieties of a particular routine are the range or repertoire of different ways of achieving a particular outcome in an organisation (Pentland 2004, 4). An example of this sort of variety is the routine involved in ordering and serving food in restaurants (Pentland and Feldman 2008).

An analytical distinction has been made recently between synchronic and concurrent varieties of routines (Pentland and Feldman 2008), a distinction based largely on the work of Barley (1990). Synchronic variations are when a number of varieties of a routine are available for implementation, however only one instance of a routine is in operation at a single point of time (Pentland and Feldman 2008). Concurrent variation, on the other hand, involves multiple variations in carrying out the same task, occurring at the same time in an organisation or where multiple routines may well overlap with each other (Pentland and Feldman 2008)⁶. This aligns with Type III of Figure 4.

The variety of routines which exists at a particular point of time, is synonymous with the notion of a repertoire of routines advanced by Feldman and Pentland (2000). These notions of routines providing a repertoire of action (Feldman 2000), underscore the notion that routines have a suite of options which can be selected according to the situation and context. Indeed the generation of multiple varieties is essential in order to identify which variety best fits specific organisational situations.

In summary, a distinction has been made in this thesis between the creation of variety, and the varieties of routines which are the result of such activity. As Dopfer (2005, 15) argues:

“variety is not a nuisance that hides the underlying reality; rather, it is the distribution of variety that is the reality and that is the pre-requisite for evolutionary change”.

As outlined in Figure 4 and the sections above, four different types of variation have been identified in the routines literature. Rather than arguing about whether or not a routine changes, or is heterogeneous, I have argued that these are properties which a routine demonstrates. While the

⁶ Feldman and Pentland (2008) also argue that there is another form of variation – diachronic variation – which they define as change in the same organisational process over time. As argued earlier, for the purposes of this thesis, the process of bring about change in routines over time has been defined as adaptation and is discussed in Section 2.5.2.

focus of the thesis is on how variety is created, the first step is to determine which type of variety exists in the first place, prior to examining how such variety came to exist.

This suggests the following research question:

- ▶ **Research Question 1: What sort of variety exists in organisational routines?**

2.4.1 THE DEMONSTRATION OF VARIETY

It is one thing to suggest that there is variety in routines – however to prove this requires the demonstration of such variety. Demonstrating variety requires the determination of the available repertoire of routines at a given time (Feldman 2000), particularly determining the number of concurrent variants of such routines. In order to establish this however, the various elements of a routine need to be identified and reported so as to be able to demonstrate variety in routines.

Thus prior to showing how selection adaptation and retention create variety in organisational routines, some mechanism is needed to show that variety does indeed exist, and if Figure 4 is correct, what sort of variety exists. Being able to identify particular routines and compare them with others is an essential empirical task (Pentland, Haerem and Hillison 2009). This requires that both theoretical and methodological considerations are taken into account in the research design.

Firstly, the various elements which constitute a routine, will be considered.

2.4.2 THE ELEMENTS OF A ROUTINE

Early research on routines tended to discuss them as undifferentiated singular entities (e.g. Nelson and Winter 1982). However recent research has noted that there are different elements of routines, and it is helpful to discuss these elements in some detail. Discussing the various elements of a routine, will assist in providing conceptual clarity (Becker 2004), and also provide a guide to the most appropriate methodology for examining routines (Pentland 2003a, 2003b; Pentland and Feldman 2005).

Becker (2004) argues that it is important to be clear about which element of organisational routines are being examined in research. There are a number of differences between routines as performances – or what happens in practice; and routines as standard operating procedures – or what is meant to happen (Becker 2004). More recently, Becker (2005b) argues that these two aspects of routines are distinct ontological levels: the ‘actual’ experienced level, and the ostensive level is where at which recurrent action patterns are conceptually understood (Becker 2005a).

Two of the most prominent empirical routines researchers (Pentland and Feldman 2005) have extended this slightly by arguing that routines should be seen as having three elements – the

performative, which “involves specific actions of specific people at specific times” (Pentland and Feldman 2005, 795); the ostensive, which are the abstract or generalised pattern of a routine (Pentland and Feldman 2005, 796), equating to the rules of Becker (2005a); and the artefacts which are physical manifestations of the routine – such as written rules and documented operational procedures (Pentland and Feldman 2005, 797). Each of these are discussed and explained in detail below.

Ostensive Element of Routines

Pentland and Reuter (1994) were probably the first to note the duality involved in organisational routines, by observing that the apparently unstructured performances of a call centre routine, while diverse, did in fact have an underlying structure. The ostensive aspect of the routine is the general pattern of the routine (Pentland and Feldman 2005), and is used by an organisation as a form of shorthand for the routine (Becker 2005a; Feldman and Pentland 2003). In other words, the ostensive captures the ‘in principle’ properties of a social phenomena (Latour 1986)

This is similar to what Argyris and Schön (1996) describe as the espoused theory – the way an organisation explains or justifies a given pattern of activity. Alternatively, Reynaud (2005) refers to this as the theoretical perspective. All of these considerations demonstrate that routines have an element which is conceptual. Following Pentland and Feldman (2005) this conceptual aspect of routines shall be referred to as the ostensive element. As routines embed organisational knowledge, it may be helpful to see the ostensive aspect of routines as propositional knowledge (Becker 2004), or declarative knowledge (Aldrich and Ruef 2006).

Becker (2004) notes that the ostensive aspect of routines might serve not so much as rules which determine behaviour directly, but rather as something akin to a heuristic device (Narduzzo, Rocco and Warglien 2002)⁷. Instead of following rules closely, agents use rules in a manner similar to a ‘quarry’ which provides a system of elements that can be selected, and manipulated according to the presenting situation (Narduzzo, Rocco and Warglien 2002).

This understanding of the rules element of organisational routines has important implications for research methodology, as a cognitive explanation for why something is done requires interviews and focus groups (Pentland 2003a, 2003b; Pentland and Feldman 2005). However, the difficulty with interviews and routines is that there is an inevitable subjectivity involved with those who provide descriptions – as they can only articulate their own perspectives (Becker et al. 2005). Nevertheless

⁷ The notion of a rules being a heuristic device is central to the work of (Cyert and March 1963) and (March and Simon 1993).

interviews and focus groups provide a highly useful way of understanding the abstract rules involved in organisational routines. This is discussed further in the Methodology Chapter which follows.

Performative Element of Routines

The second element of routines is the way the routines are actually carried out in a specific organisation by specific individuals at a particular time (Becker 2004). Feldman (2000, 2003) has shown that routines are not just simply implemented, but instead, individuals can decide how to implement a routine, and whether to amend the routine. Whereas the ostensive constitutes the ‘in principle’ properties of the routine, the performative is the ‘in practice’ list of actions (Latour 1986). This may be akin to what Argyris and Schon (1996, 13) refer to as a ‘theory-in-use’ which is implicit in the way the activity is carried out by the organisation, and which may, or may not, align with the espoused theory within the organisation.

The organisational knowledge embedded in recurrent interaction patterns is procedural knowledge – as they entail understanding how to do something (Becker 2004), and are applied to specific situations (Aldrich and Ruef 2006, 77). Becker (2005b) recently labelled this aspect as the action component of routines, while Reynaud (2005) refers to this as the pragmatic perspective. The ostensive aspect cannot account for every specific instance of the implementation of a routine as there are always contextual factors which can affect how a routine is carried out (Feldman and Pentland 2003). Reynaud (2005) argues simply that rules are explicit forms of organisational knowledge, and recurrent interaction patterns are implicit forms of organisational knowledge.

Such a perspective is important as there is likely to be differences between the espoused theory – or cognitive aspect of routines, and the pragmatic implementation of these routines – theory in use (Pentland 2003a, 2003b; Pentland and Feldman 2005).

In their definition of routines, Feldman and Pentland (2003) argue that each routine has an overarching ‘pattern of action’ which in many cases is relatively unchanging over time, while the enactments of specific parts of the pattern can exhibit considerable variety. Miner, Ciutchta and Gong (2008) put this slightly differently when they argue that a ‘routine’ is short hand for what is in fact nested systems of sub-routines. This means that while the overall pattern of a routine may well stay the same, there are specific sub-sections of the routine, and each of these may exhibit considerable change (Miner, Ciutchta and Gong 2008). This is particularly true as each routine has a repertoire of action, or a set of options which can be chosen for implementation as part of any routine (Feldman 2000). By way of example, a typical hiring routine is demonstrated in Table 2 below.

Table 2 – Demonstrating Variety in organisational routines

Routine	Hiring new staff		
Sub routine	Advertising	Interviewing	Appointing
Performative options	<ul style="list-style-type: none"> • Radio • Newspaper 	<ul style="list-style-type: none"> • Face to Face • Telephone 	<ul style="list-style-type: none"> • Casual • Permanent

In this conceptualisation, the routine is the outcome which is sought to be achieved by an organisation. The sub-routines are the repetitive pattern of action, all of which are normally required to implement a specific routine. For the example of the hiring routine in Table 2, this may include Advertising, Interview and Appointing, as interrelated stages in the overall hiring sequence. Thus as recurrent patterns of action, routines are multilevel phenomena (Vromen 2011, 193).

This finer grained and multilevel analysis will generate considerable insights into the dynamic nature of routines. The other implication for research is that while written procedures and interviews can only capture the ostensive aspect of rules, specific implementation need to either be observed or examined via archival records of procedures implemented (Pentland 2003a, 2003b; Pentland and Feldman 2005). The role of artefacts, such as company records, in organisational routines, are examined next.

Artefacts as elements of routines

Pentland and Feldman (2005) argue that there is another element of routines which are the physical manifestations of the organisational routine – what they term artefacts. Artefacts and other written representations of rules, such as public policies, are often confused with the rules aspect of routines. Consequently, it may be more accurate to describe artefacts as attempts to codify the rules of routines (Pentland and Feldman 2005). Artefacts can include computer hardware and software, forms, websites, workplace design (Narduzzo, Rocco and Warglien 2002) as routine processes are often encoded in these. From this perspective, changes to written government and company policy documents or manuals are simply a permanent attempt to record the changes which have occurred in the routine (Feldman 2000, 623). Recently, Pentland and Feldman (2008) also noted that artefacts can also record the performative aspect of routines through transaction histories or databases. The stability and availability of artefacts in order to study change or variety make them a highly attractive element of the routine to study (Pentland and Feldman 2005).

March and Simon (March and Simon 1993) make an important observation in relation to artefacts and the recurrent interaction pattern itself, although they term these the written operating procedure and the program. They argue that the artefact may have been created for a number of reasons: as an instruction to implement a new routine, as a description of the routine for training staff, or as an exposition of a routine in order to legitimise or formalise it. They go on to note that whatever the intent of the artefact, the purpose for which it was prepared is relevant to its interpretation (March and Simon 1993). Thus it is inadequate to simply examine the content or

change of an artefact – the reason that it was created in the first place is also important. Methodologically, artefacts can be examined through document analysis, observations and databases (Pentland and Feldman 2005). They form an important aspect of research into routines, as they codify rules and provide a record of the performative aspect of routines.

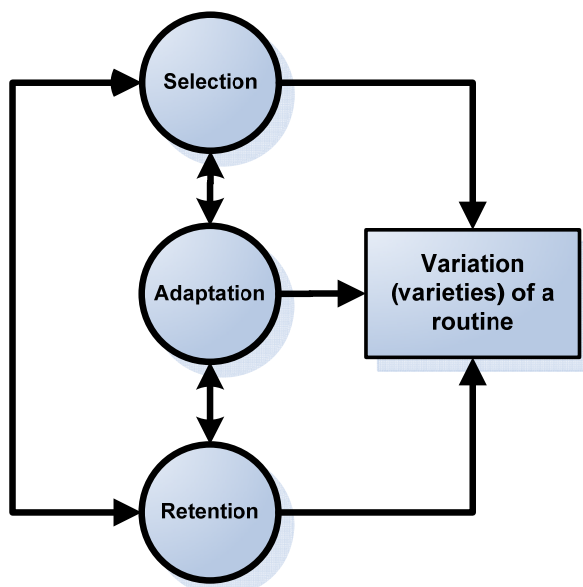
As noted earlier, while the focus of the thesis is on how selection, adaptation and retention affect variety in routines, it is necessary to differentiate between the ostensive and the performative in order to demonstrate variety in routines. Artefacts, however, can be both a record of the performative as well as an attempt to articulate the ostensive element of the routine (Pentland and Feldman 2008).

2.5 THE DYNAMICS WHICH CREATE VARIETY IN ORGANISATIONAL ROUTINES

Having clarified the construct of variation in routines, and how this variety might be measured, it is possible to move on to the processes which create such variation. Pentland (2011) has noted that the dynamic processes which create stability or change in organisational routines are an important topic for empirical research. The question then is to identify a theoretical framework from dynamic change processes in organisational routines can be examined.

Miner, Ciuchta and Gong (2008) have already undertaken a thorough review of the routines literature in relation to selection, retention and variation (what I have termed adaptation in order to separate the process from the outcome). This thesis extends their framework by exploring how selection, adaptation and retention dynamics determine variety in routines, paying attention to both the overarching routine itself, as well as the sub-routines which comprise the routine. The relationship set out in Figure 4 below is discussed in detail in the pages that follow.

Figure 5 – Core research objective – how does selection, adaptation and retention affect variety



Selection, adaptation and retention, and how they are held to create variety are examined in detail in the sections the follow.

2.5.1 SELECTION

As a process, selection is treated in two distinct ways in the literature: as a process of elimination driven by environmental forces (natural selection); and as a process of intentional and deliberate choice by an organisation (Knudsen 2002). While, the deliberate choice view is taken here, however it is important to review the natural selection view first, and explain why it has not been followed.

As noted earlier in this chapter, the dominant approach to understanding selection in routines adopts a ‘natural selection’ approach, which emphasizes the role of the environment in selecting the best option, in a sense which parallels a Darwinian understanding of the survival of the fittest in an ecosystem (Knudsen 2002, 443). In this approach the environment selects out the non-performing routines and ensures that they no longer exist (e.g. Knudsen 2008)⁸, so selection is synonymous with survival in this view. The predominant approach to discussion selection in relation to routines, understands that selection follows the logic of natural selection (e.g. Knudsen 2002; Knudsen 2008)⁹, and much the debate is about whether natural selection is Darwinian or Lamarkian (Aldrich et al. 2008; Hodgson 2001; Hodgson and Knudsen 2006).

While dominant in the evolutionary economics literature, in the organisational theory literature, many other authors argue that the natural selection approach is unhelpful. For example, Aldrich and Pfeffer (1976) note that natural selection is most appropriate at the population level of organisations, rather than at the level of individual organisations.

Further, Morgan (1997) raises a critique concerning the assumption underlying the natural selection approach in general, that organisations are simply at the mercy of their environments. Assuming that selection in organisations literally follows biological natural selection processes would be unhelpful, as there is not just analogy involved but also “disanalogy (sic) between organic and social

⁸ Knudsen (2008) advances a different set of constructs, arguing that the process of selection has three forms: subset selection, diffusion and generative selection, following the work of Price (1995). Each of these can be equated with the constructs advanced here. Subset selection involves the removal or elimination of certain economic activities or entities due to interaction with the environment (what I am terming retention), whereas diffusion involves the adoption of new approaches often through imitation of existing firms (Knudsen 2008), a process I have termed adaptation. Generative selection involves developing and keeping new routines inside an organisation (Knudsen 2008), a process which involves both what I have termed adaptation and retention.

⁹ Knudsen (Freundenburg 1986; 2011; 2002; 2008) also raises the issues of the replicator / interactor distinction in relation to organisational routines. While interesting, these construct will not be pursued here, particularly as the theorists are not at all clear about whether firms, routines or individuals are replicators or interactors.

evolution” (Campbell 1965, 30). The reality of course, is that people “have a large measure of influence and choice over what their world can be” (Morgan 1997, 71), and are not totally at the mercy of the environment, as some authors claim.

Recently Witt (2008) proposed that authors “use formal metaphors for describing organisational change and industrial dynamics. But they refrain from taking a naturalistic perspective on the changes in the economy they explore” (Witt 2008, 15). In other words, for organisational phenomena Darwinian notions of selection, adaptation and retention are heuristic constructs which are useful when examining organisational change, however no ontological assumption is made that change occurs in organisations in literally the same way as in biology (Witt 2008, 29). As Knudsen (2002, 446) notes: “So why should we look for an analogy to biological natural selection in economics? We should not. What we should look for is a sufficiently general selection theory sensitive to the specific processes in the socio-economic arena”. Thus, while notions of selection, adaptation and retention are used as heuristic devices in this thesis, the assumption is **not** made that the manner in which these particular phenomena function in organisational settings is identical to a ‘survival of the fittest’ approach. This is particularly true for the notion of selection, as the mechanism for selection in organisations is quite different from that of selection in natural systems.

It is interesting to note therefore, that while Darwin did predominantly discuss *natural* selection, he does note another form of selection – *artificial* selection undertaken by breeders (Darwin 1937). As Weik (1984b, 176) notes: “To talk about selection in organizations is to reach back beyond Darwin’s *natural selection* and revive the image of *artificial selection*”. While natural selection involves survival of the fittest, artificial selection involves the intentional, deliberate breeding of animals by humans for a particular purpose – such as to enhance a particular trait of the animal (Miles and Huberman 1984b).

Another reason why deliberate selection is preferable to natural selection in organisational settings, is due to the influence of the external environment. While natural selection is all about survival of the fittest in response to environmental changes (Darwin 1937), deliberate selection is quite different. Child (1972) suggested that decision makers in organisations are not overly affected by the external environment as they can make choices about which environment to operate in, can exert influence on that environment, and can make choices on how to respond to the environment. Thus while the environment has some effect, this influence can be softened, and may just be a factor under consideration in the selection process (Miles and Huberman 1984b, 178).

The second perspective in the routines literature is that selection is the choice amongst a set of alternatives by an organisation (Rerup and Feldman 2011). Campbell (1965) specifically argues that selection is rational in organisations – there is a process of deliberate and conscious thought involved in the selection between various alternatives. From a strategic choice perspective (Child

1972), the varieties of a routine are seen as something similar to a 'repertoire of action' (Cohen et al. 1996) which provide different options in routines to choose from. March and Simon (1993, 161) that given certain stimulus, an organisation will have "a repertory of response programs, and programs for selecting an appropriate response from the repertory". Teece and Pisano (1994) specifically argue that organisations exercise choice in which routines to implement, and which to adapt. Thus selection from a range of alternatives, or a repertoire of action, is an established construct in the organisational literature.

An empirical example of selection in routines is provided by Gersick and Hackman (1990) who describe the process of a pre-flight checklist routine. In their case study, the wrong set of choices were made in the configuration of the aircraft, as the pilots were used to warm weather and did not allow for the snow and ice outside, with the result that the aircraft crashed (Gersick and Hackman 1990).

As routines involve "determining what to do" (Nelson and Winter 1982, 400) the issue of being able to choose amongst a range of options is pertinent. Selection is critical to effective organisational change, as there needs to be some mechanism for choosing between varieties (Romanelli 1999). From this perspective, the key issue which follows from this is how organisations exercise choice between these various options. Once choice is allowed for in selection processes, then the issues of volition and agency come to the fore. Knudsen (2002) has noted the importance of agency in the selection process of organisations, as it is clear that for organisations, selective processes do not necessarily rely in the cessation of any individual person, process, or organisation, which is essential for a natural selection view of organisational change. Specifically, Knudsen (2002) argues that tacit knowledge, experience, interaction between staff influence the choices made in relation to organisational routines, just as much as the external environment. Likewise Lazaric and Raybaut (2005) emphasize the role of hierarchy and organisational knowledge in organisational routines. Clearly there is a role for agency affecting the selection of routines by organisations.

As selection involves choice between a set of alternatives, this assumes that there is some heterogeneity to select from in the first place (Van de Ven 1992, 180), as variations provide adequate raw materials for selective systems to operate on" (Campbell 1965, 28). Selection involves the deliberate choice by an organisation from among a set of viable alternatives, in order to ensure the variant of a routine which best meets the situation faced by the organisation is selected and put into practice. As Weick (1984b) notes, this is why selection needs retention.

While retention will be discussed in a later section, it is important to note that in order for selection to be able to function, there needs to be something retained in organisational memory to be selected in the first place (Miles and Huberman 1984b). In other words, the existence of a range of

options in organisational memory, provides the opportunity for organisations to select between the various options in order to great specific varieties of routines at a given point of time.

In order to operationalise this, and using Table 2 as a template, it would be possible to show how selection of different options might create variety in organisational routines (see Table 3 below).

Table 3 – Example of routine varieties created due to selection of different options

Routine	Hiring new staff		
Sub Routine	Advertising	Interviewing	Appointing
Variant 1	Radio	Face to Face	Casual
Variant 2	Newspaper	Telephone	Casual
Variant 3	Newspaper	Face to Face	Permanent

Table 3 provides a good example of how new variants of routine can be created. Each variant involves the selection of a different combination of the various options available in each sub-routine. Each new recombination in effect creates a new variety. This sort of experimentation of combinations of options in each of the sub-routines is an important element of trial and error learning (Nelson and Winter 1982, 131). Variation at this sub level, either in the order or content of the routine, is likely to be an attempt to improve the performance of the routine.

It is evident from these examples that selection may well operate at two different levels. At the sub routine-level there is the selection of options in each sub-routine. However, as Table 3 outlines, at the higher level, the specific pattern of sub-routines selected is also in a sense selected by the organisation.

Selection and Satisficing

There is a difference, however, between trying to find a procedure which performs adequately, and one which is perfect (March and Simon 1993). March and Simon (1993, 161) provide a useful comparison of the difference between optimal search and satisfactory selection from alternatives.

“An alternative is optimal if:

1. There exists a set of criteria that permits all alternatives to be compared and
2. The alternative in question is preferred, by these criteria, to all other alternatives

An alternative is satisfactory if:

1. There exists a set of criteria that describes minimally satisfactory alternatives, and
2. The alternative in question meets or exceeds these criteria”.

The difference between these two is quite stark, as to optimise requires a much higher degree of complexity than does satisficing (March and Simon 1993, 162). As Alchian (1950) argued, the real

issue is that a set of options are attempted, for it is from these trials that success can be determined. In other words, from a large number of attempts at different combinations, an organisation is likely to find a specific combination of options which ‘works’ adequately. While various metrics may be used, ‘success’ in organisational procurement is, in the end, a subjective assessment by an organisation (Miller 1999). Emirbayer and Mische (1998) underscore the importance of the intentionality of selection of schemas of action. The selection of routines is thus based on anticipated outcomes from a particular combination of elements of a specific routine.

Thus organisations choose to act in a specific situation from a repertoire of existing routines (Levinthal and Rerup 2006; Miller 1999; Romanelli 1999). March and Olsen (1998) distinguish between a logic of consequences – the anticipated outcomes from a decision, from the logic of appropriateness, which is more about whether a particular action is consistent with an organisation’s identity. The central logic for selection is that in a particular situation, organisations choose between a number of alternatives as one alternative would appear to be more attractive than others (March and Simon 1993), thus following a logic of appropriateness.

The selection of routines is thus drawn from an anticipated set of outcomes from a particular combination of elements of a routine, based on expertise and experience. This conceptualisation of selection as the choice amongst alternatives, explicitly allows for the role of organisations to have volition.

In summary, organisations exercise choice in how they enact their routines. These may be driven partly by organisational history, organisational learning, or environmental conditions (March 2008c; March and Simon 1993, 8). Indeed, organisational history may make such choices path dependent. Whatever their source, organisations can and do select specific ways of undertaking specific outcomes. Selection between various options for doing things (choice), implicitly suggests that there is a variety of options available to choose from.

In summary, while the notion of selection is drawn from a biological metaphors, natural selection in the Darwinian sense is cannot assumed at an organisational level. Instead the phenomena is closer to artificial selection, as human agency is clearly involved in the decision making process, following a logic of appropriateness. Thus, while the current literature readily acknowledges that deliberate selection requires variety (Campbell 1965, 28; Van de Ven 1992, 180), how selection might affect variety is far less well developed, as the predominant view is the natural selection approach. Consequently, research which examines how selection creates variety in routines is needed. This can be articulated in the form of the following research question:

- ▶ **Research Question 2: How does selection affect variety in organisational routines?**

Having discussed selection, the second dynamic process in routines to be examined is that of adaptation.

2.5.2 ADAPTATION

As noted earlier, seminal authors have referred to both the existence of a number of varieties of organisational processes, which they distinguish from dynamics which produce such variation (c.f. Campbell 1965). Whereas selection involves choosing from amongst a set of alternatives, adaptation involves the generation of new alternatives. Specifically, adaptation involves either change in a specific process over time (e.g. Feldman 2000, 2003)¹⁰, or the generation of distinctly new ways of operating – a process of “deliberate experimentation” (Winter 1975, 102), or the “accumulated wisdom that results from a series of experiments over time” (Knudsen 2002, 453)

It is important to note here that some of the older routines literature suggests that there were in fact two types of routines – mindless routines, which are static, and dynamic routines, which adapt and change (e.g. Dosi et al. 1997; Reynaud 1996). While this notion of two types of routines is occasionally mentioned in more recent publications (Reynaud 2005), the work of Pentland and Feldman (Feldman 2000, 2003; Feldman and Pentland 2003; Feldman and Rafaeli 2002; 2005) has shown that routines themselves are inherently dynamic and adaptable. While some routines do not change significantly over a long period of time and are seen as a source of stability, every routine has capacity to change and adapt (Feldman 2000, 2003; Pentland and Feldman 2008).

Adaptation of routines in response to performance

Knudsen (2008, 141)¹¹ has argued:

“When current solutions do not appear to suit its purpose any longer, the firm engages in risky search for new ways of doing things. Thus, negative feedback induces a process where existing routines are adapted or even replaced”

¹⁰ Pentland and Feldman (2008) have also referred to adaptation as diachronic variation – change over time. In keeping with the distinction drawn in this thesis between the process of creation variations (which I have termed adaptation) and the result of such adaptive processes (variants) I will not follow their terminology here

¹¹ Knudsen (2008) refers to the creation of new routines as generative selection, following Price (1995).

As suggested in the previous quote, a key driver for change in routines is experience – if a routine succeeds in achieving a target it is likely to be used again, and less likely to be used if it fails (Cohendet and Llerena 2003, 275). Campbell (1965, 30) refers to this as the pleasure-pain response. Unfortunately, a positive experience with an inferior routine can encourage organisations to increase their experience with that routine, at the expense of experience with novel routines which may have superior performance (Becker 2004; Levitt and March 1988). In other words experience on its own is insufficient for learning. Experience needs to be coupled with a perception that current performance is inadequate before a search is made for new ways of operating. March and Simon (1993) provide further insight by arguing that the amount of search involved decreases as satisfaction increases, suggesting there is an inverse relationship between satisfaction and search for new ways of doing things.

Thus adaptation in organisations is a deliberative process which requires intentional responses to performance. Witt (2008) calls this the neo-Schumpeterian approach to organisational evolution as it allows for intrinsic innovation. The adaptive search for new ways of undertaking processes follows from a lack of satisfaction with current situations (1993; 2002). While poor performance is often cited as the reason for adaptation in routines, Feldman (2000) argues that incremental change actually occurs for a broader range of reasons. These include: the actions do not produce the anticipated outcomes, actions produce new problems that need to be solved, actions can result in new opportunities or resources, or actions produce the intended outcome, but further improvements are still possible (Feldman 2000, 620).

While it is true that Campbell refers to ‘blind variation’, Bradie (2001) takes ‘blind variation’ in Campbell’s model to mean that there is no *a priori* ability to accurately predict the outcome of a variation. Thus all innovation is, in some sense, blind as learning and experience may lead to some general notion of the outcome, but constraints on knowledge (e.g. bounded rationality (Simon 1991)) mean that there is no certain “prescience” (Bradie 2001, 41) about the outcome of a specific adaptive attempt. Put simply, the outcome of a new adaption cannot be known in advance of its implementation (Romanelli 1999). Thus adaptation is a deliberate process, prompted by the perception that existing performance of routines are inadequate. While the outcome of adaptive processes cannot be known for sure in advance, the intent of adaptation is to improve the performance of routines (Nelson and Winter 1982).

Campbell (1965) notes that there is an important difference between organisational entities and biological entities when it comes to adaptation – individuals, processes, and sections of organisations can be modified, removed or added on an individual basis, and thus does not require the extinction of individual entities involved. For organisational routines, the primary purpose of adaptation is to improve the performance of routines, and typically involves the modification of sub-routines (Nelson and Winter 1982, 130-131). Thus as selection involves choice from amongst a set of alternatives,

adaptation involves the creation of new alternatives for the sub-routines. This is where adaptation is different from selection. While selection creates new variants through the recombination of existing options, adaptation involves the creation of new sub-routine options.

However, in order for new options to be explored the old routine needs to be viewed as being deficient, and the cost of change worth the effort required to attempt new options (March and Simon 1993). In other words, some drivers are needed to induce an organisation to bring about change in processes. These internal and external drivers of change in organisational routines are examined below.

Using Table 2 again as a reference, if adaptation involves the creation of new alternatives, then this would mean the introduction of new options into the repertoire of routines (see Table 4 below).

Table 4 – Example of how adaptation increases variety due to the increase in different options for selection

Routine	Hiring		
Sub Routine	Advertising	Interviewing	Appointing
Existing repertoire of performative options	<ul style="list-style-type: none"> • Radio • Newspaper 	<ul style="list-style-type: none"> • Face to Face 	<ul style="list-style-type: none"> • Permanent • Casual
New options introduced through adaptation	<ul style="list-style-type: none"> • Web Advertising 	<ul style="list-style-type: none"> • Teleconference • Video Conference 	<ul style="list-style-type: none"> • Fixed Term

When one of these new options is selected for implementation, along with existing options, then a new variant of the routine has been implemented. For example, is a new option available for use in a particular sub-routine (such as video conferencing when conducting hiring interviews for example). If this new option is used in conjunction with an existing option from each of the other two sub-routines, then a new variant of the routine has been implemented. Thus adaptation increases variety in routine by providing new options which are available for selection. For the working example of the hiring routine, this might involve adding the option of permanent part time work as an employment option.

Exogenous and Endogenous drivers of adaptation in routines

Campbell (1965, 22) argues that in biology there are two streams of thought concerning adaptation: that which results from dynamics internal to the organism independent of environmental forces and natural selection which is almost entirely due to environmental forces. In organisational theory generally, and routines literature specifically, this duality is also understood with change being seen as driven by forces outside the organisation (exogenous) and from within the organisation (endogenous) (Feldman 2000; Feldman and Pentland 2003). These sources and specific drivers of change are discussed below.

Exogenous forces for change in routines

From this perspective, factors in the business environment – including legislative changes, market forces and new technologies (Feldman and Pentland 2003) – are seen to drive changes in routines. Changing public policy requires organisations to amend their behaviour, or at least appear to amend their behaviour, in order to avoid fines, and prosecution. A change in technology leads to new ways of operating – witness the impact the internet has had upon business practices. Market forces, such as competition, or lack of competition, can drive change in an organisation resulting in increased or decreased pressure for efficiency. A key role of management is to respond to the external environment adapting organisational skills and resources including routines (Teece, Pisano and Shuen 1997). March and Simon (1993, 205) note that this stress for change though, can occur in different strengths – too little and the resultant apathy will provide no motivation; whereas too much stress can lead to frustration, desperation or ‘neurotic’ reactions. Successful change occurs when the desired goal is a small way ahead of the organisation (March and Simon 1993, 205).

Endogenous forces for change in routines

March and Simon (1993) note that even in a steady state in the environment, there tends to be a continuous pressure towards innovation and change in routines. Partly this may be due to organisations adjusting their measures of success over time (March and Olsen 1984). As Miller (1999) argues, success is essentially subjective. If the means for measuring success changes within the organisation, this may lead to changes to the routine itself. As changes can be due to perception that extant routines are not performing, organisations can also shift the boundaries of performance, and what might have once been acceptable previously is no longer deemed sufficient.

A number of processes of adaptation in routines are noted in the evolutionary economics literature (Becker, Knudsen and March 2006): Incremental changes in existing routines on the basis of experience, imitation of routines implemented by other firms, and the generation of new distinctively novel routines. Because of their fundamental importance, and different processes for adaptation, these are discussed in detail below.

Adaptation through incremental change

Adaptation of routines is often incremental as only one element is changed at a time, such as the rhythm, or the participants (Feldman 2000, 2003). Incremental change of routines are not exceptions to the rule, but rather an essential characteristic of the dynamic nature of routines (Becker 2004). Adaptation in this sense is the addition, or the replacement, of a existing sub-routine option with a new sub-routine option (Nelson and Winter 1982, 130-131).

According to Cohendet and Llerena (2003) a routine can be altered by a range of learning processes. Routines change in response to experience – if a routine succeeds in achieving a target it is likely to be used again, and less likely to be used if it fails (Cohendet and Llerena 2003, 275).

Adaptation through Imitation

An alternative to incremental improvement is the purposive search for new ways of doing things external to an organisation (Radner 1986). In other words, while organisations learn by doing – they can also learn from others (Argote 2003; Romanelli 1999). Imitation involves attempting to copy the processes of organisations which appear to be successful (March 2008b), which can result in isomorphism (DiMaggio and Powell 1983) between firms. DiMaggio and Powell (1983) argue that isomorphism can be coercive, for example due to changes in legislation; mimetic, as organisations imitate the behaviour of other organisations; and normative, as professional associations establish patterns and norms of acceptable behaviour. At other times, organisations can attempt to imitate another organisation's routine, if they believe that the other routine is functioning better than the existing one (Nelson and Winter 1997).

Campbell (1965) argued that there would not be opportunity for deliberate imitation of routine implemented by other organisations, as an organisation would not be able to determine whether or not in advance the alternative routine would provide better outcomes than those which are currently implemented. Romanelli (1999) gives an extensive treatment of imitation in the context of evolutionary models of organisational change, arguing that while not everything is knowable in advance, there is opportunity for some information to be available for an organisation which may lead it to conclude that the alternative way of undertaking a routine may be superior.

Thus organisations often attempt to imitate the processes of organisations that are seen to be functioning better than their own (March and Simon 1993). However, the imitation of another organisation's processes are quite difficult (Teece and Pisano 1994), as the difference between an essential component of the routine which can be applied anywhere, and those which are peripheral, are difficult to discern for an outside observer (Becker 2004). Thus imitation is quite difficult as organisations cannot exactly copy the other firms routine as they do not have exact details of every issue involved in the implementation of the routine (Nelson and Winter 1997). Once difficulties emerge with an imitated routine, subsequent incremental adaptation is necessary.

Adaptation and agency

It should be apparent that, as with selection processes of routines, adaptation processes in routines involve agency. Campbell (1965, 28) specifically acknowledged that adaptation could be either of the 'blind' variety – developed without conscious choice, as well as the results of deliberate decision making processes. In his later work Campbell (1974) explains that the 'blind' aspect did not imply a purely ecological or non-rational approach to decision making, but rather that some adaptation

happens by chance – through mistakes and happenstance. Thus the distinction is not between thoughtful and thoughtless adaptation, but rather between deliberate and accidental learning (Levinthal and Rerup 2006).

While both blind adaptation and intentional adaptation are acknowledged in the literature (Miner, Ciuchta and Gong 2008), it is this deliberative and intentional aspect of routine adaptation which sets it apart from biological adaptation and underscores caution in the use of biological metaphors. As Winter (1975, 102) argued: “A slavish pursuit of the biological analogy would be counterproductive, for it is quite clear that the bulk of what we count as interesting long-term change in business behaviour is not the product of blind chance. Rather, it is deliberate innovation”. The key issue is that human intelligence enables intentional change to systems, rather than blind chance (Witt 2008). Agents may identify a better solution, make a mistake, or be forced to change due to regulatory changes (Romanelli 1999). However it happens, agents are involved in bringing about change to organisational routines.

Major innovations involve a small chance of a significant improvement and a large chance of mediocre performance (March 2008b). Denrell and March (2008) point out that this issue relates to a sequential sampling error. When a new sub-routine is introduced and performs well, it is likely to be selected again, and errors fixed. However, if a sub-routine is introduced, and does not perform well, it is unlikely to be chosen again, and therefore there is risk aversion inherent in organisational adaptation (Denrell and March 2008).

This reinforces an important aspect of evolutionary theory which needs to be clarified – evolution in organisations does not equal inevitable progress. There are backward leaps and evolutionary lock-ins which result in decreased performance over time. As March (2008b) notes, adaptation and learning in organisations may well result in the propagation of numerous new ideas but it also results in a number of bad ideas. This is one key reason why slow incremental adaptation is better than large scale adaptation (March 2008b, 115), such as the replacement of all of the options in all of the sub routines at once.

In summary, while selection involves choice amongst alternatives, adaptation involves the generation of new alternatives, and is thus concerned primarily with change processes. Internal and external forces can drive change in organisations, and adaptation requires that there is dissatisfaction with the performance of an existing routine. However, organisations always have choice in the way that they can respond to such changes, including the process of change itself.

Thus there has been considerable work done on adaptation in organisations in general, and in organisational routines in particular. However, much of the current empirical literature focuses on the creation of new options which replace the older ways of doing things. In other words, adaptation has been shown to change an existing routine, rather than result in an increase in the number of

varieties of routines. While this creates variety over time (corresponding to Type II in Figure 4) it is less clear how adaptation creates concurrent variety, or how adaptation interacts with selection and retention to create increased number of varieties of routines. As this thesis is exploring the dynamic inter-relationship between selection adaptation and retention and how they act individually and in concert to create variety in organisational routines, it is important to examine the role that adaptation plays in the creation of variety. This suggests the following research question:

► **Research Question 3: How does adaptation affect variety in organisational routines?**

Routines are held to adapt and change over time. Such adaptive processes increase variation through the introduction of new options which can be selected for implementation, thus creating new varieties. However, the picture is incomplete without considering the dynamic of retention in organisational routines, which is covered in the next section.

2.5.3 RETENTION

The final dynamic involved in routines is the selective retention of variants (Feldman and Pentland 2003, 113). Put simply, retention is the ability to recall (Miles and Huberman 1984b). Like adaptation, retention involves evaluation of the performance of a routine. The retention process “is based on individual pleasure-pain memory systems. While it involves individual learning, it can provide for the selective retention of inter-personal arrangements or social system features” (Campbell 1965, 30). Retention involves the collective experience of individuals involved in the routine being embedded in ‘supra-individual routines’ (Argote 2003, 356). Thus routines act as a repository of organisational knowledge on how to do certain things (Argote 2003), and demonstrate remarkable persistence over time (Argote 1999).

In a natural selection approach, retention is not discussed, as it is subsumed within the selection processes, as the environment selects out the nonperforming organisms, retaining only those which can perform adequately (Knudsen 2002). Once selection is defined as choice, another mechanism is needed in order to provide the raw materials on which selection (choice) can operate (Miles and Huberman 1984b).

In a general sense, retention is the opposite of adaptation, as this leads to considerable organisational stability, as retention involves keeping routines in organisational memory (Miles and Huberman 1984b). However, unlike adaptation, the evaluation does not result in the generation of new routines or sub routines, but rather the decision about whether or not to keep, or retain, existing routines. As Teece and Pisano (1994) state, “routines are patterns of interactions that represent successful solutions to particular problems”. As noted in the section on selection, retention provides the raw material from which different options are selected in the first place.

These notions of retention and its relationship to organisational memory, and evaluation of performance are discussed in greater detail below.

Retention as organisational memory

It is important to emphasise the relationship between adaptation and retention raised in the previous paragraphs. For example, Feldman (2000, 2003) examined changes in specific routines over time. While there was adaptation in these routines from a longitudinal perspective, from a cross-sectional perspective there was only one routine in existence at any given point of time. For adaptation to result in a change in the number of varieties of a specific routine, previous routines need to be retained in organisational memory. Put simply, adaptation without retention will simply result in qualitative change to the existing stock of routines (Type II of Figure 4). However, adaptation with retention of the new varieties of routine will result in the increase in the number of varieties of a specific routine. This is because adaptation increases the stock of routines and retention maintains the existing routines as well.

Like selection, retention is essential for organisational change. This is because if there is no way for an organisation to keep (or retain) variations which are effective at delivering outcomes, there can be no way for improvement (Romanelli 1999). Indeed without the retention of useful variants and non-retention of less useful variants, the result is randomness (Romanelli 1999).

Additionally, while related to adaptation, retention is also closely related to selection processes. Once a routine has been chosen from amongst a set of options, there needs to be some way that the routine is stored in organisational memory – and therefore retained for future selection and use (Campbell 1965). In other words, selection only occurs amongst those routines which have been retained by an organisation.

Path dependence

Conversely, once a routine has been in place for a period of time, there can be considerable resistance to doing something differently due to ‘path dependence’ of the routine (Becker 2004). As change can involve issues of power, group norms, and historical preferences to undertake tasks in a certain way (Gersick and Hackman 1990); these may all act to limit or inhibit change. Alternatively, some actors are unaware of the existence of the routines, as they have become completely entrenched in organisational memory and patterns of behaviour (Cohen and Bacdayan 1994). Against this, Vergne and Durand (2011) note that path dependence as an impediment to change only holds, if the ability of actors in organisations to respond dynamically with their environment is ignored, or not acted upon. In short, if there is a higher order evolutionary process at work which involves evaluation of existing routines, and adaption of processes which are no longer suitable, then path dependence is less of an issue (Vergne and Durand 2011).

Likewise, routines embedded in organisational elements which have strong cohesion will be harder to change than those operated by new project teams (Cohendet and Llerena 2003, 280). Gersick and Hackman (1990) also argue that the more central the routine is to the organisation, and the more embedded the routine is within the organisation, the more resistant to change the routine will be, a point also found by Howard-Grenville (2005). Nelson and Winter (1982) also argue that routines forged amidst organisational conflict can take the form of an organisational truce, in order to get something done. To change the routine is tantamount to renegotiating the truce between organisational divisions which may be considerably difficult (Nelson and Winter 1982). In other words, while retention is important to ensure adequately performing routines are stored in organisational memory, overly strong retention mechanisms can in fact inhibit adaptation.

Routines as success

Thus, the replication or retention of routines over time is predicated by at least the perception that they are 'successful' in achieving outcomes for a firm. In other words, for the identification of 'successful' variants, failures are needed (Romanelli 1999, 84). In the event that an organisation settles on a single 'successful' variant of a routine as the only one it will implement, this variant of the routine would become stable and would not change (Type I – Stable in the Typology advanced in Figure 4).

Hedberg (1981) notes that difficulties in changing a routine can be due to the success that the routine has had historically. Sometimes the organisational memory of a successful response by a routine can lead an organisation to expect similar success – even when the circumstances have changed. Repeated perceived successes with a routine can lead to a certain organisational inertia towards change (Miller 1999). Weick (1984b) terms this crediting – as the routine retains its credibility in the organisation. Where a particular process has particularly strong 'buy in' from organisational members, this can result in considerable resistance to change, even in the face of evidence that the routines are not performing (Denrell and March 2008). It is in such situations that March and Olsen (1976) argue organisations should treat their memories as enemies.

Similarly Argyris (1990) has noted that organisations can inhibit change by refusing to accept that current processes are inadequate – what he terms defensive routines. By refusing to acknowledge that change is needed, organisations can inhibit learning, by either pretending that everything is functioning well, or ignoring evidence that things are not going well. Here retention inhibits adaptation through positive reinforcement of the existing routine(s) (Miles and Huberman 1984b).

Routines as sampling error

March (2008b) also argues that a number of factors inhibit adaptation in organisations. A key factor for this is that action which involves a new technology or idea takes time to achieve its potential

(March 2008b). Given short time frames typical in organisations, innovative ideas that do not improve performance immediately may not be repeated, and thus cannot demonstrate their potential, although the opposite may also be the case. Where a routine is not practiced regularly, this is less likely to be repeated as the tendency is to repeat what is known (Nelson and Winter 2002). Departures from existing routines involve considerable risk as they may or may not result in improved performance – consequently novelty in and of itself is an inhibitor of learning.

Retention and forgetting

Not all routines are remembered however. Sometimes organisations forget their routines – either deliberately or by accident (Argote 1999; Hedberg 1981). Indeed, in order to identify a routine that works, often an organisation will attempt a large number of different configurations of a routine, many of which will be failures (Romanelli 1999). Once a routine is seen as a failure, the routine becomes discredited, as the previously valued activity loses credibility through poor performance, Weick (1984b, 225). Once discredited, a routine can be deliberately forgotten. This involves a determination that a particular variant of a routine had not performed adequately, and thus the particular variant of a routine is removed from the repertoire - that is the knowledge on how to perform a particular routine is discarded (Thompson 1967).

Thus forgetting routines which do not function adequately is important for organisations. . Otherwise, non-performing routines would be maintained in organisational memory for use by the organisation, even though they had been discredited as they were determined to not work properly.

The relationship between retention and forgetting is important to discuss further, as some authors have interpreted this process as part of selection. For example Romanelli (1999) argues that selection is a choosing device which eliminates less well performing variations, which is a reflection of the biological view of selection which is not being followed here. In his later work, Campbell (1974) refined his terminology of selection by referring to 'selective retention' – in other words, organisations exercise choice in the routines they have retained. Retention is indeed selective, and those poorly performing routines are eliminated from an organisation's repertoire, while those which are retained are perceived to be successful (Teece and Pisano 1994). However, the focus in the retention dynamic process is not on choice for implementation, but evaluation resulting in retention or loss, hence the allocation of this function to the retention dynamic. In other words organisational memory does not just function as a retention device. There is a process by which there is an evaluation about the relative success of a routine and whether or not it should be retained.

Eliminating poor performing routines is important. If the dynamic of adaptation was the only one active, then the repertoire of routines would simply keep increasing (Romanelli 1999). There needs to be a mechanism for the reduction in the number of routines – which is achieved through the

retention process. Successful routines are retained and unsuccessful routines are forgotten by an organisation. Again the example of hiring routines may well make this clearer (see Table 5 below).

Table 5 – Demonstrating variety in organisational routines

Sub Routine	Time Period 1	Time Period 2	Time Period 3
Advertising	<ul style="list-style-type: none"> • Radio • Newspaper 	<ul style="list-style-type: none"> • Radio • Newspaper • World Wide Web • Recruitment Agent 	<ul style="list-style-type: none"> • Radio • Newspaper • World Wide Web • Recruitment Agent
Interviewing	<ul style="list-style-type: none"> • Face to Face • Telephone 	<ul style="list-style-type: none"> • Face to Face • Telephone • Video conference 	<ul style="list-style-type: none"> • Face to Face • Telephone • Video conference
Appointing	<ul style="list-style-type: none"> • Casual • Permanent 	<ul style="list-style-type: none"> • Casual • Permanent • Fixed-Term 	<ul style="list-style-type: none"> • Casual • Permanent • Fixed-Term

As Table 5 suggests a number of new options were introduced in Time Period 2: for Advertising the innovation was using the world wide web, and a recruitment agent; for Interviewing this was a video conference; and for appointing this was the use of fixed term appointments. The focus in retention is not on how or why a new option was introduced, but rather whether the new option was retained in practice. Looking at Time Period Three in Table 5 (the far right column) a number of options introduced in Time Period 2 have not been used again. Thus, through experience an evaluation process is undertaken by organisations in order to evaluate the credibility of organisational routines. In this example, video conferencing was introduced in Time Period 2 and due to positive experiences, was retained; in Weick’s (1984b) terminology, it retained its credibility inside the organisation. However the recruitment agent and casual appointments were no longer available for selection, as they had been reviewed and found to not achieve the outcomes that the organisation had been expecting; in Weick’s (1969) terminology – they had become discredited as valid selections inside the organisation and ‘forgotten’.

Thus, some options have been retained and used again, and others were not used again. It is possible, of course, that certain options were only used for specific cases, such as a recruitment agency for a specific type of employee. In such cases there is a difference between forgetting and not using an option. This is explored in the next section.

Forgetting routines as opposed to ‘not using’ a routine

There is another possibility to forgetting however. This can be seen by making the important distinction between ‘forgetting’ and ‘not using’. Forgetting means that a routine is discarded from the repertoire with no intention to use again. However, it is possible to store organisational routines in organisational memory and not use them for a period of time. Such routines are not forgotten, they are simply retained and not selected for a period of time. As Argote (1999, 92) argues: “so

rather than “forget” a routine used in the past, it would be preferable to remember the routine, the conditions under which it worked and why it is no longer successful”.

Thus, routines can be remembered and not used by an organisation – which is still retention. The difference here is simply that the appropriate solution has not been used. Indeed if a gap in time could be found between first and second use of a routine, this may provide evidence that the routine has been retained in organisational memory.

Thus the notion of retention involves organisations making decisions about the suitability (or not) of particular routines and so retaining the routine in organisational memory.

► **Research Question 4: How does retention affect variety in organisational routines?**

Thus retention has the potential to increase the variety of routines which are available to an organisation. As organisations search for better ways of doing things, or for a variety of ways of achieving specific outcomes in response to specific external environments, retention keeps those options ‘alive’ in corporate memory as options to choose from, provided that there was a perception that such options were viable. When a new variant of a routine is generated, provided this variant is seen to perform adequately, the new variant is also retained in organisational memory and thus increases the stock of available routines for selection. However, strong retention mechanisms can also inhibit adaptation. Thus adaptation and retention has the potential to increase the variety of routines which are available to an organisation.

2.6 SUMMARY

As can be seen from the above overview, there are a number of inter-related dynamics involved in routines. These are set out in Table 6 below:

Table 6 – Summary of central constructs in this thesis

Construct	Definition / Description
Routines	A repetitive interaction pattern, comprised of sub-routines, which achieves a specific outcome for an organisation
Sub-Routine	A specific element of the overall pattern of the routine
Option	Each sub-routine has a number of different options which can be selected for implementation
Varieties of routine	The total number of different concurrent combinations of sub-routines
Selection	The choice of a specific set of sub-routine options for implementation in a particular situation
Adaptation	The creation of new sub-routine options for selection
Retention	The process by which existing varieties are retained in organisational memory

There is a dynamic relationship between selection, adaptation and retention and each has an effect on variety. These relationships can be summarised:

- Selection presupposes variety in order to be able to make a choice
- Routines are selected from the available retained portfolio of routines
- Based on negative feedback on a routine, an organisation will seek to adapt the routine and improve its performance – either by introducing a new option for selection, or changing an existing option
- Retention involves deciding whether to retain a specific variety of a routine for future use
- When a routine is adapted, and the previous routine is also retained in the repertoire for future use, the number of varieties increases

Routines are generative systems (Rerup and Feldman 2011), and it is the interaction between the ostensive and performative aspects of the routine which drives stability and change. Thus at T=0 there is a specific repertoire (options) of sub-routines available for selection. A specific variant of the routine is selected for implementation. After implementation, there is an evaluation of process of how the variant of the routine has been implemented. This then results in either adaptation – change of the variant of the routine, or retention of the variant of the routine. Note there can be positive retention (keeping of the variant of the routine), or negative retention (forgetting of the variant of the routine). Creation of a new sub-routine option through adaptation and retention of all previous routines, will increase the variety in the repertoire of sub-routine options available. Creation of a new sub-routine option without remembering the previous version of a sub routine option, will maintain the number of sub-routines. Likewise, retention, without adaptation, will maintain the number of sub-routine options.

2.7 CONCLUSION

This theory chapter has set out to identify a theoretical gap in the literature to which this thesis can make a significant contribution. Specifically the intent is to examine how selection, adaptation and retention creates variety in organisational routines.

Thus the research seeks to undertake an analysis into the dynamic nature of routines. Whereas previous research has tended to focus on either adaptation (change) of routines over time or the existence of variety in routines, this research will focus on how selection, adaptation and retention creates variety over time.

In order to explore this, the theory section identified four main types of variety in current empirical studies of organisational routines: Type I = Stability (High Stability and Low Heterogeneity); Type II = Adaptive (Low Stability, but Low Heterogeneity); Type III = Diversity (High Heterogeneity and High Stability); and Type IV = Dynamic (with High Heterogeneity and Low Stability).

Thus in order to determine how selection adaptation and retention might affect variety, the first task is to identify the type of variety extant in organisation routines, as different researchers have found different sorts of variety previously. As part of this process, the multi-level nature of routines needs to be determined – both the sub-routines which make up the overarching pattern of the routine, together with the options which can be selected as part of each sub-routine.

Once the type of variety has been determined, then examination of how selection, adaptation and retention might affect variety needs to be examined. This involves examining which combination of sub-routines is selected. Different combinations of sub-routines will result in different varieties of routines. Likewise the creation of new options for selection through the adaptation process is likely to result in new varieties, as the new option would be combined with existing options to create a new variety of the routine. And lastly, the retention of existing and new routines over time will also influence variety, as the number of routines cumulatively remembered and forgotten over time will impact on the number of varieties of routines.

The methodology of how these questions have been empirically examined is outlined in the chapter which follows.

CHAPTER THREE

3) METHODOLOGY

In Chapter 2, a number of important research questions were advanced in relation to how selection-adaptation-retention might create variety in organisational routines. These were:

- ▶ **Research Question 1: What sort of variety exists in organisational routines?**
- ▶ **Research Question 2: How does selection affect variety in organisational routines?**
- ▶ **Research Question 3: How does adaptation affect variety in organisational routines?**
- ▶ **Research Question 4: How does retention affect variety in organisational routines?**

As outlined in Chapter Two, empirical research into variation in routines has tended to focus either on sequential variation over time (e.g. Feldman 2000, 2003) or on concurrent variety (Levitt and March 1988; Pentland 2003a, 2003b) of routines. This thesis examines both of these aspects of variation – seeking to undertake a longitudinal analysis of variety, along with the selection, adaptation and retention process which is evident in each of these time periods.

The remainder of this chapter elaborates the philosophical considerations, overarching research strategy, design and data collection methodologies used to examine the research questions advanced in Chapter Two. Research Ethics clearance was obtained from QUT for the conduct of the thesis: QUT Ethics # 0900000951.

3.1 PHILOSOPHICAL CONSIDERATIONS

It is important to note the philosophical stance from which the research has been undertaken. While researchers are asked to posit their research as being either qualitative or quantitative, with the commensurate assumptions concerning epistemology and ontology, sometimes the opposite can also occur. Under these conditions, philosophical considerations can drive the methodology. As this thesis involves both qualitative and quantitative at the same time, this poses a conundrum. Indeed some people have argued that mixed methods research is impossible due to the incommensurability of the epistemological assumptions underpinning various methods (Bryman 2009).

As the goal is to describe, explain and understand better the dynamic processes involved in routines, the research would fit within an interpretivist paradigm (Gioia 1999). However, the correlations involved in the secondary data analysis would suggest a more positivistic approach (Tabachnick and Fidell 2007). Such dilemmas are common in mixed methods research, which has led some authors to argue that mixed methods research should be essentially pragmatic in its focus (Creswell and Plano Clark 2007; Morgan 2007). Pragmatism is concerned with clarity of thinking and practical application of research (Peirce 1878), which can enable the resolution of previously intractable problems (Peirce 1878), and is concerned with seeking the empirical and practical consequences of ideas (Dewey 1948). In short pragmatism seeks to better understand real world phenomena (Johnson and Onwuegbuzie 2004), and is not wedded to a particular data collection methodology. In the end, as Miles and Huberman (Miles and Huberman 1984a, 21) note: “epistemological purity doesn’t get research done”.

Following the advice of Tashakkori and Teddie (2003) a pragmatist approach was undertaken in this research, as the benefits of being able to use multiple data collection methods to triangulate findings and undertake longitudinal analysis, are significant issues in this research. Additionally, a pragmatic approach allows for multiple levels of analysis, and for both empirical and descriptive precision (Onwuegbuzie and Leech 2005).

Greene et al. (1989) in contrast, advanced a number of reasons for the combination of qualitative and quantitative data, each of which were used in this study and are discussed in the sections which follow:

- Triangulation – there can be corroboration of results from different methods
- Complementarity – results from one data source can clarify the results from another source
- Development – results for one method help develop or inform the other method
- Initiation – results from one source can contradict the results from another method which leads to additional exploration, analysis and theory development

3.2 OVERARCHING APPROACH AND STRATEGY – CASE STUDIES

As noted in the preceding chapters, the number of empirical studies of routines is quite small, and the empirical contexts somewhat different. For example, researchers have studied a single routine in a single organisation (Howard-Grenville 2005); a single routine, across multiple divisions of a company (Pentland 2003b); a number of routines within in the same organisation (Feldman 2000, 2003), and a single routine across multiple organisations (Pentland and Rueter 1994). These are summarised in Table 6 below.

Table 7 – Examples of the number of routines and number of cases

	Single Routine	Multiple Routines
Single Company	Howard-Grenville (2005)	Feldman (2000, 2003)
Multiple Divisions (single Company)	None known	None Known
Multiple Organisations	Pentland (2003)	None known

The focus of the study is on how selection adaptation and retention creates variety in organisational routines. What is currently lacking in terms of empirical examination is to examine the single routine across multiple divisions of the same organisation. Thus in terms of research intent, a project which examined routines in this context provides additional empirical evidence on routines, as well as expanding the contexts in which they are examined.

As noted in Chapter Two there is a dearth of existing empirical work undertaken in the area of routines (Becker 2004, 2005a). In such cases exploratory research using case study methodology is seen to be appropriate (Babbie 2004, 87-88) as a series of case studies can develop the application of theory to an area (Eisenhardt 2002), and test the applicability of that theory for utility in explaining specific phenomena. As a set of research questions drawn from the literature has been developed in Chapter Two, the applicability and utility of this theoretical framework can be tested through a series of case studies (Eisenhardt 2002). Theory testing undertaken here is appropriate as the theory is tested in a real life setting (Thomas 2004). Thus, as a strategy, case studies provided the overarching framework in which to conduct exploratory and explanatory research into the creation of variety in organisational routines.

3.2.1 MULTIPLE EMBEDDED CASE STUDIES

Case studies are best suited to real life phenomena where researchers have little control (Lee 1999), and are appropriate for examining events or activities (Cresswell 2007). Yin (2003a) also argues that case studies are particularly pertinent to explorations of complex causes. As this thesis is undertaking an in depth analysis of how organisational routines are selected, adapted and retained, which is held to be a complex and little understood process, multiple case study methodology is appropriate as an overarching strategy.

Additionally, the specific research questions are around how the dynamics of selection, adaptation and retention affect variety. Multiple case studies are well suited to answering how and why questions (Dooley 2002; Huberman and Miles 1994; Perry 1998), particularly in relatively unexplored research areas (Eisenhardt and Graebner 2007), such with routines. This is because, multiple case studies enable researchers to clarify whether a finding is peculiar to a singular case study, or whether it is consistently replicated across several cases (Eisenhardt 1991), or whether there are differences between cases. The

process of examining the same phenomena across multiple cases follows a logic of replication. Two types of replication are possible – literal and theoretical (Lee 1999), both of which are used here.

A process of *literal replication* is followed, as the same variables are examined across different cases (Lee 1999). As Eisenhardt and Graebner (2007, 25) argue: “Like a series of related laboratory experiments, multiple case studies are discrete experiments which serve as replications, contrasts and extensions of the emerging theory”. By examining the same phenomenon, but in different sections of a very large organisation, the research method is literally repeated. Thus the examination of the same routine across multiple organisational units enables each case to be compared and contrasted. Such comparisons enable a better understanding of the selection-adaptation-retention dynamics of the routine.

Theoretical replication involves situations where different sets of variables or linkages are evidenced (Lee 1999). In other words, a different set of findings allows the theory to be extended or validated. Thus while the same routine is examined across divisions, a different set of routines may be evident between these divisional units, together with how they were selected, adapted and retained. As the multiple cases in this study are within a single organisation, any differences found in the organisational routines of different divisions would not simply be as a result of a different organisational history or culture, or because the organisation operates in a different industry. Thus the embedded case study approach would allow for differences intrinsic to the organisation to be evident between cases, while variables extraneous to the organisation are controlled for.

Thus, studying multiple cases of an organisational routine within a single organisation enables both theoretical and literal replication to be achieved. As the goal is to improve the theoretical understanding of the dynamics and dimensions of a routine, Yin (2003b) argues multiple case studies are appropriate when the goal is to improve theoretical understanding. As this research seeks to develop a better theoretical understanding of organisational routines, multiple case studies have therefore been chosen as an appropriate overarching method (Yin 2003b, 50).

3.3 UNIT OF ANALYSIS

Feldman and Pentland (2005) have already articulated a strong rationale that the unit of analysis in research on routines is the routines themselves. As noted in the previous chapter, routines are “‘recurrent interaction patterns’ involving multiple actors working to achieve a particular outcome” (Becker 2004, 645, 2005b, 818). In case studies, the focus is often on a single phenomenon in its context (Yin 1999, 1211). For this thesis, the single phenomenon under examination is a specific organisational routine, which is examined across multiple case studies. In other words, the routine (the unit of analysis) shall be examined across multiple case studies. In particular, how selection, adaptation, and retention results in variety – is examined.

Routines though, are complex phenomena, comprising ostensive and performative elements together with artefacts which attempt to codify them (Pentland and Feldman 2005). Routines also often consist of a number of other sub-routines (Feldman 2000). While capable of examining complex phenomenon, case studies can also easily contain lesser units of analysis within them (Yin 1999) which again reinforces the utility of using case studies to study organisational routines, as routines are multilevel phenomena (Vromen 2011).

Finally, routines are not necessarily static objects, but can change over time (Feldman 2000). Any attempt to study routines is thus complex, as all of these aspects and elements need to be investigated in order to understand the phenomena of routines, their subroutines, and how the dynamics of selection, adaptation, and retention affect variety. The next section outlines the specific methodology used to examine routines in this thesis.

3.4 MULTIPLE DATA COLLECTION METHODS USED IN CASES

As a research strategy, case studies are not restricted to a particular research method (Hartley 2004). Indeed, Yin (2003b) argues that case studies should include multiple sources of evidence, as this enables triangulation of data. As noted in Section 3.2, exploratory and explanatory analysis of routines was undertaken using embedded case studies as the overarching strategy and framework for conducting the research. Qualitative data collection methods for each case study included semi-structured interviews, a limited number of observations (of meetings, working groups, and training sessions) and document analysis. Quantitative analysis was also undertaken of a data base which provided 973 discrete records of engineering asset (and related services) procurement events over a ten year period.

Such an approach is exploratory as it seeks to gather data in each of the case studies to gain a better understanding of how these dynamics operate and function. The study is also explanatory as it tests the theoretical explanation of how selection, adaptation, and retention create variety in routines. By using both qualitative and quantitative elements to the research process, a ‘conversation’ emerges “one method enables the other to be more effective, and, together both methods provide a fuller understanding of the research problem” (Hesse-Biber & Leavy 2006: 317).

Such an approach is supported in extant research to routines, as both qualitative and quantitative methods have been used to examine routines. For example Feldman (2000, 2003) undertook her analysis of multiple routines based on qualitative data collection methods. Other researchers have also used databases to examine routines (for examples see Pentland, Haerem and Hillison 2009; Reynaud 1996)¹². Indeed, Pentland and Feldman (2005, 2008) argue that multiple methods are needed in order to examine

¹² While D’Addario (2008) collected data from a database, this was not analysed in a quantitative manner.

the various facets of an organisational routine. Considering the phenomena under question, the research methodology literature, as well as extant research into routines, pursuing a mixed methods approaches appears appropriate. Triangulation

Triangulation of data was undertaken (Jick 1979) in order to confirm a particular finding from multiple data sources. For example, a number of interviews advocated the use of specific contracts for specific situations – such as for a certain value, or for purchasing certain types of assets. This qualitative data was corroborated with information from the database, which confirmed that specific types of contract were used for specific purchases in a particular value range. Thus triangulation of qualitative and quantitative data was achieved and used to establish the relationship between certain contract types and specific procurement situations.

3.4.1 COMPLEMENTARY METHODS AND DEVELOPMENT

Integrated mixed model designs (Tashakkori and Teddie 2003) are an advanced mixed model design which uses both quantitative and qualitative data to answer the research questions, and also allows for the data to be converted into another form. For this study, quantitative data from the data base was ‘qualitised’ (Tashakkori and Teddie 2003) in order to demonstrate variety in procurement processes . In other words the small N in some of the fields in the data base was important to the notion of variety, so this data was treated in a qualitative manner (through tables and display charts), rather than quantitatively – which would tend to ignore the small N in certain tests. This process enabled the demonstration of variety in routines – showing the number of different combinations undertaken. Thus the database was in part analysed in a qualitative manner.

In the process of creating the database, some of the data from text fields was coded into categorical variables in the database. Additionally interviews indicated a certain number of different forms of contracts were used, however the database indicated the existence of a larger variety of contracts than were indicated in the interviews. Consequently, additional interviews were undertaken which provided feedback and clarification on the number of different types of contracts. Interview data indicated that some of the forms of contract listed differently in the database were actually the same type, so these were re-coded in the database, based on the interview data. Thus there was complementarity and development between the interviews and database, which led to improvement in the quality of both.

This transformation of data (Tashakkori and Teddie 2003) is a literal application of the assertion of Morgan (2007) that the inductive results of qualitative research can serve as inputs for the deductive processes of quantitative data analysis. Thus the qualitative data allowed for improvement to the coding in the database, and thus better quantitative analysis. Additionally, the database led to further questions being asked in interviews which improved the quality of data from this source.

3.5 SAMPLING

There are two aspects of sampling that need to be explained more fully for this study – the sampling of cases and sampling *within* cases. How cases were sampled is explained in the section which follows.

3.5.1 SELECTION OF CASE STUDIES

As noted earlier, while studies have examined routines in organisations, the potential for routines to vary between organisational divisions has not been explored significantly to date. By examining the same phenomena across multiple divisions in the same organisation, the goal was to improve the understanding of the phenomena under examination. Such an approach follows the same logic as experimentation, where each case is a test to see whether the research questions hold, or whether they need to be amended (Eisenhardt and Graebner 2007, 25).

Five divisions were studied as embedded cases within the organisation. Prolific Projects consists of more than five divisions, however only those divisions actively involved in the procurement of engineering assets were included in the study. Thus representative sampling (Miles and Huberman 1994), has not been followed. As will be shown in the findings section (Sections 4.1.1 and 4.1.2), each of the cases demonstrates differences in the value and volume of procurement activities. Thus the selection of cases was undertaken on the “opportunity to learn” (Stake 2003, 130), and because the cases were information rich, and generated considerable insight about the phenomenon (Miles and Huberman 1994; Patton 2002).

While the sampling was purposive, it was also undertaken in order to develop theory. Theoretical sampling is typical for cases study research as the goal is to identify cases which are likely to replicate or extend emergent theory (Lee 1999; Yin 2003b). Thus for theoretical sampling, cases were selected in order to ensure that the cases provided data which “manifests the constructs of interest” (Patton 2002). Consequently, organisational units which did not significantly participate in procurement of engineering assets were not included in the sample as they do not undertake the process being examined.

Additionally, a stratified purposive sampling method (Patton 2002) was also be used. Stratified purposive sampling seeks to ensure that a diversity of activities are examined in order to ensure that variations and differences are identified and explored. Consequently, sampling of cases sought to ensure diversity of procurement routine processes. A summary of cases is provided in Table 8 below.

Table 8 – Summary of Case Studies (by volume, value and variety of assets purchased)

Division	Volume of Tenders	Value of Tender Amount (mode)	Variety of Different Types of Assets / services Purchased
Alpha	Medium	Low	Medium (35)
Beta	Low	High	Low (13)
Gamma	Low	Low	Low (15)
Delta	High	High	Medium (48)
Epsilon	Very High	Medium	High (83)

As Table 8 indicates, each of the cases varies across three key aspects of procurement: the volume of procurement activity, the average value of purchases, and the variety of different assets purchased. This pattern of activity validates the multiple case study approach, as the same activity (procurement) is undertaken in diverse manner (as shown by volume, value and variety). Examining the same routine, in multiple cases, where the routine is undertaken in different ways, will lead to the improvement of theoretical understanding (Eisenhardt 1989, 2002; Eisenhardt and Graebner 2007).

In terms of the number of cases included, four to five cases are considered a reasonable sample for case study research (Eisenhardt 1989, 794). As five cases have been included in this study, the sample of cases can be concluded as being adequate.

Thus in terms of the number of cases and the differences between cases, the sample would appear adequate and allows for replication in order to prove theoretical understanding of how selection adaptation and retention creates variety in organisational routines. Having examined sampling of cases, the sampling within cases is examined next.

3.5.2 SAMPLING WITHIN CASE STUDIES

As noted earlier, multiple data sources were used in the case studies. Sampling within each of the case studies sought to ensure that data is gathered in order to provide evidence which examines the key research questions outlined in Chapter Two. As is discussed below, interviews and the database were key data sources, while observations and documents provided supplementary data sources. A summary of the number of interviews, documents, observations and database entries by each case is provided in Table 7 below.

Table 9 – Number of Data Source by Case and Source

	Interviews	Observations	Database	Documents
Alpha	7	8	98	Documents only made available on a whole of organisation basis
Beta	6	5	18	
Gamma	3	2	14	
Delta	9	9	212	
Epsilon	6	21	452	
Total	30	46 (additional from reflective activities)	790 list wise (with all data) 973 in total	50

Each source is discussed in detail below.

Database

The contents of an entire procurement database were made available by the industry partner, which consisted of 973 records of specific procurement activities conducted over a 10 year period. This sample was the entire population of the database, and contained information on the procurement activities of

every division examined as a case study. Of these, 796 records contained complete data for the procurement event, and were therefore useful to this study,

Key Informant Interviews

As routines involve rule based action in organisations (March 2008b), decision makers are key informants of such rules as they have developed capability in a particular area over time (March and Simon 1993, 11). Initially, primary contacts inside the organisation brokered access to key informants, typically managers of sections. These informants provided initial information about the organisation, and the people who were central to the procurement process within each of their divisions. These initial informants provided a list of additional people who should be interviewed, thus starting a snowball sampling strategy (Milward and Provan 1998).

The sample size of interviews in qualitative research is determined by theoretical saturation – once there is no new data coming forward in interview, then there is a probability that theoretical saturation has been reached (Bryman and Bell 2003). By the final five interviews, no new data emerged concerning the routines within the organisation. Consequently, theoretical saturation was achieved by 30 interviews.

Observations

Due to the commercial and in-confidence nature of much of the tendering and contracting process it was not possible to be present during procurement negotiations. However observations of some meetings were possible – particularly training meetings where new approaches to purchasing were introduced to the organisation. Additionally, I was able to sit as part of the contracting section within Epsilon division for a number of weeks while coding the database. This provided additional insights into the rationale behind certain purchasing decisions and seeing some of the interaction between divisions around the procurement process. Coding the database provided extended opportunity to observe the database as an artefact, and as part of the process of procurement.

Documents

Only current documents for the entire organisation (e.g. annual reports and company policy documents) were made available. I did however have access to all publically available documents. Unfortunately, there had been a purge of all historical documentation by the organisation just prior to commencing research, which meant that I could not undertake a longitudinal analysis of documentation such as organisational policies. It is therefore unclear what sample of the total population of documents these amounted to.

3.6 SOURCES OF DATA AND THE UNIT OF ANALYSIS

As noted earlier, the overarching strategy was multiple embedded case studies as this strategy was the most appropriate to examine the problem at hand. Case studies investigate “multiple bounded systems

(cases) over time, through detailed, in-depth data collection involving multiple sources of information, (e.g. observations, interviews, audiovisual material and documents and reports) and reports a case description and case-based themes” (Cresswell 2007, 73).

Three elements of routines – ostensive, performative and artefact – require different data collection techniques. Interviews tend to disclose directly the ostensive aspect of the routine – the rationalisation, justification and generalisation of the routine as accepted within the organisation, together with the documentation (artefacts) of such routines (Becker 2004). Observations are particularly important in order to capture the variation between espoused theories and theories in practice (Pentland 2003a), in other words the performative aspect of routines. For some types of routines, this can also be discovered through interviews and analysis of the documents and artefacts, particularly if the routine is documented in or by these sources. Artefacts, as attempts to codify the ostensive aspect of routines, can also be examined through document analysis, and observation, depending on the nature of the artefact. Databases are unusual in this respect as they are both artefact (indirectly reporting the ostensive encoded within it as part of the routine), and a direct record of the performative aspect of the routine.

Consequently, in order to examine the various elements of routines, multiple methodologies are necessary. The following table summarises this understanding of the elements of routines, and the methodologies appropriate for researching each of these.

Table 10 – Direct and indirect evidence of the elements of routines from each data source

Data collection Element of Routine	Interviews	Observations	Document Analysis	Database
Ostensive / rules / espoused routines	Direct	Direct	Direct	Indirect
Performative / routines in practice	Direct	Direct	-	Direct record
Artefacts / documents, data bases etc.	Indirect	Direct	Direct	Direct

According to Dingwall (1997, 53) there are only three basic methods to qualitative research: what he refers to somewhat colloquially as “asking questions”, “hanging out” and “reading the papers”. Asking questions relates to interview techniques, hanging out to observations, and reading the papers to document analysis. Thus not only are these techniques advocated in the routines literature, they also reflect a strong representation of these methods across a range of disciplines and a long and strong association with research. Together, each of these methods provides insights into a particular element of routines (ostensive, performative and artefacts) as well as each of the research questions advanced in the literature review. Consequently, multiple data collection techniques undertaken in this study enabled the triangulation of data on each of the elements of the complex phenomena known as routines, together with each of the research questions. Each of the data sources is examined in detail below.

3.6.1 SEMI-STRUCTURED INTERVIEWS

Semi-structured interviews were conducted with individuals involved in the procurement of engineering assets – within each division studied. Semi-structured interviewing was selected as a data collection

technique, as it allows easily for cross-case comparability (Bryman and Bell 2003) and enabled finding out what was actually happening in practice (Saunders, Lewis and Thornhill 2000). In summary, “interviews are a highly efficient way to gather rich, empirical data” (Eisenhardt and Graebner 2007, 28), and are held to be important for investigating routines (Pentland 2003a), particularly the ostensive aspect (Pentland and Feldman 2008).

Given the number of specific research questions raised during the Literature Review (Chapter Two), an interview guide or protocol was used to structure the interviews (see Appendix A). By initially developing a theoretical framework from the literature, and then conducting interviews based on that framework across multiple cases studies, the validity and reliability of qualitative case studies is greatly improved (Healy and Perry 2000). The semi-structured interviews used open-ended questions primarily. While the questions are specified in advance, the content of the response is open (Bouchard 1976). Using open ended questions enables flexibility in the data gathering process, and for informants to provide information not anticipated by the researcher. The overall data handling process for interview data is summarised in Table 11 below

Table 11 – Data Handling Process

Data Collection	Data Conversion	Data Cleaning	Data Coding	Data Checking	Data Analysis
<ul style="list-style-type: none"> • Undertake interview • Save audio to file server • Clear audio device 	<ul style="list-style-type: none"> • Up load file to FTP site • Email link to transcriber • File downloaded by transcriber • Receive file back from transcriber 	<ul style="list-style-type: none"> • Check transcript for accuracy • Delete audio file • Remove identifying data from transcript • Save as a new file 	<ul style="list-style-type: none"> • Code in NVivo 	<ul style="list-style-type: none"> • Send interview summary to interviewee for checking • Triangulate interview data with database 	<ul style="list-style-type: none"> • Undertake analysis of interviews based coding

While there is still flexibility in a semi-structured interview protocol, having the same elements included in each interview provides for a more systematic approach to the collection of data (Patton 2002). However, the interviewing was not so structured as to restrict the answering of questions to a specific order, or fixed response. While specific questions are pre-determined and listed on the interview protocol, the flow of the interview determined the questioning, as interviewees can answer a question before it is asked, or their answer may suggest an alternative order to the questions on the interview schedule (Bailey 2007). Follow up and probing questions were used to elicit more detail on specific responses (Patton 2002).

One possible difficulty with interviews as a methodology, is that recollection of historical events may be biased by the interviewee’s memory of the event (Bryman 2001). Consequently, the questions were structured to encourage interviewees to reflect upon specific instances of procurement, thus grounding the data in specific examples, rather than generalisations, which also served to improve the validity of the data (Flannagan 1954). Recall how in the literature review (Chapter Two), Becker (2005a) argued that routines should be examined by gathering data about the antecedents, the characteristics and the

outcomes of the routine. Advocates of critical incident technique argue that observing critical incidents requires an understanding of the events which led up to the incident, the actions of the people involved in the incident and the outcomes of the critical incident (Davis 2006). Thus critical incident technique was useful in examining specific instances of routines, and grounds the recollection in specific examples, not generalisations.

The interviews provided particular information on why certain sub-routine options were chosen, why certain subroutine options were adapted, and why they were retained. In short they interviews provided most of the information about the dynamic processes of routines, as well as the ostensive decision making processes behind each of these.

Once recorded, interviews were transcribed into text, and this text was then coded in NVivo in order to identify themes in response to the questions, and to facilitate comparison between the cases.

3.6.2 OBSERVATIONS

Interaction with and observation of the research setting are an important aspect of qualitative research (Bailey 2007), and is an essential element of contemporary investigation of routines (Pentland 2003a). Patton (2002) specifically mentions the appropriateness of observations for the examination of routines: “for someone to provide information in an interview, he or she must be aware enough to report the desired information. Because all social systems involve routines, participants in those routines may take them so much for granted that they cease to be aware of important nuances that are apparent only to an observer who has not become fully immersed in those routines” (Patton 2002, 262-263). Observation is a particularly important data collection tool for research into routines and is critical to gaining data on any differences between the ostensive routine and the routine as implemented (Pentland and Feldman 2008).

Observations can be undertaken in an overt or covert manner (Bailey 2007). and both of these can either be participant observer or unobtrusive (Patton 2002). For this thesis, the collection of observation data, was overt, rather than covert, as I was not employed in the organisation, nor gave advice on procurement. Angrosino (2007) argues a researcher’s role is overt if they are known and recognised as a researcher by organisational participants, and relates to the organisation as a researcher, rather than a member. I was definitely identified clearly as someone external to the organisation as entrance to the industry partner’s premises required wearing a ‘visitors tag’ at all times. As my presence as an outsider was apparent to all, my position was overt.

Some authors have expressed concern about the reactivity involved when participants are aware that their behaviour is being observed. Kerlinger and Lee (2000 cited in Thomas 2004) argue however, that this problem is typically overstated, and that an observer’s presence is unlikely to significantly modify behaviour unless that behaviour is illegal. My experience was that members of the organisation were very

accepting of me as a researcher, particularly as I carried letters of endorsement by senior executives with me at all times.

Adler and Adler (1987) argue that the role of the researcher is to observe, interact, but not participate in the process being observed. While overtly a researcher, I did not provide advice on procurement processes, so my role was unobtrusive. One advantage of unobtrusive observation is that there is a higher level of objectivity possible, when compared to participant observation (Thomas 2004). Therefore observations were overt and unobtrusive in this research project.

While observation often takes place on a full time or a nearly full time basis, Patton (2002) notes that observations can be undertaken on a part-time or limited basis. This part-time option for observation was utilised in this study.

One extended period of observation did occur while I was manually entering data from the database. I was physically located within the contract section of Epsilon group for approximately one month. This enabled me to observe the interaction and process of tendering and contracting first hand, listen to the interaction as tenders were sent out, received, processed, sent out for deliberation, with questions being answered on all stages of the process, all of which was highly informative. Additionally, I was able to clarify the meaning of some of the codes in the database and clarify the process involved in tendering and contracting while working within this section.

According to Delamont (2004) observations have three phases – watching, recording and reflection. The section above on observations proper has addressed the issue of watching. The other phases of recording and reflecting are discussed below in the field notes section.

Field Notes¹³

Field notes are descriptions of events, behaviours and discussions, and are therefore selective representations and interpretations of what has been observed (Gibbs 2007). Field notes have been occasionally used as a key element in data collection processes for routines (Feldman 2000, 2003), and are useful for promoting creative thinking through issues or research processes and aid in the structure of thinking through problems (Janesick 1999).

¹³ While different methodology books refer variously to a field notes, research diary or research journal, reflective journals etc., these are taken to be merely different names for the written records of observation and/or the reflection on the research process. These written records are referred to herein as field notes for the sake of consistency.

Following Burgess (1981), my field notes consisted of a substantive account, a methodological account and an analytical account. The *substantive account* chronicled events observed and informants interviewed, organised around where, when, what and who (Burgess 1981). The *methodological account* focused in contrast the context, surroundings, the experiences of undertaking observations (Burgess 1981). Field notes also provide an opportunity for researchers to reflect on problems, and their role as a researcher (Thomas 2004), and such self analysis “is to be commended to all who engage in field research” (Burgess 1984, 173). The *analytic account* refers to the series of reflections on the theory and findings of the study (Burgess 1981), as well as “dead ends and surprises” (Gibbs 2007, 26). As Stake (2003, 128) has argued “Perhaps the simplest rule for method in qualitative casework is this: ‘Place your best intellect into the thick of what is going on.’ The brainwork ostensibly is observational, but more critically, it is reflective”.

Thus field notes provided the vehicle for recording what is observed; reflect on personal decisions and discussions; and consequently provide an initial analysis of the data. This recording of, and reflection on, data created an overlap between the data collection and data analysis phases (Bailey 2007, 119; Gibbs 2007, 92-93), which served to fast track the overall analysis process (Eisenhardt 1989). Additionally, major findings about the nature of the data itself – such as the iteration and data quality improvement process between the database and the interviews – were able to be recorded in the field notes so the process and source of improved data quality was not lost.

Computer aided field data collection

While valuable for understanding organisational processes, field data, including data on observations, artefacts, and field notes can be extremely laborious to collect (Ice 2004). Pocket sized hand held computers greatly increase the speed of jotting down field notes, recording verbal notes of important experiences and subsequently downloading these notes to a computer for analysis in a software programs such as NVIVO (Greene 2001). Given the importance of writing up field notes as soon as possible after the event (Darlington and Scott 2002), the use of a PDA, smart phone or small computer greatly facilitates the recording of data as soon as possible after it occurs, as the device can be used readily on the field.

Specifically, a windows based mobile phone was used to record the initial ‘aid de memoires’ in OneNote Windows Mobile Office software as soon as possible after observations had completed. These initial notes were uploaded to a computer and expanded to the full field notes. The use of small handheld devices to make rapid notes following observations ensured as full a documentation of processes as possible, and enhance the process of collection, coding and analysis, and enabled recording of the ‘flashes of insight’ and ruminations on findings while away from a computer.

3.6.3 DOCUMENTS AS DATA

Documents are key data sources for the artefacts and ostensive elements of routines, and thus form primary data sources for this research. Document analysis is a technique for gathering and analysing the content of text (Neuman 2000, 292). The greatest strength of content analysis is that it is unobtrusive and nonreactive (Orton 1997), and is viewed as an objective way of obtaining data of the content of various forms of communication (Marshall and Rossman 1999, 117). These forms of data focus on the espoused aspect of organisational routines, which are often documented (Pentland 2003a). Given that much of the procurement routine is summarised in documents (particularly tender processes and contracts) the use of documents to track changes is particularly pertinent as they were written before the outcomes were known and “are less dramatically filtered by hindsight biases and retrospective rationality” (Orton 1997, 425). Additionally, the “concreteness of materials studied in content analysis strengthens the likelihood of reliability” (Babbie 2004, 324). Primarily available documents were annual reports and company policy documents, although some blank contract documents were also obtained.

Unfortunately, many of the historical documents were not available as all old policy documents, were destroyed just prior to entry to the site. However, another type of document – computer records – were available. For this study this enabled an examination of the performative aspect of the procurement routine, and how these changed over time. The computer records of the database are discussed below. While a manual record was kept of contracts over 10 years old, these records were not utilised in this research.

Secondary Data – Data Base

While initially arguing that artefacts are the physical representation of the ostensive aspect of a routine (such as a written procedure) (Pentland and Feldman 2005), Pentland and Feldman (2008) have more recently argued that the performative aspect of a routine can also be represented in artefacts, particularly as in the case of a transaction history or data base. As Ramduny-Ellis et al. (2005, 77) argue “artefacts act as a residual record of work done and work in progress; in and of themselves they form a resource for analysis”.

Of particular interest to this study are historical records of procurement purchases, which dated back numerous years, and were recorded in a data base as well as paper copies of contracts. Records of the various elements of procurement routines demonstrated: a) the variety of routines at various points of time, b) the number of times each variant was used. Additionally, artefacts are seen to embody or crystallize knowledge in organisations (Ramduny-Ellis et al. 2005). In other words, while the database is a record, the way the database was structured and the way data was entered into the database reflected the main stages of procurement (defining what is to be tendered, which contract was used, the tender method and the approach to market, together with the outcomes of each of these activities.

The database consisted of 973 discrete records of specific procurement events. This database was only available online, and thus all the contents of the database had to be transcribed manually into a relational database I designed. Once this data was entered any fields or data which would identify the industry partner were removed. This database was then converted into a spreadsheet and imported into SPSS for data analysis and cleaning. The process of data handling is outlined in Table 12 below.

Table 12 – Data handling process for the database

Data Collection	Data Conversion	Data Cleaning	Data Analysis
Enter data manually into database from online source	Remove all identifying codes in the data Convert the data into the SPSS file	Undertaken missing data analysis Check data quality	Undertake quantitative analysis of the database

The first step in utilising the database was to undertake a data cleaning process.

The data base became the primary source of information about routines, as it provided a 10 year record of what had been done in the organisation. In order words, it provided a record of the enactment of each of the variants of the routine, in each case over time. This historical record is important in order to show what variants where in use in each time period, and then to examine selection, retention and adaptation patterns over time.

3.6.4 HOW THE SOURCES OF DATA ANSWER THE RESEARCH QUESTIONS

Each of the data collection strategies may be more or less amenable to answering each of the research questions. How each data collection technique relates to the specific research questions are outlined in Table 13 below:

Table 13 – Summary of Data collection methods and how these answer the research questions:

	Interviews	Observations / Field Notes	Database
Research Question 1: What sort of variety exists in organisational routines?	✓		✓
Research Question 2: How does selection affect variety in organisational routines?	✓	✓	✓
Research Question 3: How does adaptation affect variety in organisational routines?	✓	✓	✓
Research Question 4: How does retention affect variety in organisational routines?	✓	✓	✓

The use of field notes has not been highlighted in the text above. However, it will be argued that field notes are an important part of the observation and analysis process (Eisenhardt 1989). These various data collection methods are discussed in detail below.

3.7 DATA QUALITY

Observations of the contracting and tendering process [Observation 28], interviews with procurement officials, together with analysis of the 10 years of historical data showed that there was a specific pattern of subroutines involved in each procurement event. As has been noted earlier, these four sub-routines were Scope of Works, Contract, Tender and Approach to Market. Some fields in the database were text fields (e.g. those which gave the type of contract, or the scope of work being undertaken in the contract). For Type of Contract a categorical variable was created and each contract coded by type. The iterative process for ensuring these codes captured the variant types of contacts has already been discussed in Section 3.4.1. The total number of options available for each of the parts of the overall pattern of the procurement routine is provided in the table below.

Table 14 – Initial data for total number of options for Procurement Routines

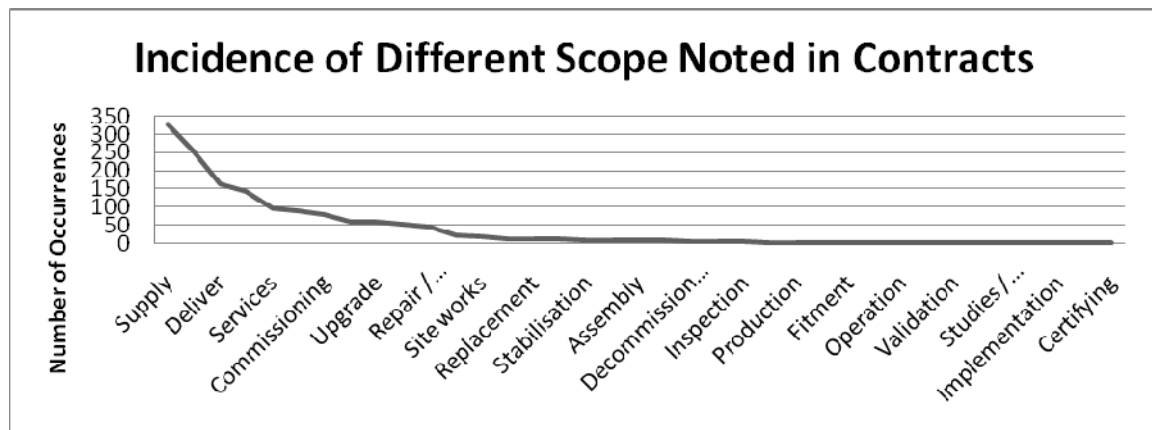
<i>Key activity</i>	<i>Scope of Works</i>	<i>Type of Contract</i>	<i>Tender Method</i>	<i>Approach to Market</i>
Total Number of Options Available from the database	38	13	3	4

In each procurement record, only one contract, tender and approach to market was used. In other words each of these categorical variables were sub-routines in the overall procurement routine. For Scope of Works, there were 38 different options, which were coded from the text field. These were simply coded in a binary fashion (present/absent) and a review of the data showed that many of these were used in combination (e.g. design, manufacture, test and install; design and construct; etc.) depending on what was being purchased. Given the repeated co-occurrence of the binary scope of works, a decision was made to reduce the number of scope of works through a clustering process. This is discussed in the next section.

3.7.1 DATA REDUCTION OF SCOPE OF WORKS DETAILS

Following on from the build / buy decision, Prolific Projects determined what I have termed the scope of procurement – in other words what is to be purchased. These codes were derived from a text field in the database for each project, where the specific goods and services that were being purchased were noted. The content of these text fields were coded as binary variables (presence and absence) for each project, and a total of 38 distinct activities were found. Figure 6 sets out the incidence of each of the scope items.

Figure 6 – Incidence of Scope Items in Contracts



The volume of each of the options identified in the database for scope in contracts, follows an exponential curve, with some items present in 40% of procurement events (supply), while others were only present once (e.g. validation).

Due to the rather long tail involved in the number of scope items in the contracts, the decision was made to attempt to reduce the number of items used in detailed analysis, as even simple statistical analysis with chi squares was not possible (due to very small categorical numbers). Additionally, discussions during the observation period, suggested that the contents of the text field which had been coded into SPSS should not necessarily be considered exhaustive, so some data reduction seemed warranted based on observation of the binary presence or absence of specific scope of works items.

Having manually coded the data, the co-occurrence of many of the binary scope of works was noted. This co-occurrence of scope of works was confirmed when cross tabs of all of the scope of works was undertaken. An 'incident matrix' showing the correlation of the various scope items is provided in Table 15 below. Additionally, many of the scope items were not discrete but co-occurred in each procurement event.

Table 15 – Incident Matrix (Correlation) of Scope Items

	Construction	Supply	Design	Production	Manufacture	Stockpile	Deliver	Loading	Commissioning	Testing	Consultancy	Repair / Overhaul / Refurbishment	Demonstration	Decommission / Demolition	Stabilisation	Maintenance	Services	Upgrade	Fit out	Relocation / Removal	Replacement	Landscape	Procurement	Install	Assembly	Setting to work	Site works	Filment	Validation	Training	Inspection	Hire	Studies / Research	Operation	Valuation		
Construction	254																																				
Supply	69	327																																			
Design	40	60	142																																		
Production				2																																	
Manufacture	1	52	53		89																																
Stockpile					2	3																															
Deliver	1	134	35		59		164																														
Loading		51					51	51																													
Commissioning	1	62	49		27		31		79																												
Testing		34	44		37		36		33	60																											
Consultancy			5								10																										
Repair / Overhaul / Refurbishment	11	5	4		2		3		6	6	0	46																									
Demonstration													2																								
Decommission / Demolition	2	2										1		5																							
Stabilisation	5		1												8																						
Maintenance		3	1				1	1	1		4					23																					
Services	8	6	4		1		2				4	2			6	9	96																				
Upgrade	10		6								3					1	1	59																			
Fit out	1	1	1		1		1		1	2									7																		
Relocation / Removal	2	1				1			1		2		1		1			3		12																	
Replacement	8																					11															
Landscape																							1														
Procurement	2		4									1											4														
Install	7	86	47		21		10		49	21	4		1		1	2		1	1					4	123												
Assembly		1	3		7		7			7																7											
Setting to work		7	4						3	3							1									7	7										
Site works	11	1	2							1		1					2		1	1	6		1	1		1	17										
Filment		2	1		1				1	1																		2									
Validation		1					1		1	1															1					1							
Training		1					1		1																1							1					
Inspection	1	1															2																	4			
Hire	1	1	1																															2			
Studies / Research		1	1		1												1																	1			
Operation																	1																		2		
Valuation																	1																			1	

Some items clearly correspond with other scope items in contracts. For example loading occurs 51 times in total and co-occurs in each case with supply and deliver. However, supply and deliver co-occur with a much larger array of scope items. Others, such as demonstration, are not related to other cases at all – only occurring on their own. Thus the data set contains both a very dense set of relationships as well as a dispersed set of relationships, reflecting the curve found in Figure 6.

Given the nature of the binary categorical data and the co-occurrence of this data, the decision was made to use cluster analysis to reduce the scope of these variables to a smaller set. This process is discussed next.

3.7.2 CLUSTERING OF SCOPE OF WORKS CATEGORICAL VARIABLE

To determine which codes might be included in the specific routine, there is little theoretical guidance on which to base categorisation – particularly as routines are likely to be quite idiosyncratic to an individual firm. In such situations, cluster analysis provides a useful way to investigate and determine coherent groups within a data set (Johnson 1967). Cluster analysis involves the process for classifying a set of unclassified data into groups which are similar to each other, but different to other groups (Everitt 1981)

Numerous authors have recommended that the estimation of clusters be undertaken in a 2 stage process. Stage 1 is an exploratory process which uses hierarchical cluster analysis (HCA) to determine the number of clusters (Arabie and Hubert 1996; Arabie, Hubert and De Soete 1996). The second stage is to use the number of solutions suggested by HCA as the initial starting point for k means clustering (Arabie and Hubert 1996; Arabie, Hubert and De Soete 1996; Milligan and Cooper 1988). The hierarchical cluster analysis will be examined first.

Hierarchical Cluster Analysis

One particular aspect of this clustering process which should be noted, however, is that the nature of the data is binary, and this requires careful consideration in order to choose the correct clustering algorithms. Firstly, there are two types of binary data. Symmetrical binary data is where both the 1 and the 0 are equally important (such as with binary coding of female and male); in contrast asymmetrical coding occurs where there is presence or absence of the variable in question (Kaufman and Rousseeuw 1990, 26). In other words only the presence (1) of the data is of interest or consequence. It is important to note that the scope of works binary coding was presence/absence or asymmetrical binary data. This has implications for the clustering coefficient and method, as symmetric binary cluster analysis would require alternative coefficients (Xu and Wunsch 2008).

Cluster Coefficient

The typical coefficients for asymmetric binary hierarchical cluster analysis are the Jaccard, Dice and Sokal and Sneath (Kaufman and Rousseeuw 1990). These measures are appropriate for asymmetrical binary data (Xu and Wunsch 2008, 27). Therefore both Kaufman and Rousseeuw (1990) and Xu (2008) would argue that a Jaccard, Dice or Sokal and Sneath are the best coefficient for asymmetrical binary data. Tests were run on all methods for Jaccard coefficient, but no results were able to be found. Instead Sokal and Sneath (1) (1963) coefficient was used.

Cluster Method

A number of possible methods can be used when undertaking Hierarchical clustering. Complete linkage, also known as furthest neighbour (Landau and Everitt 2004), was chosen as this method ensured that cases were joined to clusters where they are similar to all other members of the cluster, which tends to result in tight clusters in analysis (Sharma and Kumar 2006; Xu and Wunsch 2008). While there are other methods, complete linkage overcomes some of the disadvantages of other methods and tends to produce more homogenous clusters (Wasserman and Faust 1994, 381).

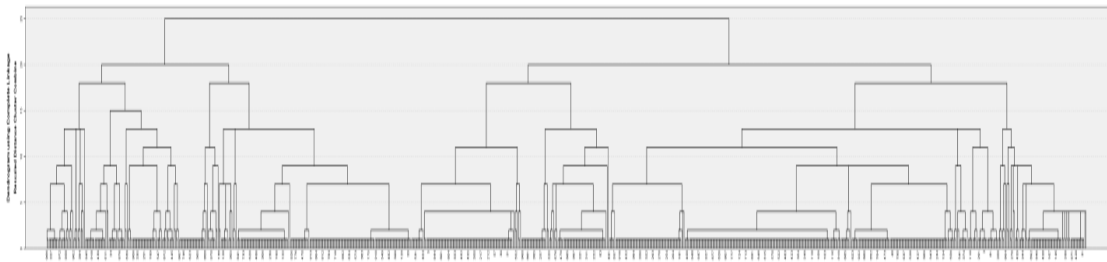
Consequently, HCA was undertaken using Sokal and Sneath given the binary nature of the data, with furthest neighbour in order to determine the most different clusters (Sneath and Sokal 1973; Xu and Wunsch 2008).

HCA involves computation of a similarity or distance matrix between entities, and ends up with a dendrogram showing where all the individuals are in a single group (Everitt 1981, 25). While a dendrogram provides a complete list of all of the clusters, the challenge is to determine how many should be included.

“Overall the problem of determining the most appropriate number of clusters for a set of data can be a difficult one. Despite the numerous attacks on the problem in the literature it must be said that no completely satisfactory solution is available. The main difficulties with deriving formal significance tests in this area appear to be specification of a suitable null hypothesis, the determination of the sampling distribution of the distance or similarity measure used, and the development of a flexible test procedure.” (Everitt 1981, 66).

Afifi, Clark and May (2004) suggest that one way of determining the optimal number of clusters is to look for large differences in the values at various clustering phases. In other words if there is a significant step between cluster distances this indicates that there are two distinct clusters which have been joined (Afifi, Clark and May 2004; Landau and Everitt 2004). The results of the HCA are provided below.

Figure 7 – Results of the Hierarchical Cluster Analysis



The understanding from the methodology literature that a large step between clusters would enable determination of the right number of clusters (Xu and Wunsch 2008) did not prove possible, regardless of how the data was ordered. While no clear resolution was possible from the HCA analysis, the exploratory process suggested that somewhere between 5 and 7 clusters would be appropriate for this data set. Consequently, 5, 6 and 7 clusters were requested from K-Means clustering solution.

Unfortunately, each of these attempts resulted in a large number of clusters (25% at a minimum) being assigned to a cluster which was not correlated to any other individual item. In other words in each case one of the clusters created by the K-means algorithm did not relate to another of the categories. The process simply created an ‘other’ category where a large part of the data was allocated. Correlating these solutions via ANOVA also failed repeated significance tests. Thus while there were clusters created, these were not meaningful or different statistically against other variables, and included too great a percentage of ‘other’ categories to be useful.

Given the failure of the K-means clustering solutions, the smaller binary variables were excluded as inputs to the k-means cluster solution. However, this did not mean the removal of the actual procurement event, as in nearly every case there were more than one scope of works involved – the co-occurrence of data noted earlier.

A total of 10 scope of works items were identified as having sufficient numbers to undertake clustering, as shown in Table 16 below.

Table 16 – Number of occurrences of scope items in the contracts

Activity	Number of instances in database	Activity	Number of instances in database
Construction	254	Loading	51
Supply	327	Testing	60
Design	142	Commissioning	79
Manufacture	89	Services	96
Deliver	164	Install	123

These binary variables were used as variables to conduct the k-means clustering process on. The K-Means splits the matrix into a specified number of sets which “uses an iterative process to maximise the variation between sets when compared to the variation within sets” (Wasserman and Faust 1994, 708). Six clusters were requested from the K-means process, with 500 iterations requested. Convergence was achieved due to no or small change in cluster centres. The maximum absolute coordinate change for any centre was .000. The current iteration is 227. The minimum distance between initial centres was 2.000. The composition of each of the clusters is provided in Table 17.

Table 17 – K-means cluster analysis – Final Cluster Centres

	Cluster					
	1	2	3	4	5	6
Construction	0	0	1	0	0	0
Supply	0	0	0	1	1	1
Design	1	0	0	0	0	0
Manufacture	1	0	0	0	0	0
Deliver	1	0	0	1	0	1
Loading	0	0	0	0	0	1
Testing	1	0	0	0	0	0
Commissioning	0	0	0	1	0	0
Services	0	1	0	0	0	0
Install	0	0	0	0	1	0

Cluster 1 is thus a set of activities defined as “Design, manufacture, deliver and test”. Cluster 2 is Services. Cluster 3 is construction. Cluster 4 is “Supply deliver and commission”. Cluster 5 is “supply and install”. Cluster 6 is “supply deliver and load”.

Having hand coded the data initially, these results make sense. Loading occurred often in conjunction with supply and delivery so should stand out as a cluster. Construction often occurred on its own and services are definitely separate activities to construction or manufacture. Thus in relation to the correlation in Table 15 and the manual observation of patterns in the data, suggested that this was a reasonable solution.

The number of purchasing events allocated to each cluster is displayed in Table 18 below.

Table 18 – Number of Cases in each Cluster – k-means cluster of binary scope of works.

Cluster	Number of purchasing events in each cluster
1	43
2	94
3	415
4	27
5	117
6	100
<i>Valid</i>	796
<i>Missing</i>	0

Importantly, these six separate solutions account for all of the projects in the database, with no missing projects and each cluster involving at least one scope item. Thus the solution is inclusive of

the relevant fields and incorporates all of the procurement events which contained all necessary data.

Validation of K-Means Cluster Solution

Blashfield (1976) recommends that cluster solutions be validated as clusters should have some predictive value against independent variables. Assessing the validity of the clustering solution against independent variables is important, as “the value of a cluster solution that has successfully passed an external validation is much greater than a solution that has not” (Aldenderfer and Blashfield 1984, 66).

Consequently, in order to validate the clustering solution, ANOVAs were undertaken against continuous variables which were not present in the creation of the K-means clusters. 3 continuous variables were used in the ANOVA – Time between tender and contract, the number of tenders per contract, and the value of the approved tender. The log of each of these was used as normal distributions was not assumed. In each case a significant difference was found between the clusters and the scale variables, each of which is discussed below.

ANOVA between 6 different scope of works and the number of tenders received

A significant difference was found between the number of tenders approved for each scope of works [F(5,784)=9.464,p<.001]. The differences between each of the scope of works is noted in Table 19.

Table 19 – Comparison of Log of Number of Tenders Received (mean difference)

Scope of Works	1	2	3	4	5	6
1	-					
2	-511**	-				
3	-.378*	.133	-			
4	-.007	.504*	.371	-		
5	-.043	.468***	.335***	-.036	-	
6	-.519**	-.008	-.141	-.512*	-.476***	-

*Legend for Significance of Difference: *=<.05, **<.01, ***=<.001*

As shown in the ANOVA and Table 16, there is a significant difference between the time between many of the Scope of Works clusters. Again this goes to support the validity of the clustering solution.

ANOVA between 6 scope of works and the time taken between tender and contract

A significant difference was found between the time between tender and contract for each scope of works [F(5,756)=10.079,p<.001]. The mean difference is shown in Table 20.

Table 20 - Comparison of [log] Time taken between Tender and Contract (mean difference)

Scope of Works	1	2	3	4	5	6
1	-					
2	.721***	-				
3	.635***	-.086	-			
4	-.118	.839***	-.752***	-		
5	.625***	-.096	-.010	.743***	-	
6	.506**	-.216	-.129	.623**	-.119	-

Legend for Significance of Difference: *=<.05, **<.01, ***=<.001

As shown in the ANOVA and Table 17, there are significant differences between the clusters in the time taken between tender and contract.

ANOVA between 6 scope of works and the Value of the contract

A significant difference was found between value of the contract for each scope of works [F(5,786)=16.371,p<.001]. The mean difference is shown in Table 21.

Table 21 - Comparison of [log]of Value of the Contract (mean difference)

Scope of Works	1	2	3	4	5	6
1	-					
2	2.334***	-				
3	1.996***	-.338	-			
4	.925	-1.409**	-1.070*	-		
5	2.535***	.201	.539*	1.610***	-	
6	1.671***	-.663	-.325	.746	-.864**	-

Legend for Significance of Difference: *=<.05, **<.01, ***=<.001

As shown in the ANOVA and Table 18, there is a significant difference between the value of the contract between many of the scope of works

Thus the ANOVA of the clusters provided by K-Means has been validated by reference to a set of external variables which were not involved in their creation. In each case there is a significant difference between each of these which is unlikely to have occurred by chance. Thus the three ANOVA’s undertaken have validated the k-means cluster solution, and thereby increased the validity of the solution (Aldenderfer and Blashfield 1984, 66).

In summary, due to the complex nature of the data, and the co-occurrence of the binary data, reduction was needed. Those binary variables with smaller incidence were excluded, and 10 binary scope of works were used to deliver a k-means cluster solution. However this solution included all procurement events, provided sufficient numbers for further analysis, and demonstrated external validity through a set of ANOVAs. Consequently, this solution is regarded as adequate.

However, while this solved the data reduction process, some data, particularly quantitative data, was missing. A full detail of the missing data analysis is provided in Section 3.7.3.

3.7.3 MISSING DATA ANALYSIS

According to Tabachnik and Fidell (2007, 63) more than 5% missing data is likely to create difficulties in data analysis. Large amounts of missing data can affect the reliability, validity and generalisability of findings (McKnight et al. 2007). Unfortunately, frequency analysis indicated that a number of fields had levels higher than 5% of missing data (see Table 22 for details).

Table 22 – Percentage of Missing Quantitative Variables

Quantitative variables	Percent Missing
Contract Type	8.5
Number of Tenders Received	16.4
Value of Approved Tender	24.4

Missing values analysis (MVA) thus indicated a high percentage of missing variables – particularly number of tenders received, value of approved tender, and contract type. Schafer and Graham (2002) note that there are three types of missing data: Missing At Random (MAR), Missing Completely at Random (MCAR), and Missing Not At Random (MNAR). The distinction between MNAR and MAR can be difficult to determine, and depends on whether there is a pattern or consistency underlying the missing data (McKnight et al. 2007, 61-62). McKnight et al. (2007) argue that sources of ‘missingness’ must be investigated and the appropriate response be derived from the nature of the missing data itself. This is discussed below.

Data Missing Not at Random

On examining the database a clear relationship emerged between some categorical variables and the quantitative missing data. This correlation indicated that there was a strong relationship between the “status” of the project and the quantitative variables in particular.

The database contained a large number of projects which either had not proceeded, and therefore were missing details in relation to value or contract; or alternatively were only in a preliminary stage of the tendering process, which again meant that the value and contract types were missing. This makes sense, as projects which did not proceed, have yet to be awarded or are only in preliminary stages would not include contractual values. MVA showed that 100% of the missing tender value, 95.4% of the missing number of tenders, and 72.3% of missing contract type were simply due to the fact that the procurement process was incomplete.

Consequently, a binary dummy code was created which coded all projects which either did not proceed, were still out to tender, or in preliminary phase – as 0, and all others as 1. This dummy code was used to select cases for further analysis in SPSS, which reduced the overall number of cases with full information to 796.

Missing at Random

There is a possibility that both MNAR and MAR could be in the same data set, what McKnight et al. (2007) refer to as messy missing data, as is the case with the database. While some data was missing – not at random, Univariate statistics identified more missing data (excluding with the MNAR data) as outlined in Table 23 below.

Table 23 – Univariate analysis of missing data

	N	Mean	Std. Deviation	Missing		No. of Extremes ^a	
				Count	Percent	Low	High
Number of Tenders	790	2.96	2.633	6	.8	0	46
Value of Approved Tender	736	3.3479E6	1.42844E7	60	7.5	0	85
Contract Category	796			0	.0		
Status	796			0	.0		
Tender Process	792			4	.5		
Contract Type	764			32	4.0		
Client	794			2	.3		

a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).

Now, only one value was missing more than 5% of records - value of approved tender. Fortunately, given the large number of existing contracts, and the correlations between additional variables which were not included in the actual analysis, estimations can be made for the missing quantitative variables. Table 24 provides the results of the separate variance *t* tests.

Table 24 – Separate Variance *t* Tests for correlation between quantitative variables.

		Number of Actual Tenders Received	Number of tenders sought approval to apply	Number of tender approved to apply	Value of highest bid	Value of lowest bid	Value of approved tender
Value of Approved Tender	T	-2.8	-1.1	-1.7	6.5	5.7	.
	Df	58.0	57.4	56.8	687.0	681.5	.
	P(2-tail)	.006	.276	.090	.000	.000	.
	# Present	734	735	735	687	686	736
	# Missing	56	57	57	3	3	0
	Mean(Present)	2.85	4.56	3.42	3.9432E6	3.1441E6	3.3479E6
	Mean(Missing)	4.43	6.26	6.07	197089.6667	148459.6667	.

For each quantitative variable, pairs of groups are formed by indicator variables (present, missing).

a. Indicator variables with less than 2% missing are not displayed.

Given the *t*-test values, and the high significant correlations recorded, an EM correlation was sought, with Little’s MCAR test, which is reported in Table 25 below.

Table 25 – EM Correlations and Little’s MCAR test

	Number of Tenders	Registrati on Applied	Registrati on Approved	Value of highest bid	Value of lowest bid	Value of Approved Tender
Value of Approved Tender	-.081	-.069	-.070	.978	.990	1

a. Little’s MCAR test: Chi-Square = 114.834, DF = 33, Sig. = .000

As can be seen – there are high correlations between variables. Having created estimations of the missing values, comparisons between the raw data and the data set which included estimations was necessary in order to ensure that the resulting values did not change significantly. This is reported in Table 26 below.

Table 26 – Comparison of Original raw data and revised data with EM estimation

	Original			Revised data with EM Estimation		
	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>
Value of approved tender	736	3.3479 E6	1.42844E7	793	3.3091E6	1.37667E7

Thus the outcome of the data estimation was an increase in data, which did not vary the mean or standard deviation from the original significantly.

Some categorical variables also had a large number of missing values, but as a categorical variable. However, estimations were not undertaken of categorical variables.

Missing Categorical Data

As noted earlier, mixed methods research can occasionally allow for the transformation of data (Tashakkori and Teddie 2003), where information from qualitative data sources enables the transformation of quantitative data. In this case, qualitative interviews indicated that there were four ways in which the market was approached – open tenders (a tender was placed in the open market so any company could tender), closed tenders (only certain companies were invited to tender), pre-qualification (only companies who had previously been qualified as meeting specific criteria were permitted to tender), sole-invitee (only one company invited to tender)

In the manual coding process, information from these codes was derived from three different sources. Pre-Qualification was noted on an ordinal scale variable in the original data, although was re-coded as a binary present (1) or absent (0) in SPSS. Closed tenders and sole invitee binary codes were derived from a text field. In other words, the data for the three codes came from different sections in the database, so the possibility of correlation was not immediately apparent.

Crosstabs were run between sole invitee, pre-qualification and closed tender methods, which showed that there was a significant correlation between these codes, although this correlation was due to the absence of co-occurrence. Counts of chi square correlations (number of times that the same category is coded as 1 in contracts)¹⁴, are provided in Table 24 below.

¹⁴ One case included both closed and sole tender – however this has been treated as a coding error

Table 27 – Number of Times Sole Invitee, Closed Tender and Prequalification Occurred in same procurement event

	<i>Sole Invitee</i>	<i>Closed Tender</i>	<i>Pre-Qualification</i>
Sole Invitee	-	-	-
Closed Tender	0 **	-	-
Pre-Qualification	0**	0**	-

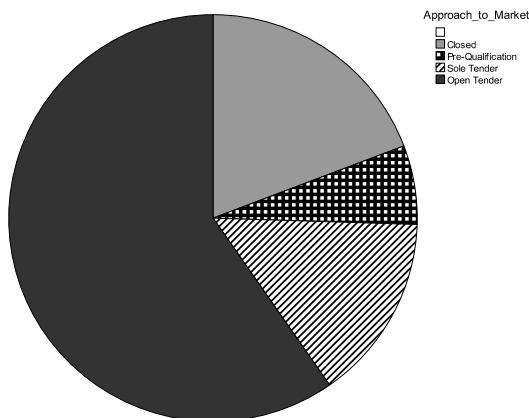
** $p < .01$

All correlations were significant at the 0.01 level. In other words, cross tabs show that the binary codes were mutually exclusive categories which coded the way tenders were placed in the market.

Reflecting back through the interview notes, it was evident that there was a code missing from the data. While sole invitee, closed and pre-qualified tenders were mentioned in the interviews, so too was ‘open tender’ – which interviewees argued was the predominant method. However the database did not include open tenders. Discussions with database entry staff determined that only the exceptions were noted in the database, while the normal process of an open tender was not coded. Additionally the number of procurement instances which were missing the invitation method accounted for approximately half of the total procurement instances in the database. In other words, half the procurement events were missing invitation data, and this data was missing because only the exceptions were coded.

Consequently, a new categorical variable was created “Approach to Market” which re-coded Closed Tender, Pre-Qualified and Sole Invitee as the various methods of inviting tenders (populated from the existing binary variables). The remaining missing data (the open tender category) was re-coded into the Approach to Market Variable as ‘open tender’. The break down (in percentage) of the Approach to Market categorical variable is show in Figure 8 below.

Figure 8 – Approach to Market – percentage of recoded data.



This process shows that there is considerable value in mixed methods approaches when using secondary data as the data is not collected for the purposes of the researcher, and missing values can be estimated or calculated provided that there is corroboration from alternative data sources.

However, as the graph shows, including ‘Open Tender’ enabled the creation of a new categorical variable from chi squares. This meant that nearly over 50% of additional data was included in this categorical variable.

3.8 DATA CODING

3.8.1 CODING OF QUALITATIVE DATA

The first stage in data analysis is to convert all data to text form. While the observations and documents already exist in this format, interviews were transcribed from audio files to text by a stenographer in order to speed up the process from data collection to data analysis (Gibbs 2007). Once the text was transcribed, this was imported into NVIVO (NVIVO qualitative data analysis software; QSR International Pty Ltd. Version 8, 2008), and coding of the qualitative data commenced.

Initial coding of interviews, observations and documents occurred into major codes using the NVIVO qualitative data analysis package. NVIVO can import documents from a range of formats (such as word, rich text format, PDFs) and thus provides single point at which all of the qualitative data collection (interview transcripts, observational field notes, documents) were collected, coded, and analysed.

Gibbs (2007) provides a useful outline of the various types of possible codes: *descriptive codes* – which describe specific types of activities (e.g. tendering) and which can allocated sources to discrete cases being examined; *categorical coding* – which refers to specific topics or categories of data being examined (e.g. why a routine was retained or not); and *analytic codes* – which are new coding arising from reflection and analysis of the data itself.

As noted in Chapter 2, there are a number of phases in procurement and a number of options involved in the procurement process. Initial coding was drawn from the existing understanding of how procurement operates as well as any sub-routine options in the tendering or contracting process, and so is concept driven coding (Gibbs 2007), as the coding commences with existing concepts.

Following the advice of Gibbs (2007) an initial set of codes was constructed as set out in Table 28:

Table 28 – Coding of Qualitative Data and Examples

Type of code	Examples
Descriptive	Stage of procurement (e.g. tendering)
Categorical	Source of data (interview, observation, document)
Analytical	Theoretically derived coding (retention, selection, adaptation)

Examples of this were to code each of the four sub-routines (tendering, scope of works, approach to market, contract). Each of the options under each sub-routine was also coded. For example, alliance

contracts, design-build contracts, construction management contracts etc. were each coded separately. These are essentially descriptive coding which describes what happened. The category of the data was also coded, although most of the qualitative data came from interviews.

Additionally, information on the selection, adaptation and retention of each option in the sub-routine was provided, which is an example of analytical coding. For example, the reasons for the instigation of alliance contracts (adaptation), and why they may not be used again (retention) were coded. This enabled cross referencing with the information in the database. This enable triangulation of data. A summary of the improved accuracy from this is found in Appendix 7.4.

However, these initial codes were insufficient to uncover the full richness of the data examined, and this underscores the fact that data coding and analysis is not a single event. Following initial coding, subsequent coding became more focused as codes become reclassified and larger or more detailed dimensions were identified (Bailey 2007). For example, adaptation was also coded into lower level codes, which showed the source of the adaption (internal, external) and the time of adaptation (retrospective or prospective). Adaptation which was prospective (in advance and not following experience) is a new understanding of adaptation in routines, so this type of coding was data driven (Gibbs 2007).

In the process of coding, a list of the emerging codes was kept separate to the data, including the description of the analytic idea it referred to, how it relates to other codes and when the code was created or changed (Gibbs 2007). These were recorded in the field notes.

Coding enables the process of identifying patterns in data more specific and possible. A key process of analysis involves looking for patterns in data – looking for consistency and inconsistency in the data, looking for disconfirming evidence, comparing evidence from different sources of data (Angrosino 2007). Specifically, analysis sought to identify variation across cases, setting and events and how various factors might affect the outcomes (Gibbs 2007).

3.8.2 CODING OF QUANTITATIVE DATA

Coding of quantitative data was derived directly from the database as discussed in earlier. As was noted earlier a new categorical variable was created through the k-means cluster process; a new variable 'approach to market' was created from binary data; and the number of contracts was consolidated.

Additionally, as there was a date for when the tender was put to the market, and another date for when the contract was signed, a new scale variable was calculated for the number of days between tender and contract.

Full list of Variables in the Data base

The database consisted in a number of categorical and scale variables:

Categorical variables

- Division (the part of the organisation who was undertaking the procurement)
- Contract type (type of legal contract – each of which has different conditions)
- Main type of purchase (service, civil, machinery, etc)
- Scope of Works (specific goods and services being requested in the contract) – created through the k-means clustering process
- Tender Method
- Approach to Market

Scale Variables

- Value of approved tender
- Number of tenders who applied
- Processing Time (calculated from the difference between when tender was sent to market and when contract was signed)

3.9 DATA ANALYSIS

3.9.1 QUALITATIVE DATA ANALYSIS

Inductive analysis involves discovering patterns of data – as the findings emerge from the data, which can be contrasted with deductive analysis where data is analysed according to an existing framework (Patton 2002). Deductive analysis in contrast establishes research questions which are subsequently examined according to data (Patton 2002). For this project a set of research questions have been developed and were tested in this research; this means that the analysis is not purely inductive. However, the research also falls somewhat short of formal model testing, so is also not purely deductive. As Orton (1997) notes, research into organisational processes such as routines fall somewhere in the middle of these two paradigms and are marked by considerable iteration between data and theory. Likewise Becker (2005a) argues that research into routines is neither inductive or deductive, but rather ‘abductive’ – and iterative. Consequently the data analysis in this project is iterative between the theory and data.

Within case analysis is the first step in coping with a large amount of data which can be generated in case study research (Eisenhardt 2002). Such analysis is aided through data displays which condense key incidents or elements of the study. The provision of a dialogue between ideas and evidence is important in the analysis phase, as it enables the opportunity of seeing relationships, themes,

patterns and clusters of data, and affords the opportunity of developing explanations about such data.

Patterns in data were shown through a number of formats. For example matrices were developed which showed relationships or differences between different phenomena. Coding thus enables comparisons between data. However, coding can also enable comparison between cases, and shows, for example, the different approaches to procurement and how different cases approach the procurement process.

Once each case study was been finalised, cross case comparisons are possible, which strengthen the external validity of the research (Huberman and Miles 1994). During this phase of the research, patterns of similarity or difference between cases were sought, together with iteration between data and emergent theory which is strengthened and built from multiple cases and multiple data sources (Eisenhardt 2002).

3.9.2 QUANTITATIVE DATA ANALYSIS

A number of quantitative techniques were used in the case studies. As noted in Section 3.3, routines are multilevel phenomena. Consequently, various statistical tests are suited to different levels of analysis. A summary of methods and the specific test, as they relate to either the case, the routine or the sub-routine are noted in Table 29 below.

Table 29 – Quantitative analysis method and reason for using the statistical method

Method	Reason for the test
Chi Square	In order to test for correlation between categorical variables (options in the sub-routines).
ANOVA (analysis of variance)	Analysis of variance was used to test for variance of quantitative data (e.g. value of procurement projects) across categorical variables (e.g. cases, sub-routine options)
Principal Component Analysis (PCA)	PCA was used to identify correlations between sub-routine options in each of the case studies.
Test for Proportional variance	This test was used to demonstrate the preferred use of certain sub-routine options between the case studies
R²	R ² was used in scatterplots to assess the goodness of fit of trend lines

Given the binary nature of some of the data, this has implications for the PCA and Chi square analysis in particular which is discussed next.

Chi Square

Chi square tests are typically used to identify correlations between categorical variables (Cochran 1952). In this thesis the Chi square test was used in order to determine if pairs of sub-routine options occurred together in such a way that is unlikely to be by chance.

It is important to note that the nature of the data was binary data. In each procurement event, the presence of a particular sub-routine options was coded with a '1', and were the option was not used a code of '0' was entered for the particular procurement event.

Given the binary nature of the data, Fisher's Exact Test is reported for the Chi square correlations, rather than Pearson's correlation, as each correlation of sub-routine options consists of a 2 X 2 table, with the number of incidences often less than 20 (Cochran 1952). For 2x2 tables, Phi is the preferred measure for the strength of association between two categorical variables (Cohen and Lea 2004, 211; Field 2009, 695). On this continuum, a '+1' Phi would indicate a perfect association between two variables (which for binary means they are always correlated), '0' indicates no association between two variables, and '-1', a negative association between two variables (which for binary means they are not correlated) (Freeman 1987, 95; Urdan 2005). Thus, the Phi measure reports both the positive and negative correlations of various sub-routine options.

Cross Case Analysis of Proportional Variance in Use of Sub-Routine Options

Chi square tests were also undertaken in the cross case analysis to see if there were any significant differences between the cases and the various sub-routine options. While a chi square can tell if there is significant difference, on its own it is unable to determine what particular association is causing the significant relationship.

In order to test to see which rows and columns are responsible for this relationship, a columns proportion test was undertaken. Each case study was a column in the test, and each row was the particular set of sub-routine options. Pair wise tests of the equality of column proportions (Z-tests) are used to examine the "relative ordering of categories of the categorical column variable in terms of the category proportions of the rows categorical variable" (PAWS ND, 141-142). Essentially, the test determines if the proportion of times that a case study uses a particular sub-routine option is different to other case studies. This the test will determine if different case studies use a particular sub-routine option a greater proportion of the time compared to the other cases.

Principal Component Analysis

Principal Component Analysis (PCA) is a method of determining the empirical association between a number of variables (Tabachnick and Fidell 2007, 610), by generating a unique mathematical solution which analyses variance (Tabachnick and Fidell 2007, 635). As a central focus of this thesis is to examine variety, a process such as Principal Component Analysis which explicitly examines variance and seeks for correlation between variables is particularly pertinent. While Comrey and Lee (1992) suggest that large sample sizes are needed in order to correctly undertake factor analysis, Monte Carlo analysis studies by both Hogarty (2005) and de Winter, Dodou and Wiering (2009) have shown that factor analysis can be undertaken on samples as low as 12, provided that the number of factors is low and the factor loadings very high. In such conditions, particularly when the goal is for

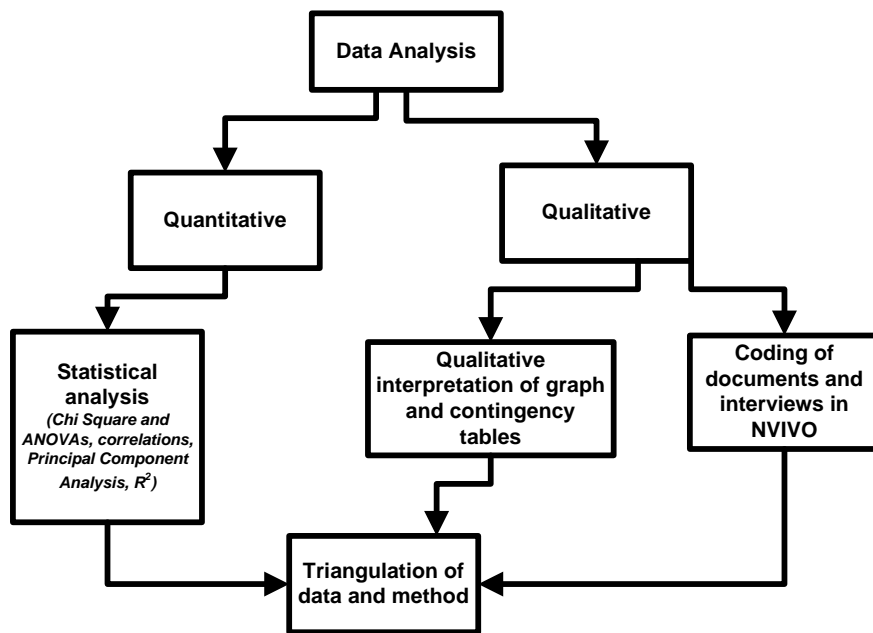
correlation of variables, rather than seeking factors which may underlie certain variables (Hogarty et al. 2005, 223), smaller numbers are adequate. Consequently Principal Component Analysis, with Oblique rotation and Kaiser Normalisation, was used to examine the relationship of the covariance matrix of the co-occurrence of all sub-routine options used in each case study, the results of which are reported in each case. Due to the small sample size in many of the cases, only component loading of .71 or greater were used for determining components, which according to (Comrey and Lee 1992, 243) can be considered an excellent rating¹⁵.

3.9.3 TRIANGULATION OF ANALYSIS

Thus the mixed method design allowed for the ‘quantasising’ of qualitative data and the ‘qualitising’ of quantitative data (Bryman 2009). Additionally the iteration between qualitative and quantitative data allowed for improvement in the quality of both (Bryman 2009). This is shown in

Figure 9 below:

Figure 9 – Triangulation of data and method



¹⁵ There is some debate about whether the pattern or structure matrix should be reported for oblique analysis. However Child (Child 2006) noted that the structure matrix captures the correlation between variables and factors. Comrey (1992, 243) specifically argues that when oblique rotation is used, the structure matrix correlation should be used to assess the value of specific variables for the interpretation of a particular factors. Consequently the structure matrix is reported here.

3.10 VALIDITY, RELIABILITY AND GENERALISABILITY

Validity, reliability, and generalisability are hallmarks of good research. How quality of qualitative research issues are addressed in this study are discussed in detail below.

3.10.1 VALIDITY

Yin (2003b) argues that there are different types of validity – construct validity, internal validity, external validity, and reliability, each of which is discussed in turn below.

Construct validity involves identifying the correct operational measures for the concepts being studied (Yin 2009). Yin (2009) argues that construct validity can be enhanced through the use of multiple sources of evidence, and having key informants review draft version of the case studies. As noted earlier, a number of sources of evidence (interviews, documents and observations) were used in this study, which enabled identification of the various aspect of routines and triangulation of findings between data sources.

Member checking is a way of enhancing validity and trustworthiness of the qualitative research (Bailey 2007). When key informants check the study for veracity of data and findings, the construct validity of qualitative research is strengthened (Mertens 2005), as does multiple data sources (Lee 1999). *Credibility* is established through member checks of transcripts and reports (Searle 1999), as interviewees were provided with opportunity of viewing their verbatim interview responses prior to inclusion in the text (checking of data collection), and also were provided with the opportunity to give feedback on the findings, via review of each of the case studies.

Internal validity in qualitative research seeks to identify any causal relationships (in explanatory and causal case studies) (Yin 2009). Internal validity can be enhanced through the development of predictions from theory and then testing to see if the theory holds (Lee 1999). Explanation building, logic models, addressing rival explanations, pattern matching and cross case synthesis are ways of improving internal validity in case study research (Yin 2009).

In this study, a set of research questions and limited range of assumptions have been developed from the literature, which are examined across multiple cases. Patterns in routines were identifiable once the data has been collected and coded. Building explanations from these cases, and developing a synthesis of understanding from multiple cases strengthened the internal validity of the study. Additionally, rival explanations of causes of variety were examined in the cross case analysis.

External validity in case study research involves the issue of generalisability of studies. As noted earlier, by sequentially testing theory across multiple case studies, the theory can be tested and

modified as the research progresses -- the iteration between theory and data improves the quality of the research and the external validity is enhanced by testing the theory across multiple cases (Yin 2003b).

For case study research, “generalisation is about theoretical research questions, not populations” (Hartley 2004, 331). Case studies are thus appropriate for generalising back to theory, or “analytic generalisation” (Healy and Perry 2000), rather than attempts to generalise to a specific population. This is because in case study research, generalisability is concerned primarily with the generalising to theory (Maxwell 2002), or in demonstrating that the theory is useful in making sense of similar situations, rather than making conclusion about a population based on statistical sampling (Yin 2003b). Additionally, the use of multiple case studies enhances the generalisability of findings back to theory or policy (Eisenhardt 1991; Yin 2003b), due to the fact that the same phenomena are investigated in multiple contexts (Schofield 2002). Examining a phenomenon in multiple situations leads to better understanding, and perhaps better theorising, about an even wider selection of cases (Stake 2003).

As multiple case studies were used, replication of the same methodology and logic can improve the external validity, reliability and transferability (Yin 2003b). Thus the methodology, outlined above, by using multiple case studies, multiple sources of evidence and involving informants in checking interviews and modes, improved the external validity and generalisability of the findings (Yin 2009).

Reliability involves demonstrating that the data collection procedures can be repeated with the same results (Yin 2009). Reliability, or methodological trustworthiness (Healy and Perry 2000), is more about the consistency and dependability of the methods, rather than degree of random or sample error. Reliability in qualitative research was achieved through creating an audit trail which demonstrates adequacy in the information, and ensures that findings would be repeated with the similar results in a similar context (Hartley 2004). As noted earlier, the field notes included an element of critical self reflexivity in order to make plain decisions, conundrums, deliberations, conclusions, and unforeseen aspects of the study.

Transcripts were prepared by a stenographer, in order to speed up the process of converting interviews to data. However, each of the transcription was re-checked to ensure they did not contain any mistakes, thereby improving the reliability of the data (Gibbs 2007).

20% of each audio transcription was undertaken by myself, to ensure the accuracy of the transcriptions. The average error, across 30 interviews (189,591 words), was 3% which was considered not statistically significant. Full details of the process and results for each interview can be found in Appendix B.

3.11 LIMITATIONS AND DELIMITATIONS

A limitation of interviews asking people to recall the reasons for why a decision was made, a number of years after an event, what Eisenhardt and Graebner (2007) refer to as ‘retrospective sense making’. Historical recall of an event is reliant on correct recollection for the reasons behind an event, and may instead result in data demonstrating a post hoc rationalisation for the event instead (Bryman 2001). The impact of this is limited, by focusing on critical incidents which help top ground the discussion in actual events not some generalised ideal setting (Davis 2006; Flannagan 1954).

The subjective nature of some of the data (observations and field notes in particular) is a limitation. This has been off-set by the use of multiple sources of data and triangulation between data and cases. The triangulation of data across multiple case studies significantly improves the reliability and generalisability of the data.

The rapid execution and time frame means that there is limited scope for observations as these would be better if a longer term engagement was possible. Fortunately, this is also off-set with other forms of data. In particular, the records kept of procurement contracts keeps a large amount of data on decisions made over a long period of time, and this data is largely factual and objective, although only recording what decisions were made, not how such decisions were arrived at.

According to Thorngate (1976, 126): “it is impossible for an explanation of social behaviour to be simultaneously general, simple, and accurate”. Explanations which are simple and accurate, must neglect ability to generalise to wider populations; those which are simple and general, neglect accuracy; and those which are general and accurate, are not simple (Thorngate 1976). As this thesis examines the selection-adaptation-retention dynamics of a single routine through longitudinal multi-case analysis, using multiple data collection techniques, it arguably is not simple. However, it does seek to be accurate and to be able to generalise to theory.

3.11.1 DELIMITATIONS – BOUNDARIES TO THE RESEARCH

This research has focused on a single routine, procurement, within a single large organisation, albeit five divisions of that large organisation. Consequently, the research does not attempt to generalise routine behaviour inside a single company to the entire industry. However, as argued earlier in this chapter, it is possible to generalise back to theory, particularly how selection, adaptation and retention affect variety in organisational routines.

Additionally, there are many related routines inside the organisation which are also not examined – even though these might bear relevance on the activity being examined (for example budgeting or maintenance routines). However, the scope of the study enables considerable advancement of

understanding of routines, and consequently narrowing the focus is an important aspect of determining the dynamics of the single routine being examined.

3.12 CONSENT, ACCESS AND PARTICIPANT'S PROTECTION

Access to the organisation has been undertaken through extensive consultation and negotiation, including intellectual property negotiations, confidentiality agreements and reporting requirements.

Individual informants, divisions, organisations and types of assets purchased have not been identified in this research. All interviews were conducted in confidentiality, and the names of interviewees have been withheld. Additionally the name of the organisation in which the research has taken place has also been concealed, as were details of certain assets purchased, or any other data which might disclose the identity of the research partner.

Informants signed informed consent forms which set out the scope of the research, how data was to be handled, and the rights in relation to data provided.

Members of the organisation were also provided with an opportunity to review publications prior to these being published to ensure validity of findings, and that anonymity was preserved.

3.13 CONCLUSION

This chapter has outlined the process for gathering and analysing data in order to examine the research questions developed in Chapter Two. Specifically a longitudinal multi-case study was articulated, which uses multiple methods to gather data. The five divisions of Prolific Projects are examined as five embedded case studies. The primary data collection methods were semi-structured interviews, and a database of procurement activities covering a 10 year period. Policy documents and observations provided supporting data. Multiple data sources enable triangulation of data, in order to improve the validity of findings. Several processes have been undertaken to improve and verify data quality, such as missing data analysis, and random verification of transcription accuracy.

Having established the methodology used to collect and analyse data, the next chapter reports the findings from each of the case studies.

CHAPTER FOUR

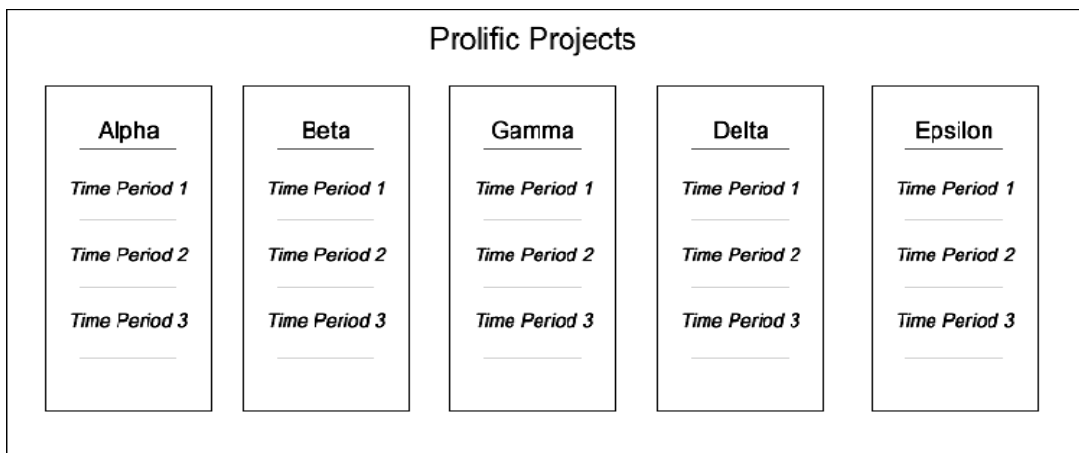
4) CASE STUDY FINDINGS

As stated previously in the Theory Chapter, the aim of this thesis is to explore how selection, adaptation and retention create variety in organisational routines. The Methods Chapter outlined that this research objective is explored through a longitudinal, multiple case study design, using a number of data collection strategies. This chapter reports the findings of each of the case studies, structured according to the research questions developed in Chapter Two. Firstly, however, an overview of the cases is appropriate.

4.1 INTRODUCTION TO THE CASES

As noted in the methods section, the multiple embedded cases in this study enable the examination of the same routine across multiple organisational units within the same company. As Figure 10 (below) indicates, the cases are not independent of each other, but are embedded in the same parent organisation – Prolific Projects (a pseudonym).

Figure 10 – Overview of Embedded Case studies



Prolific Projects had a number more divisions than these five, however only those divisions which specifically undertook procurement of engineering assets, the phenomena under observation, were included in the cases.

Importance of Embedded Cases and their Setting

The cases embedded within Prolific Projects are all operating in the same industry, in the same company, in the same country. Therefore some of the variance, which might be caused by some exogenous factors, is controlled for. In other words, difference in the routine varieties implemented *between* case studies is unlikely to be due to **exogenous** factors such as the nature of the industry, company related issues (e.g. structure, culture) or the country (e.g. legislation, economic systems, systems of government) as the cases are all located in the same country, operate in the same industry, and are part of the same overarching company. However, examining each case study over a 10 year period enables the analysis of change over time, potentially due to changing legislative or economic environments. Thus exogenous factors are still taken into consideration for change in procurement practices through the longitudinal design of the study; however, differences between the case studies as a whole are not likely to be due to these external factors.

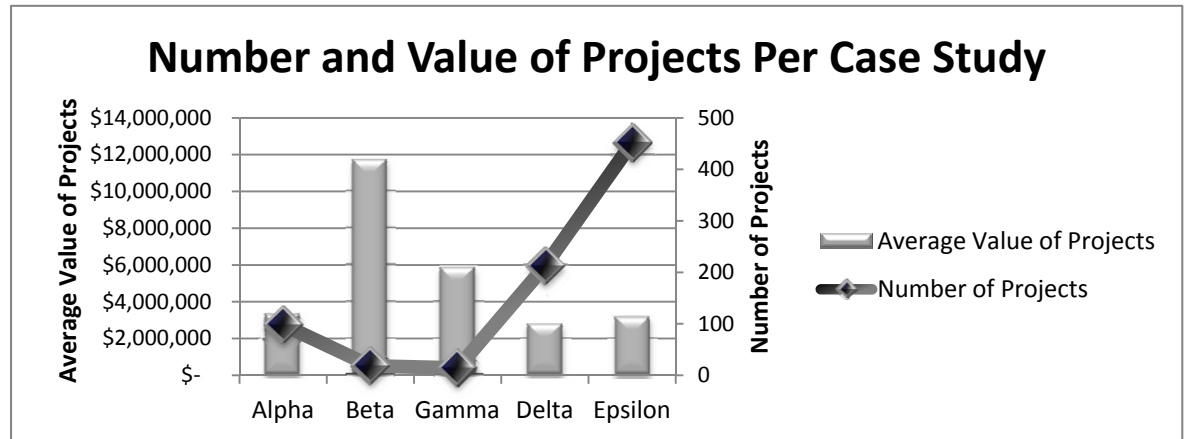
The other major exogenous event, the Global Financial Crisis (GFC) which may have affected the case study (economic) would not be due so much to macro-economic factors – as each case study was based in the same country and the same industry. Thus the GFC would have affected all of the cases, not just one. However, the nature of what is being procured – such as construction versus mechanical engineering assets may well exhibit differences – in other words micro-economic factors may come into play. However, as will be shown below this is also addressed in an endogenous way, as each of the cases tended to purchase different types of engineering assets to different degrees. As all the cases were examined over the same time period, there is the potential to look for similar or different patterns of change over time.

While external factors have been largely discounted as being the cause of differences between the cases, due to the research design, there is still potential for variety to be caused by **endogenous** differences between the cases. The issue of the volume of purchases and the value of purchases are all likely to be contributors to variety in procurement processes. How each of these factors is similar or different across the case studies is examined in the sections that follow directly. Firstly – a brief overview of the volume and value of procurement activities is warranted, followed by the case studies proper.

4.1.1 DESCRIPTION OF THE CONTEXT OF PROLIFIC PROJECTS AND THE EMBEDDED CASES

When examining each of the cases, it is important to note from the outset that there were differences in the volume and value of procurement projects between case studies. Figure 11 shows the average value and the volume of projects per case study for each case study.

Figure 11 – Value and Volume of Projects per Case Study



As Figure 11 shows there is considerable differences between the volume of procurement activity (the line on the graph) with two cases (Beta and Gamma) having less than 50 projects over a 10 year period, while one (Alpha) had close to 100 purchasing events, Delta had close to 225, and Epsilon undertook approximately 450 procurement events.

However, Beta had the highest average value of contracts, followed by Gamma, with Alpha, Delta and Epsilon fairly close behind. In other words, Beta and Gamma undertook a low number of high value contracts during the period, and Epsilon and Delta undertook a larger number of smaller value contracts. In fact there is almost an inverse relationship between the number of procurement activities undertaken, and the value of these contracts. Alpha is the closest to average in terms of volume and variety overall. In terms of purposive sampling this differentiation is highly useful in order to explore the differences between the case studies. Thus each case study provides a different average number of tenders, and different average value of approved tender.

In order to verify this, an ANOVA was conducted to test to see whether this difference in the value of projects was significantly different between the case studies. This showed that there was a significant difference in the value of projects between case studies [F (4,785), =16.594, $p < .001$] (log of values was used). The effect size (η^2) was 0.08 which is a small effect. Thus while there are statistically different prices, the actual size of the difference was fairly small.

The ANOVA thus confirms the visual data in Figure 11 that the different values are statistically different between the cases, and these differences are unlikely to have occurred by chance. Post hoc analysis (set out in Table 30) shows the differences in average value of projects. Alpha spent

considerably less per project on average than Beta, Gamma, Delta, and to a lesser extent, Epsilon. The average value of Beta projects is also significantly more than Epsilon, and Delta is also significantly more than Epsilon.

Table 30 – Post-Hoc analysis of differences between values of contracts between case studies

	Alpha	Beta	Gamma	Delta	Epsilon
Alpha					
Beta	-2.560068***				
Gamma	-1.473209*	1.086859			
Delta	-1.393454***	1.166614	0.079755		
Epsilon	-.646778**	1.913290***	0.826432	.746676***	
Legend: *= $p < .05$; **= $p < .01$; ***= $p < .001$					

Thus while the number of cases in Beta and Gamma is quite small, the value of these purchases is considerably higher than for other cases. Consequently it is difficult to amalgamate the cases, even with the small numbers, into a single case study. In fact, the differences in volume and value between cases provides a fertile source of information for the cross case analysis.

In terms of endogenous causes of variety, there is considerable differences in the value of the purchases and the volume of procurement activity between cases.

4.1.2 DIFFERENCES BETWEEN CASES IN THE DIFFERENT TYPES OF ASSET,

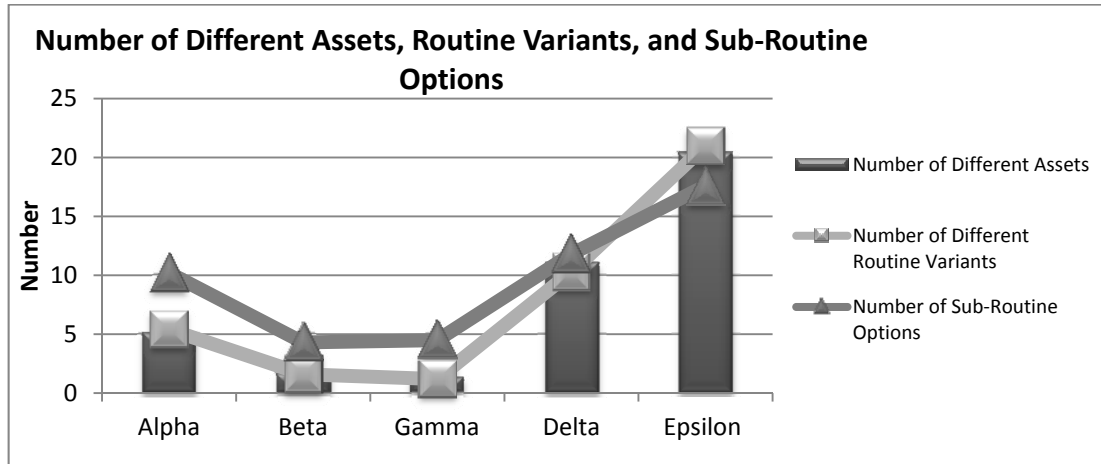
A contingency table setting out each of the variants of the routine as implemented by year and case study was undertaken, but is too large to display here (please see Appendix C for this table). The specific varieties used will be reported on a case by case basis. Each routine variant was assigned a number in this table. Where a specific variant of the procurement routine is referred to in the cases, this numbering will be used to facilitate discussion in each of the case studies.

A total of 114 varieties of routines were implemented by Prolific Projects during the ten year period. While 114 routines were used across 796 projects (which is a ratio of approximately one routine variant to seven projects) the table also consists of considerable amounts of blank space. Theoretically there are approximately 1008 different possible variants of the routine possible¹⁶ so only 11.31% of total theoretically possible variants were implemented across all cases.

¹⁶ 6 Scope of Works x 14 Contracts x 3 Tender Processes x 4 Approaches to Market = 1008 possible variants

As with volume and value, there are also considerable differences between each of the cases – both in terms of what was being purchased and the variants by which such purchases were undertaken. Counts of the number of different assets procured, as well as the routine variants and sub-routine options used in each case showed that these amounts were quite similar (see Figure 12).

Figure 12 - Variety in Assets Purchased and the Routines Variants and Sub-Routine Options used to effect such purchases



Thus each of the cases is different in terms of the volume purchased, the value of such purchases as well as the variety of different types of assets, and the routine variants used to procure such assets. These differences will prove useful when comparing the similarities and differences between cases in the cross case analysis. However, the small number of procurement events in both Beta and Gamma presented challenges in quantitative analysis, as in a number of years there was no procurement activity at all for these two case studies. Consequently, instead of analysing variety and adaptation in each year, data was grouped into three time periods.

4.2 COMPARISON OF PROCUREMENT ACTIVITY ACROSS THREE TIME PERIODS

As noted in Section 5.1, many of the data in the case studies was quite sparse, which made analysis and discussion of changing processes difficult, particularly for some of the small cases which did not buy assets in every year. Consequently, data was grouped into three time periods. Approximately 1/3 of all procurement events are included in each time period, ensuring that there was a relatively equal distribution of events in each time period. Descriptive statistics show that the average number of tenders for each project, and the average value for contracts was similar for each data period. However, there are significant differences in terms of the time taken from tender to contract (see Table 31 below).

Table 31 – Time Periods for Data Analysis

	Dates	Number of projects	Percentage of Total Contracts	Average Value of Contracts (in millions)	Average Time Taken	Average Number of Tenders
Period 1	2000 to 2004	267	33.7%	3.106	110	3
Period 2	2005 to 2006	238	30.0%	3.978	78	3
Period 3	2007 to 2010	288	36.3%	2.975	78	3

Thus in terms of the average number of projects, average value in millions and average number of tenders, the different time periods were fairly close to each other. However, the time taken between tender and contract was much longer in the first time period, compared to the other two time periods. Thus in terms of breaking the data into three time periods for analysis, there is a strong similarity in terms of the number of projects undertaken, the cost of the projects, and the average number of tenders. There is a significant difference in terms of the time taken between tender and contract. As there is already variety in the individual cases in terms of volume, value and variety, then this should not cause a problem from a cross case analysis process. Indeed differences between time periods would not be due to the way the data was structured, but would more likely be due to the differences between cases. Having discussed the overall differences between cases, and the need to analyse some of the data from three different time periods in order to show change over time, the following section outlines how procurement routines have been analysed.

4.3 OUTLINE OF PROCUREMENT ROUTINES

As outlined in the methods section, each procurement routine is seen to be comprised of a number of sub-routines (following Pentland 1995, 2003b; Pentland and Feldman 2005; Pentland, Haerem and Hillson. 2010). The existing literature suggested that there were at least two related stages of tendering and contracting (Samuelson 1986) involved in procurement.

For Prolific Projects however, the interviews and database together determined that there were in fact four sub-routines involved in the procurement of engineering assets. These sub-routines are: the **scope of works** being requested, the **contract** which is established to undertake the scope of works, the **tender method** and the **approach to market**. This of course goes to the unique way organisations implement their routines, and that analysis of organisational routines needs to happen in the specific, rather than in the abstract (Pentland 2011). A brief discussion of each of these sub-routines is warranted.

The **Scope of Works** is essentially *what* needs to be done. A graphic symbol '✖' is used in the various tables to assist in the differentiation of *Scope of Works* options from other subroutine options.

Examples of a scope of works option are to 'Supply and Install' a piece of machinery, or to 'Construct' a particular building. Thus the scope of works is concerned with *what* needs to be procured. The second sub-routine is the **Contract** itself. A graphic symbol '☒' is used in the various tables to assist

in the differentiation of contract options from other subroutine options. As noted in Chapter 3, a contract establishes the relationship between the contractor and Prolific Projects, and the terms, conditions, remuneration and penalties associated with the particular piece of work being undertaken. Examples include a 'Minor Works' contract, or an 'Alliance' contract. So contracts establish how the work is to be undertaken, and how money will change hands. The third subroutine involves the **Tender** process, and is concerned with when companies are invited to tender for work. A graphic symbol '①' is used in the various tables to assist in the differentiation of Tender options from other subroutine options. An example is one stage process where companies are simply invited to place an offer or tender for work (RFO/Tender). An alternative is a two stage process of 'Registration', where companies must first establish their technical competence before they are able to submit a 'Tender' (Registration → Tender). The fourth sub-routine is the **Approach to Market**, which is essentially concerned with who is invited to tender. A graphic symbol '④' is used in the various tables to assist in the differentiation of Approach to Market options from other subroutine options. Examples include a 'Closed tender' where only a select few companies are invited to tender for work, and an 'Open tender' where the call for tenders is made in an open manner: advertisements are placed in papers and virtually anyone is able to tender to conduct the work.





These sub-routines are interrelated as the scope of works is specified in the contract. Once the tendering process, and approach to market has been determined, the contract is sent out along with tender documentation. Together these four sub-routines form the pattern of action for each procurement routine. As will be shown, there is considerable variety in the actual performance of procurement routines, with each cases using a number of variants of the routine.

As suggested in the previous paragraphs, each of these sub-routines has a number of options, only one of which is selected for implementation in a given project. In other words there are four distinct, although related, sub-routine phases involved in procurement. Each sub-routine has a number of options available, although for each procurement event only a single option was implemented for each sub-routine. All the options available for each sub-routine are detailed in Section 4.4 below.

4.4 SUMMARY OF PROCUREMENT ROUTINES, SUB-ROUTINES, AND ALL OPTIONS AVAILABLE

A full set of all the options available for each of the sub-routines (as identified from the data base and interviews), and is provided below:





Table 32 – Total Set of Options Available for Each Sub-Routine across all cases

	 Scope of Works ¹⁷	 Contracts	 Tender Process	 Approach to Market
Options	<ul style="list-style-type: none"> • Design Manufacture and Test • Provide services • Construction • Supply, deliver and commission • Supply and Install • Supply, deliver and load 	<ul style="list-style-type: none"> • Alliance • Construction Management • Consultancy • Design and Construct • Engineering and Civil Works • Supply • Maintenance • Major Supply And Install • Minor Supply • Minor Works • Services Panel • Repairs • Services • Other 	<ul style="list-style-type: none"> • Registration → Tender • RFI/EOI → Tender • RFO/Tender 	<ul style="list-style-type: none"> • Closed Tender • Prequalified • Sole Tender • Open Tender

A single variant of a routine involves a specific combination of one option from each of the sub-routines. For a full list of all of the variants of the routine, together with the cases and time period(s) in which it was implemented, please see Appendix C).

In order to explain this further, two variants of the routine (Variants #19 and #44) are provided in Table 33 below, by way of example. The format of reporting the specific variants of procurement routines is followed throughout the rest of the thesis in order to provide consistency and help to frame the discussion and analysis of routines and their variants.

Table 33 – Examples of two variants of procurement routines in Prolific Projects

Variant	 Scope of Works	 Contracts	 Tender Process	 Approach to Market
#19	Provide Services	Service	RFO/Tender	Open Tender
#44	Construction	Engineering and Civil Works	RFI/EOI → Tender	Pre-Qualification

As displayed in Table 33, while the pattern of action is the same each time (Scope of Works, Contract, Tender Process, Approach to Market), the specific combination of sub-routine options creates the specific variants of the routine. Thus each specific combination of sub-routine options creates a different variant of the routine.

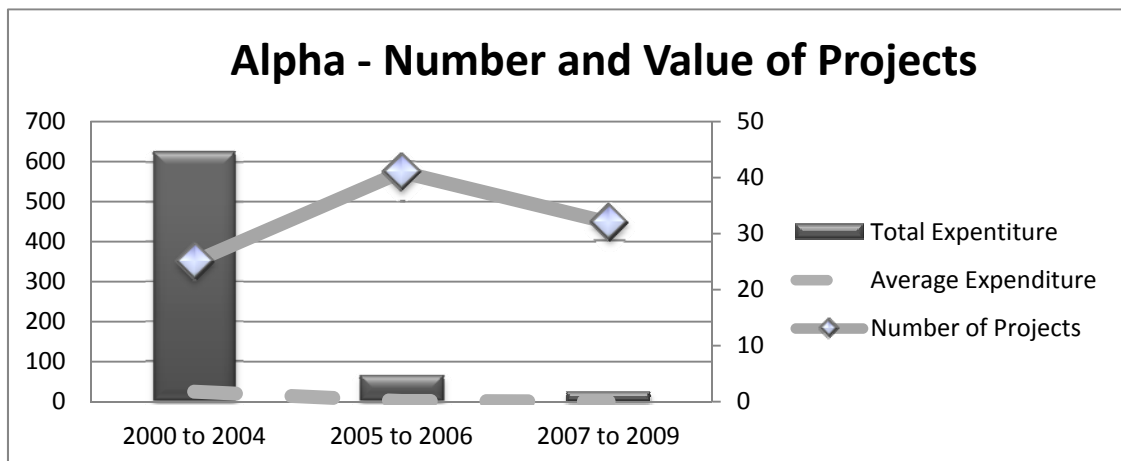
¹⁷ As noted in the methods section, these Scope of Works were created through data reduction. See Section 3.7.2 for details.

Having outlined the cases, and how procurement routines are composed, the remainder of this chapter details the findings from each of the cases – particularly the variety evident in procurement routines, together with the possible causes of such variety. Please note that the first section of each case is largely exploratory – demonstrating the existence of variety. The second part of each case is more explanatory – how selection, adaptation and retention create variety in organisational routines. The first case study (Alpha) is provided below.

4.5 ALPHA CASE STUDY

Alpha implemented a total of 98 procurement events over a ten year period, which had a total value of over \$712 million. The rate of expenditure over time and number of projects was different during each time period. In Period 1, there were 25 projects valued at approximately \$626 million, in Period 2, 41 projects valued at \$64 million, and in Period 3, 32 projects valued at a total of \$32 million (see Figure 13 below).

Figure 13 – Alpha – Number and value of Projects per Time Period



While there was a difference in the total value of contracts over time, a statistical test is needed in order to determine whether this difference is statistically significant or not. Consequently, an Analysis of variance (ANOVA) was conducted in order to test whether there was a significant change in the average value of projects over time, the average number of tenders, or the time taken to process the tender and award the contract. The ANOVA did not report a statistical difference in the average [log] value of projects over time, as the average value of the projects was not significantly different between each time period (see the dotted line in Figure 13 above).

So in total, Alpha implemented nearly 100 procurement events, although there was different value and volume between each of the time periods. The next section examines what sort of variety exists in the procurement routine.

4.5.1 RQ 1 – WHAT SORT OF VARIETY EXISTS IN PROCUREMENT ROUTINES?

Recall from Chapter 2, how different types of variety had been found in organisational routines (see Section 2.3): adaptive, stable, varied, and dynamic. The presence (or absence) of each of these types of variation is considered in turn below. As diversity is the easiest to demonstrate, this will be examined first.

Evidence of Type II Variety – Diverse – Alpha case

This section examines whether there is heterogeneity in the variants of procurement routines in the Alpha Case study. Table 34 below sets out all of the routine variants implemented by Alpha in each of the three time periods.

Table 34 details the specific variants of the procurement routine implemented by Alpha over a ten year period, and has been laid out in order to show the consistency and differentiation between the variants. The first column displays the scope of works for each procurement event. The ‘ditto’ marks (“) indicate that the sub-routine option is the same as the one above¹⁸. The number of times the variant is used is shown under the three time periods, with the total of times used shown in the far right column.

¹⁸ Ditto marks are used in order to reduce the clutter of the table and emphasises at which point the variant is similar and different to others.

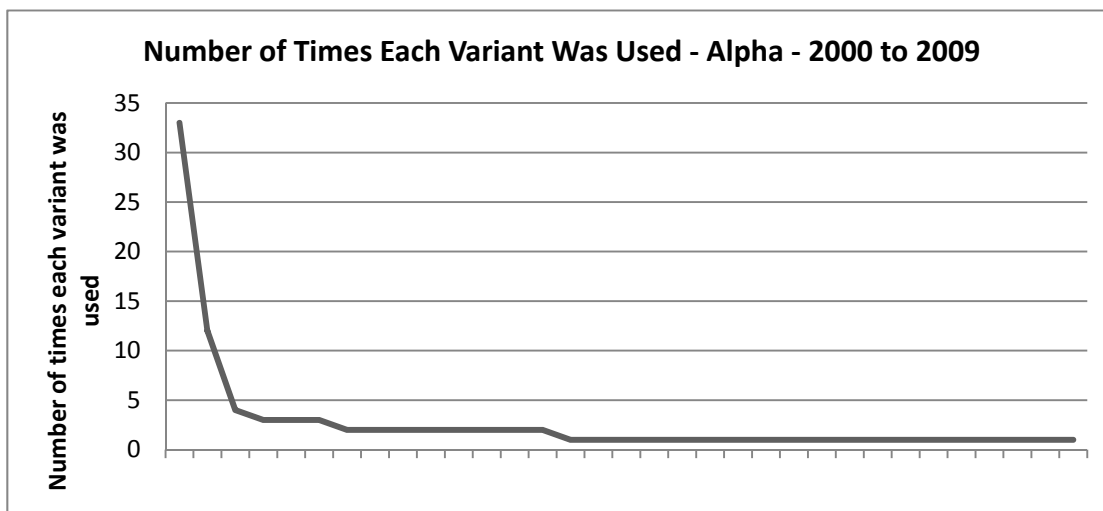
Table 34 – Variants of Routines in Use by Alpha over Three Time Periods

Variant #	Scope of Works	Contracts	Tender Process	Approach to Market	2000 to 2004	2005 to 2006	2007 to 2009	Total	Extension
1	Design, manufacture and test	Supply	RFO/Tender	Open Tender			1	1	* (1)
3	"	Major Supply and Install	RFI/EOI -> Tender	Open Tender	1			1	
4	"	"	RFO/Tender	Closed			1	1	
5	"	"	"	Sole Tender	1			1	* (1)
6	"	"	"	Open Tender	2			2	* (1)
17	Provide services	Service Contract	RFO/Tender	Closed			1	1	
18	"	"	"	Sole Tender	2			2	
19	"	"	"	Open Tender	5	17	11	33	* (15)
22	"	Maintenance services	RFO/Tender	Open Tender		1		1	
31	Construction	Construction Management	RFO/Tender	Closed			1	1	
33	"	Consultancy	RFO/Tender	Closed		1		1	
34	"	"	"	Open Tender		1		1	
38	"	Design and Construct	RFO/Tender	Open Tender		1		1	
44	"	Engineering and Civil Works	RFO/Tender	Closed			1	1	
47	"	"	"	Open Tender		1		1	
48	"	Service Contract	RFO/Tender	Sole Tender		1	2	3	* (1)
49	"	"	"	Open Tender			1	1	
51	"	Supply	RFO/Tender	Sole Tender			1	1	
52	"	"	"	Open Tender		6	6	12	* (4)
53	"	Maintenance services	RFO/Tender	Open Tender	1	1		2	* (1)
58	"	Major Supply and Install	RFO/Tender	Open Tender	1	1		2	
60	"	Minor Supply and Install	RFO/Tender	Open Tender	3	1		4	
66	"	Minor Works	RFO/Tender	Sole Tender			1	1	
67	"	"	"	Open Tender		2	1	3	
77	Supply, deliver and commission	Major Supply and Install	RFO/Tender	Sole Tender	3			3	* (1)
88	Supply and install	Major Supply and Install	RFO/Tender	Closed	1			1	
89	"	"	"	Sole Tender			1	1	
90	"	"	"	Open Tender			2	2	
97	"	Minor Works	RFO/Tender	Open Tender		1	1	2	
98	"	Repairs contract	RFO/Tender	Open Tender	2			2	
103	Supply, deliver and load	Service Contract	Registration -> RFO/Tender	Open Tender	1			1	
104	"	"	RFO/Tender	Closed		1		1	* (1)
106	"	Supply	RFO/Tender	Closed		1		1	
114	"	Minor Supply and Install	RFO/Tender	Open Tender		2		2	

A total of 34 different routine variants were implemented by Alpha over a 10 year period, (see Table 34 for details). Of all the 114 different varieties of routines implemented by Prolific Projects overall, Alpha used approximately only 30% of all of these possible varieties, and 34 routine variants amount to only 3.4% of the total 1008 theoretical varieties, which could have been implemented by Alpha. Thus there was diversity in the number of variants of routines implemented by Alpha.

There are two dominant variants of the procurement routines (# 19, and #52) used by Alpha, which together account for 48.4% of all projects conducted by Alpha in a ten year period. This is reflected in Figure 14 below which reports the number of times each routine was implemented by Alpha – ranked left to right from most used to least used. The distribution follows a Pareto distribution, with a few routines being implemented a number of times, and the long ‘tail’ of specific variants implemented only once or twice. In fact, 24 variants were implemented only once by Alpha.

Figure 14 – Number of Times Individual Variants of Procurement Routines Were Used



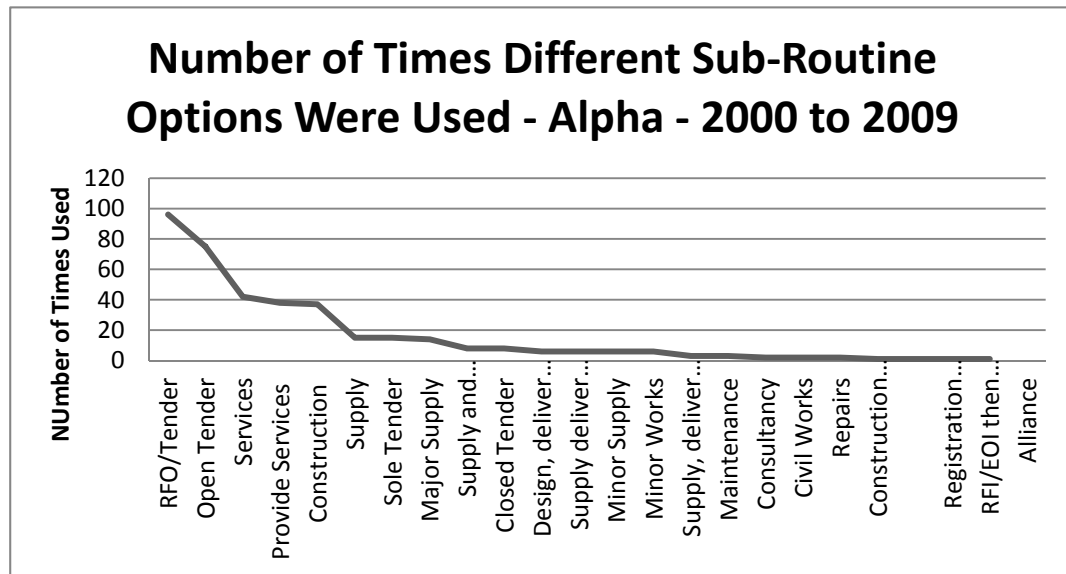
Thus while two variants account for 48% of all procurement events, the other 52% of projects involved a large number of performative variants of the routine which were only used once or twice. So not only is there diversity in the number of variants of the routine, there is also differences in the number of times that each is used. Possible causes of this variety are explored later in the chapter. A preliminary answer to the first Research Question, then, is that there would appear to be diversity (high variety and low change) in the routines implemented by Alpha.

Each routine is comprised of four different sub-routines, and there are a number of options available for selection within each sub-routine. Given that routines are multi-level phenomena (Vromen 2011, 193), and that one of the possible causes of variety is how specific combinations of sub-routines are combined together (Becker 2005b), analysis of variety will also be undertaken at the sub-routine level.

A line graph (Figure 15 below) displays the rate of use of each of the subroutine options over the ten year period (ranked left to right in order of the number of times used). As with routine variants, the

distribution roughly follows a Pareto distribution curve, with some sub-routine options used clearly more than others.

Figure 15 – Number of Times each Sub-Routine was used by Alpha over a ten year period



As Table 34 indicates, and Figure 14 and Figure 15 confirm, there are a number of different varieties of routines implemented over a ten year time period by Alpha. Thus there is diversity in the number of variants of the procurement routine in Alpha, as well as the number of sub-routine options.

Having considered the existence of diversity, the potential for stability will now be examined.

Evidence of Type I Variety – Stable – Alpha Case

Analysis of Table 34 indicates that only one routine variant was used in each time period (#19), although 7 were used in at least two time periods, while 24 routine variants were implemented only once. Thus while there are a number of variants of the routine implemented, there is some evidence of stability at least for one variant of the routine. In other words, Variant #19 was used in each and every time period, accounted for over 35% of all procurement events and was the highest used routine variant overall.

Additionally this variant was extended a total of 15 times along with 9 other routine varieties implemented by Alpha in the 10 year period (see the far right column of Table 34). An extension in one sense is a choice to not implement the procurement routine, but instead to simply extend the existing arrangement. In other words, instead of going back through the whole process of defining scope, developing a contract, calling for tenders, etc. the existing arrangement with a supplier was simply continued.

As one interviewee noted in relation to extensions:

The two extensions had come about because the demand has exceeded the initial expectations and there is a real speed factor hanging on the need to have these extensions in place to be able to meet the demand in the immediate future. It is most expeditious to do it this way given that we have got contracts already in place.

[Interview 12]

Thus at the routine level, while there is variety, there is also stability in the sense of a particular variant of a routine being used to a far greater extent than others. Additionally, this particular variant was extended another 15 times. Thus not just was the variant itself the most used, and the only one used in specific circumstances, but specific arrangements with specific companies were extended on multiple occasions, with speed of delivery being a key contributing factor.

At a sub-routine level, a number of sub-routine options were used in each and every time period as well (see Table 40 below). RFO/Tender became the only Tender option used in Period 2 and Period 3, and thus became a constant in each and every procurement variant used.

Thus, Alpha did not have stability in the sense of only having a single routine variant in use, there was a variant which was used extensively, and was used in each time period. RFO/Tender became the only tender method used in the last two time periods. Thus there is evidence for stability at an individual variant level, and in a specific sub-routine option.

In order to confirm this, Chi squares were requested in order to test the strength and significance of associations between each of the sub-routine options, for each of the time periods.

Chi Square Correlations - Alpha 2000 - 2004

As outlined in the methods chapter, Chi square analysis was undertaken with Fisher's Exact test to test for correlations, and Phi to test for effect, in order to verify the co-occurrence of sub-routine options conducted by Alpha – in the 2000 to 2004 period.

Significant associations were found between:

- Design, Deliver and Test and Major Supply Contract [$\chi^2(1, N=23) = 7.532, p=.014, \phi=.572$]
- Provide Services and Services Contract [$\chi^2(1, N=23) = 18.867, p=.000, \phi=.906$];
- Construction and Minor Supply Contract [$\chi^2(1, N=23) = 12.42, p=.006, \phi=.735$];
- Supply, Deliver and Commission and Major Supply Contract [$\chi^2(1, N=23) = 5.367, p=.047, \phi=.483$];
- Supply and Install and Repairs Contract [$\chi^2(1, N=23) = 14.603, p=.012, \phi=.797$].

There was one statistically significant negative correlation between¹⁹:

¹⁹ Phi can show positive and negative associations. A negative association simply means that the two sub-routine options are not associated with each other and this non-association was statistically significant.

- Provide Services and Major Supply Contract [$\chi^2(1, N=23) = 6.469, p = .013, \phi = -.53$].

Chi Square Correlations - Alpha - 2005 to 2006

Chi square analysis was undertaken with Fisher's Exact test to test for correlations, and Phi to test for effect, in order to verify the co-occurrence between sub-routine options conducted by Alpha – in the 2005 to 2006 period.

Significant correlations were found between:

- Provide Services and Services Contract [$\chi^2(1, 39) = 27.977, p < .001, \phi = .847$];
- Construction and Supply Contract [$\chi^2(1, 39) = 7.042, p = .013, \phi = .425$];
- Supply and load and Minor Supply Contract [$\chi^2(1, 39) = 11.236, p = .023, \phi = .537$].

Significant negative correlations were found between:

- Provide Services and Supply Contract [$\chi^2(1, 39) = 7.313, p = .010, \phi = -.433$].
- Construction and Services Contract [$\chi^2(1, 39) = 19.585, p < .001, \phi = -.709$].

Chi Square Correlations - Alpha - 2007 to 2009

Chi square analysis was undertaken with Fisher's Exact test to test for correlations, and Phi to test for effect, in order to determine the strength of association between sub-routine options conducted by Alpha – in the 2007 to 2009 period.

Significant associations were found between:

- Provide Services and Services Contract [$\chi^2(1, 32) = 21.760, p < .001, \phi = .825$];
- Construction and Supply Contract [$\chi^2(1, 32) = 8.296, p = .010, \phi = .509$].
- Supply and Install and Major Supply Contract [$\chi^2(1, 32) = 16.327, p = .003, \phi = .714$].

There were also a couple of negative correlations again:

- Provide Services and Supply Contract [$\chi^2(1, 32) = 6.400, p = .014, \phi = -.447$];
- Construction and Services Contract [$\chi^2(1, 32) = 6.472, p = .016, \phi = -.450$].

Thus in each time period there were a series of strong correlations between sub-routine options. Such associations are important as it is highly unlikely that such association has occurred purely by chance.

Only one combination of sub routines (Provide Services and Services) was significantly related in every time period (Period 1: [$\chi^2(1, N=23) = 18.867, p = .000, \phi = .906$]; Period 2: [$\chi^2(1, 39) = 27.977, p < .001, \phi = .847$]; Period 3 [$\chi^2(1, 32) = 21.760, p < .001, \phi = .825$]). Construction and Supply Contracts were significantly related in the last two periods (Period 2 [$\chi^2(1, 39) = 7.042, p = .013, \phi = .425$]; Period 3 [$\chi^2(1, 32) = 8.296, p = .010, \phi = .509$]).

Thus Chi Square analysis indicated that there are a number of statistically significant associations between sub-routine options in each time period. One of these associations was significant in each

time period, and one was significant in two consecutive time periods. RFO/Tender became a constant in the last two time periods, to such an extent that chi squares could not be calculated. These correlations suggest stability of association between sub-routine options. Notably, the only routine variant present in each time period (#19) involved Provide services and Services contracts, and this association was shown to be significant in each and every time period. Additionally, the inability to calculate chi squares due to RFO/Tender being a constant in the calculations, is also evidence of the stability of this sub-routine option in the last two time periods.

Consequently there is evidence of stability with one variant of the routine used in each time period, and a number of sub-routine options were statistically associated with each other in each time period. Additionally, RFO/Tender became the sole method of tendering in the last two time periods.

Having considered diversity and stability, the possibility of adaptivity in routines is considered next.

Evidence of Type III Variety – Adaptive – Alpha case

In each time period a number of new variants of the procurement routine were implemented, predominantly through recombination of existing sub-routine options. For example, the combination of 'Minor Supply and Install Contract', 'RFO/Tender' and 'Open Tender' was used with Construction scope of works (Variant #60) in Time Period 1. In Time Period 2, 'Minor Supply and Install Contract', 'RFO/Tender' and 'Open Tender' were used with 'Supply, deliver and load' scope of works (Variant #114), which had been used already in Period 1 in another variant. Thus for Alpha, some new variants were created through recombination of existing sub-routine options.

However recombination is not adaptation in the sense of introducing something new to the organisation. The best way to track adaption is to note when a new sub-routine option is introduced into the repertoire. Table 35 outlines the various sub-routine options in use in each time period. The appearance of a new sub-routine option, not previously used by the organisation is marked in **bold**.

Table 35 – Sub-Routine Options in Use – Alpha

Sub-Routine	Option	2000 to 2004	2005 to 2006	2007 to 2009	Total
Scope of Works Clusters	Design, deliver and test	4		2	6
	Provide Services	8	18	12	38
	Construction	5	18	14	37
	Supply, deliver & commission	3			3
	Supply and install	3	1	4	8
	Supply deliver and load	2	4		6
Contracts	Construction Management			1	1
	Consultancy		2		2
	Design and Construct		1		1
	Civil Works		1	1	2
	Supply		7	8	15

	Maintenance	1	2		3
	Major Supply and Install	9	1	4	14
	Minor Supply and Install	3	3		6
	Minor Works		3	3	6
	Repairs	2			2
	Services	8	19	15	42
Tender Process	Registration then Tender	1			1
	RFI/EOI then Tender	1			1
	RFO/Tender	23	41	32	96
Approach to Market	Closed Tender	1	3	4	8
	Sole Tender	7	3	5	15
	Open Tender	17	35	23	75

Examining Table 35 it is clear that there are a number of new sub-routine options introduced in each time period. Consider the second row of sub-routines – which is the set of contracts implemented. Over time, the number of different contracts used increased from 5 in 2000 to 2004, to 9 in 2005 to 2006, and back to 6 in 2007 to 2009. At the third level (Tender) there is a rationalisation over time, so that in the last two time period, only one Tender Method (RFO/Tender) is in use in every single time period²⁰. Thus while there is variety, there is also change over time in the repertoire of routines.

Consequently in answer to the first research question, procurement routines in Alpha also demonstrate adaptation over time, as a number of new sub-routine options are introduced in each time period. Thus new sub-routine options are combined with existing sub-routine options to create new variants of the routine. This is discussed further in the section on adaptation and variety below (Section 4.5.3).

Having examined diversity, stability and adaptivity, the next section examines whether this constitutes a dynamic form of variety.

Evidence of Type IV Variety – Dynamic– Alpha Case

As noted in the earlier section, no one single routine variant completely dominated the way Alpha undertook procurement. However, there is some evidence of stability – with one variant of a routine used in each time period, and a number of sub-routine options used in each time period, while RFO/Tender became the only means of tendering in Time Periods 2 and 3. There is evidence of variety – with multiple different variants of the routine, as well as multiple options for selection in the sub-routines. There is also a set of new sub-routine options introduced in each time period,

²⁰ Incidentally this made Chi Square analysis of the relationship between contracts and tender, and tender and approach to market to be impossible, as Tender became a constant in each and every chi square calculation.

which were combined with existing sub-routine options to create new variants of the routine. Thus there is evidence of some stability, adaptation, as well as variety in Alpha.

As each variant of a routine is a specific combination of sub-routine options, there was a possibility that there may be an underlying pattern in the data. Given the binary nature of the data, that overall patterns are being examined, rather than simple variables, and that there are very long ‘tails’ in the data, statistical analysis is quite difficult. However, as the ‘tails’ indicate variety, it is impossible to simply ignore them in the context of this study. Statistically, one way of identifying underlying patterns in data is through a Principal Component Analysis (see Section 3.9.2. for the explanation of this).

Principal Component Analysis

As noted in the methods chapter, Principal Component Analysis (PCA) is a method of identifying patterns in data, which in the case of this study is to identify whether various options selected for implementation by a given case study might be selected in conjunction with each other, or whether there is evidence of stability and variation. In other words, within the array of correlations between the sub-routine options, the Principal Component Analysis looks for distinct statistical groupings of the data²¹. In terms of stability and correlation, as well as variance, PCA is one way of identifying structure in complex data sets.

A matrix of the co-occurrence of sub-routine options for this case was developed. This provided a simple count of the number of times each sub-routine option occurred with other sub-routine options in a specific variant, with non-occurrence coded as a ‘0’. A PCA with oblique rotation and Kaiser Normalisation was requested from SPSS on the matrix of the co-occurrence of sub-routines, for all procurement events implemented by Alpha. Analysis of the scree plot indicated there were two components present in the data. This was confirmed through the extracted sum of loadings (reported in Table 36) which shows that these two components, explained 96% of variance between them.

Table 36 – Total Variance Explained in components identified by PCA analysis of sub-routine options – Alpha study

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	1537.783	88.023	88.023
2	139.353	7.977	96.000

²¹ PCA is used here in preference to Factor Analysis as no assumption is being made about underlying factors and no model is being presumed or tested. Instead the focus is simply to identify any correlations between sub-routine options.

In other words, just two components accounted for most of the data. The full structure matrix with component loadings is provided below in Table 37:

Table 37 – Structure Matrix for rescaled component loadings of PCA Analysis

	Rescaled Component	
	1	2
✂ Construction	0.978	-0.291
✂ Supply	0.905	-0.235
① RFO Tender	0.874	-0.77
↔ Open Tender	0.835	-0.804
✂ Design and construct	0.781	-0.276
📦 Minor Supply and Install	0.773	-0.321
📦 Minor Works	0.772	-0.285
📦 Maintenance	0.745	-0.439
📦 Consultancy	0.697	-0.154
📦 Engineering and Civil Works	0.697	-0.154
📦 Major Supply and Install	0.582	-0.244
✂ Supply and Install	0.576	-0.339
↔ Sole Tender	0.559	-0.273
📦 Repairs	0.507	-0.351
✂ Design Manufacture Test	0.493	-0.248
📦 Construction Management	0.487	-0.011
↔ Closed Tender	0.48	-0.238
✂ Supply Deliver and Load	0.455	-0.397
✂ Supply, Deliver & Commission	0.286	-0.076
① RFI / EOI → Tender	0.132	-0.078
✂ Provides Services	0.51	-0.986
📦 Services Contract	0.536	-0.976
① Registration → Tender	0.085	-0.416

Legend: ✂ Scope of Works 📦 Contract ① Tender Process ↔ Approach to Market

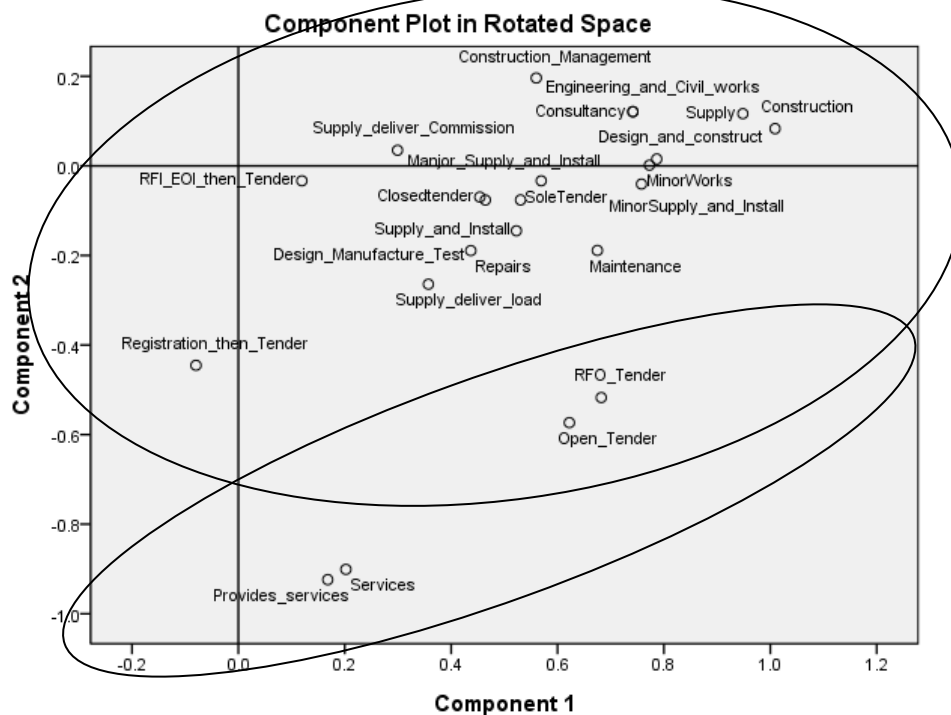
The rotated solution revealed the presence of a fairly simple structure of components, each with strong loadings, although there is a fair degree of cross loading. Each sub-routine loaded on at least one component, although two sub-routines loaded significantly across more than one component. It is important to note, given the sparse nature of some of the binary data, only correlations over .71, which (Comrey and Lee 1992, 243) rate as excellent, are given credence.

Analysis of Component 1 shows that it is focused on the construction and supply of components or materials related to operations of Alpha, including the minor works and maintenance, and explained most of the variance in the matrix (88%). Component 2 is specifically related to the provision of services, rather than the purchasing of assets, and identifies less of the variance (8%).

There is significant high level cross loading of RFO/Tender and Open Tender sub-routines between the two components. This is largely due to the fact that RFO/Tender and Open tender are used in nearly every procurement event, particularly in Periods 2 and 3. Thus the variation is not so much in the tendering process but in the activities being undertaken, and the contracts being used. The very high factor loadings are highly instructive as they indicate a strong association with the component. As PCA is a measure which explains variety, it makes sense that the four sub-routine options which

were most correlated a) formed a coherent component, and b) explained less variety, as they occurred together more frequently. The two distinct components can be seen visually in Figure 16 below (the circles indicating the components are mine). Thus PCA has identified two coherent components (which use the same tendering processes).

Figure 16 – Plot of Principal Component Analysis of Sub-Routines Options Used by Alpha – with Oblimax Rotation



When considering selection, Alpha, while primarily using the same tendering processes, had two distinct sets (components) of processes – one around the procurement of assets themselves, and the second around the procurement of services in relation to those assets. Thus the Principal Component Analysis has confirmed that there are two sets of sub-routines, and these relate to the purchasing of different things. One relates primarily to the purchasing of construction activities, and the other to the purchasing of services.

What the PCA demonstrates, particularly in Figure 16, is that there is both variety and stability in the procurement routine variants implemented by Alpha. The variety in the data is clearly shown by the first component which is grouped together and statistically accounts for most of the variety in the combination of sub-routine options. Some of this variety has already been shown to be due to the introduction of new sub-routine options. Stability is shown with the cross loading of RFO/Tender and Open Tender between the two components, as these two became strongly associated with every procurement activity Alpha undertook, and in fact RFO/Tender became the only tender option used. Additionally, the most used routine variant (#19) was recognised as a statistical component in the

data, separate from the rest of sub-routine options in use. Thus in the one data set, there is evidence of stability, adaptation and heterogeneity.

Thus in terms of Research Question 1, simple count and graph data, as well as chi squares and PCA, have provided evidence of stability, diversity, and adaptivity in the routine variants implemented by Alpha. The existence of diversity and adaption suggests that a dynamic form of variety is present in Alpha. Thus there is evidence of all four types of variety in the Alpha case study.

The second research question is considered next.

4.5.2 RESEARCH QUESTION 2: SELECTION AND VARIETY- ALPHA CASE

As argued in the literature review, selection involves the choice between various options. Routines are comprised of a set of sub-routines, and each sub-routine has a set of options available for selection. A variant is created through the selection of a single option for each of all four sub-routines. Selection then, is where sub-routine options are chosen together to form a particular variant of a routine.

In order to analyse this, counts were made from Table 34 above, of the number of routine variants in use in each time period, and the number of new variants which were created from a recombination of existing sub-routine options. The results of this are set out in Table 38 below.

Table 38 – Recombination of routines over time – Alpha

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of variants in use	12	16	15
Number of new variants due to recombination	-	5	9
% of variants due to recombination		31%	60%

In order to aid in the interpretation of Table 38, the following explanation of each of the rows might be helpful. Number of variants in use is the total count of variants in use in each time period. Number of new variants due to recombination, means that the variants are new in a given time period, but each of the sub-routine options from which it was comprised, was present in the previous time period. Thus while the variant is new, it is new due to recombination of existing sub-routine options, rather than introduction of a new sub-routine option, which I have defined as adaptation.

As Table 38 shows, 5 variants in Period 2 (31%) and 9 in Period 3 (60%) were not as the result of the introduction of new sub-routine options, but were created by recombination of the existing pool of options already available. This was determined manually, by considering only those variants which were comprised of sub-routine options which occurred in the first time period.

The chi squares and the PCA have already indicated that the association between certain sets of sub-routine options were highly unlikely to have occurred by chance. Within Alpha, the interviews indicated that there was in fact a deliberate process of selection involved in approaching the market. For example:

... the tendering process if you like, you know, do you just go out for a straight public tender, ad in the paper, any Joe Bloggs around the country or world can tender for this job...then there is a restricted tender, you might not want to have to evaluate twenty or thirty tenderers ... [Interview 13]

The interviewee then went on to describe the way tendering was approached:

You could have a process of a two-step tendering process in which you basically have the initial step which is to shortlist, might call it an expression of interests, pre-registration or pre-qualification and then you select out of a pool through that tendering process, the ones that you are going to go and ask them to price the job... All those combinations, you need to choose one of each of those and then come up with the final thing [Interview 13]

In other words, for tendering there was a combination made up from the different options available, and a choice must be made between these options.

Likewise for contracts, there is a process of selection – which seems to relate to the specific nature of the project. For example, there is a specific logic about when to use construction management as opposed to another form of contract:

Again you just need to match the right contract with the right circumstances, construction management was very successful at DI1 with the contract we had, but you wouldn't use it for a \$1million job where you know you are going to get Joe Bloggs and Billy Smith who you know ... won't know how to do it [Interview 13]

This is confirmed by another interviewee:

So the specifications or the contract documents are written specifically for a particular type of procurement, such as a major construction, minor construction, equipment with installation, equipment without installation, yes he's got a suite of documents that are appropriate to a particular type of project [Interview 8]

For Alpha, it seems that people undertaking the selection were aware of the options, and made a deliberate choice to use a specific tender method and contract. The nature of the job, timeframes and personnel all play a part in the decision process:

obviously the nature and size of the job is important, the timeframes that you have to get this work done in, the market conditions that are applicable at the time you are going to go for tender ... there is also the personnel that you've got to administer the contract [Interview 13]

In fact some forms of contract may not be used unless the people with the right capabilities to manage the specific form of contract are available:

Our existing contract engineers are used to those other forms of contract so in the case of construction management, they haven't got any expertise in construction management contracts [name deleted] is the only one that really knows how to manage it [Interview 5]

So these factors – the nature of the project, and the capabilities of the people all influence the decision process:

You've got to tailor this to what you are trying to do so there is no, this isn't the answer for any procurement solution by any stretch of the imagination, but we as a project team tailored this to suit what we want to do, and it all depends on the culture of the organisation that you work in and the people that you have on your project team and what their capabilities are. [Interview 3]

Interview data thus corroborates the chi square and Principal Component Analysis which indicated that selection is a non-random process. There would appear to be a set of internal and external factors involved in selecting sub-routines. Indeed, selection seems to operate from the repertoire of sub-routines level, with specific internal and external conditions affecting which contract is chosen, which tender method is used, and which approach to market was deployed.

In this case study, selection creates variety by choosing from an existing pool of sub-routine options and recombining these in order to create new varieties. This finding is consistent with the view of Campbell (1965) who argued selection is a process of choosing between various alternatives. While Levinthal (2006) argues that organisations choose to act from a repertoire of existing routines, it would seem from this case study, that selection operates at the sub-routine level – a selection of options in the sub-routines, which are put together into a specific variant of a routine, and this creates variety. Having considered selection in relation to variety, adaptation is considered next.

4.5.3 RESEARCH QUESTION 3: ADAPTATION AND VARIETY – ALPHA CASE

As argued in the literature review, selection involves the choice of various options. In each time period there were a set of sub-routine variants chosen, and variety was created through recombination of existing sub-routine options. However, this was not the case for every new routine variant. Table 39 provides the number of new routine variants created due to adaptation in each time period:

Table 39 – Number of New Routines due to adaptive processes (Alpha case)

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in Use	12	16	15
Number of new routine variants from adaptation	-	7	1
% of new routine variants as a result of adaptation	-	44%	7%

As Table 39 shows, there were 7 routines in Period 2 and 1 in Period 3 which were as a result of adaptation. The number of new routine variants due to adaptation was determined by identifying the new variants, and verifying that at least one of its component sub-routine options was *not* present in the previous time period. In other words the new variety is as the result of adaptive processes which introduced new sub-routine options, not just simply the recombination of existing sub-routine options. Table 40 provides the number of sub-routine options which were new in each time period.

Table 40 – Number of new Sub-Routine Options Over Time – Alpha

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	17	17	14
Number of new sub-routines options	-	5	1

Comparing the data from Table 39 and Table 40 shows that in Period 2, there were 7 new routine variants which included at least one of the 5 new sub-routine options which had not been in used previously. In Period 3, there was one new routine variant, which included the single new sub-routine option introduced.

Thus adaptation increases variety by providing new sub-routine options which can be selected for inclusion in the routine variants. Following the language of routines, adaptation increases variety by increasing the repertoire of sub-routine options. Increasing the repertoire of sub-routine options increases the total number available for selection, and therefore the total number of potential combinations of sub-routine options (variants).

Reasons for Adapting Specific Sub-routine Options

Several reasons were provided by interviewees for the introduction of new sub-routine options:

Engineering and Civil Works Contracts

When asked for the reasons for introducing the new Engineering and Civil Works contract in Period 2, Interview 5 noted:

we took a decision that we needed to be a bit more in line with the rest of the ... industry so we did a review and agreed that we would move away from [the previous in house contract] to um, engineering and civil works contracts [Interview 5]

Prior to this, Alpha had used some propriety contracts which contractors were not necessarily familiar with. This was true not just for engineering and civil works contracts, but also for the majority of other forms of contracts implemented by Alpha in Periods 2 and 3. As the interviewee explained:

by moving to an industry ... standard, then it levels the playing field out for everybody. All the contractors are familiar with those terms, we've got some slight amendments, but they are not overly complicated so all contractors then know they are going to bid for work with Prolific Projects, it is engineering and civil works contract [Interview 5]

The expectation was that a contract which aligned with the industry standard, would include terms and conditions familiar to the majority of suppliers. The expectation was that this would increase the number of suppliers who would apply, as they would be familiar with the terms and conditions [Interview 5]. Thus the innovation here was a deliberate decision to cease using a propriety form of contract and adopt an industry standard form of contract, with the expectation that this would increase the number of tenders received.

In order to corroborate this, an Analysis of Variance (ANOVA) was undertaken to see if there was a difference in the number of tenders received by Alpha in Period 2 and Period 3. There was a significant difference in the [log] number of tenders received [$F(2, 94)=8.32, p<.001$]. The size of the effect, using η^2 was 0.177, which according to Cohen (1988) is a large effect. Post hoc analysis, using Tukey HSD, showed that there were significantly less tenders in Period 1 ($M=0.43, SD=0.64$), compared to both Period 2 ($M=1.22, SD=0.91$) and Period 3 ($M=1.36, SD=1.05$). Thus, there were considerably less tenders received by Alpha for projects in Period 1 compared to the other two time periods. The ANOVA thus supports the information from the interviews, that there was an increase in the number of tenders received following the introduction of standard forms of contract.

Construction management

The logic behind the introduction of construction management was a bit different to engineering and civil works contracts, although again – the nature of the job drove the choice of contract. The key reason seemed to be that while the nature of the work to be tendered out is most often specified up front in the contract, in the case of the particular project (DI1) this was not possible:

[there] are significant risks plural, and the project cannot be accurately documented um as far as um the work that will need to be done.... there were an incredible number of similar unknowns, we didn't have and couldn't find, search as we may, drawings for the existing buildings. We didn't know what we were in for [Interview 4]

Thus for a specific project, the detailed activities required in the contract could not easily be specified in the contract up front, as it was unknown. The construction management contract can cope with this uncertainty as both design and construction teams are engaged concurrently and work together, instead of a process of designing first and building second (McLagan 1991, 159-160). As the existing repertoire of contract options did not include a form of contract which could handle this uncertainty, an alternative form of contract was introduced to meet the needs of the specific situation.

Introduction of stage gate process

While most of the adaptation noted in the case study revolved around the introduction of new sub-routine options, the additional gateways would be required to give the go ahead for expensive procurement projects. Gateways are internal approval processes which need to be gained, before progressing to the next stage of the procurement process.

If it is a major project over \$20 million it has to go through a gateway after the concept, after the pre-feasibility and after the feasibility. Then there has to be a project review at the end of the execution process [Interview 4]

Design, Build and Maintain

A final innovation, which is still in the early stages of implementation and is not in the database, is what could be termed, design, build and maintain approach to procurement. Historically, Prolific Projects maintained much of their own engineering assets. This particular project was implemented specifically in order to contract out the maintenance as well as the design and construction of a specific asset:

the project started off really just as procurement of new Asset 3c and then that stock will be maintained by Prolific Projects, but we are approaching it now rather differently, we are looking at it as a whole of life procurement for its' design, build and maintain for whole of life and whole of life is typically about twenty years. [Interview 3]

The process includes an additional stage after initial tendering which involves a series of workshops to refine the details of the proposals.

We are currently preparing for a request for proposal process where we have a performance specification, where we will be looking for some sort of proposal and then there will be an assessment process which will consist of a series of workshops to refine the details of that proposal and then best and final offer process. That includes not only the procurement of the critical assets, but [also] building maintenance facilities and undertaking maintenance contracts associated with that critical assets [Interview 12]

This project involves more than just procurement and goes to a core strategic decision by the organisation about whether to make or buy a particular asset or service – in this case maintenance.

The role of new people in introducing new sub-routine options

One of the key ways that innovation was implemented in Alpha was by bringing in new people from outside the organisation. As an interviewee explained:

That is another reason you want outside people and then when you look at outside people you look at it and say these people if you just employ them and if they work on the plan that nobody else is going learn, then they should have some influence in the way of thinking about the business, so if you bring them in at a level where they can influence the organisation and the unit. ... so you set up a structure and you bring in other people to learn and also to have respect for each other to work together, because they have all got their own strength and weaknesses
[Interview 7]

Thus for engineering and civil works contracts, the innovation was to align company processes with industry standards. For construction management, the existing set of contract options did not contain an appropriate response to a specific situation, so a new contract was introduced. For design-build-maintain, the choice was made to outsource maintenance arrangements for a particular asset. Whatever the reason for the new option, adaptation creates variety by introducing new sub-routine options, which are used in the creation of new variants of the routine.

4.5.4 RESEARCH QUESTION 4: RETENTION AND VARIETY – ALPHA CASE

As noted in the literature review, retention involves the retaining in memory of organisational routines (Nelson and Winter 1997). One way of determining this is to identify those variants of a routine which are implemented in two successive time periods. This would show the number of times a routine continued in use, or was retained. Likewise, a count could also be made of the number of variants of a routine which did not continue from one time period to the next. Both of these counts are shown in Table 41 below.

Table 41 – Number of Routine Variants Retained (continued) in organisational memory - Alpha

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in use	12	16	15
Number of Routine variants continued	-	4 (25%)	5 (33%)
Number of Routine variants discontinued	-	8 (50%)	11 (73%)

In terms of retention then, a number of routine variants were continued from one time period to the next (4 in Period 2 and 5 in Period 3). In other words the variant remained largely unchanged between these times (although as noted earlier in the case, only one routine variant remained in use for each of the three time periods). However a number of routines were *not* retained between time periods with 8 in Period 2 and 11 in Period 3, not continuing from period to period. Thus there is evidence of routine variants both being remembered and re-used, as well as others not being re-used, and possibly forgotten.

The story is slightly different at the sub-routine option level, however (see Table 42 below).

Table 42 – Number of sub-routine options retained in organisational memory - Alpha

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	17	17	14
Number of sub-routine options continued	-	12 (71%)	12 (86%)
Number of sub-routine options discontinued	-	5	5
Number of sub-routine options re-introduced	-	-	1

In terms of retention, a number of sub-routine options were discontinued (5 in Period 2, and 5 in Period 3). Discontinuation means that the sub-routine option was used in one time period, but not in the second. However, a larger number were retained and used in subsequent time periods (12 in Period 2, and 12 in Period 3). Interestingly, one sub-routine option (design, deliver and test) from Period 1 is reintroduced in Period 3. In other words the sub-routine option was reintroduced after a break in use. This provides support for the notion that routines involve organisational memory, as the sub-routine was not actually forgotten, but reintroduced years later.

Thus at a sub-routine level, in each period there are new sub-routine options introduced, existing sub-routine options which are continued, and a number which are discontinued. Compared to variants of routines, there is a much stronger retention, in terms of continued use, of sub-routine options over time.

Beyond selection from existing sub-routine options, and introduction of new sub-routine options, this suggests that there is an ongoing process of retention in which some routine variants and sub-routine options are continued over time, whereas others are left aside. If all sub-routine options had continued, a total of 23 (17+ 5 + 1) would have been in operation in Period 3. Instead there is a dynamic of remembering and maintaining the use of existing sub-routine options, introduction of new-sub-routine options, and the non-use and potential forgetting of certain sub-routine options. Additionally, one sub-routine option (Design, deliver and test) which was not used in Period 2, reappears in Period 3 after an absence of 2 years, which indicates that sub-routines are not necessarily forgotten, but can be retained in organisational memory for later use. All this goes to support the notion that selection, adaptation and retention are inter-related dynamics which together affect variety in organisational routines. Part of the non-use of specific options may be due to the introduction of a more formal review process into the procurement of engineering assets within Alpha.

Review process for projects

Alpha has introduced a process of attempting to learn from each procurement project:

That is just part of our tracking process that we are trying to put together now where the outcomes of every project are discussed and those issues that we would

need to pick up in a like project in the future need to be recorded somewhere
[Interview 8]

Qualitative examination of the tables of routines implemented thus shows that there has been retention of routine variants and sub-routine options; adaptation (through the introduction of new subroutine options), and recombination of existing sub-routine options into new variants of the routine. Over time, the introduction of new sub-routines, and retention of the majority of sub-routines results in increased repertoire of sub-routines.

In answer to the research question then, retention affects variety by the net number of routine variants and sub-routine options which are retained in organisational memory from period to period. If all routine variants (or sub-routine options) were kept from one period to the next, and adaptation kept adding new ones, there would be steady increase in their number over time. For this case, that would have meant $12+12+10=34$ routine variants, and $17+5+1=23$ sub-routine options. However, not all routine variants, or sub-routine options are retained, and thus the total pool of routines and sub-routines in use in the final time period was actually less than at other time periods. However, the reintroduction of the sub-routine after an absence of a couple of years leaves open the question about how big the actual repertoire of sub-routines really is. It would seem that the 'non-use' of a particular sub-routine option, is not the same thing as 'forgetting' a sub-routine option.

4.5.5 SELECTION, ADAPTATION AND RETENTION IN RELATION TO THE OSTENSIVE, PERFORMATIVE AND ARTEFACT ELEMENTS OF ROUTINES

In terms of the ostensive, performative and artefact elements of routines (Feldman and Pentland 2003; Pentland and Feldman 2005) in selection occurs from the ostensive element of the routine, is performed in the performative, and is recorded in the artefact element of the routine (as is evidenced by the records in the database). This is because a choice is made before enactment. It is clear from the interviews that there is clear understanding amongst individuals concerning what a specific sub-routine might achieve for an organisation. While adaptation often follows reflection on the outcomes of previous enactments (e.g. the stage gate process above), in the case of the design, build maintain contract above, the adaptation of the ostensive can happen in advance of the performative (e.g. the design, build, maintain contract above). What is being adapted in each case is the ostensive element of the routine, as the change is occurring in the understanding or operation of a future enactment of the sub-routine option. Following implementation, there is a review of the performance of the routine – and those which perform adequately are retained. However, what is retained is not the performance itself, but rather a mental picture of the performance – the ostensive element. Each sub-routine option which was selected, and adapted, is recorded in the database. The database also provided evidence of those sub-routine options which were retained over time.

4.5.6 SUMMARY – ALPHA CASE

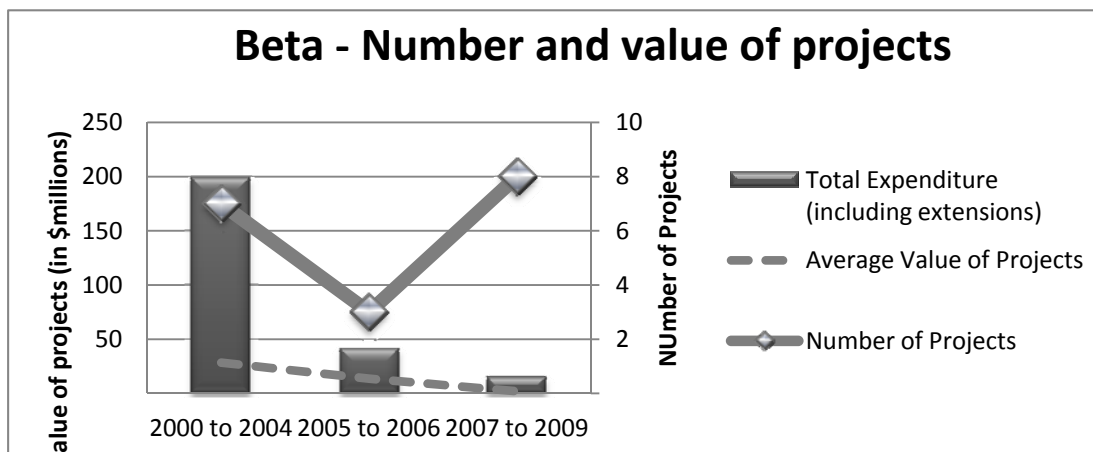
In conclusion, this case study has provided evidence of stability, diversity and adaptation, and dynamic variety at the routine and sub-routine level. Selection has been shown to create variety by recombining existing sub-routine options in new ways, thus creating new varieties of the routine. Adaptation affects variety by increasing the repertoire of sub-routine options available for selection. Retention affects variation by retaining, or removing, from organisational memory the specific pattern of routines or sub-routines from one time period to the next.

Having explored each of the research questions in Alpha, the Beta case study can be examined next.

4.6 BETA CASE STUDY

Beta implemented a total of 18 projects over a ten year period, with a total value of over \$ 255 million. There was a different rate of expenditure over this time period, and a different number of projects in each time period. In Period 1, Beta had 7 projects, valued at approximately \$199 million (average of \$22 million); in Period 2, 3 projects valued at \$41 million (average of \$5million) and in Period 3, 8 projects valued at approximately \$15 million (average of <\$1 million) (See Figure 17 below). In comparison, the average cost of projects in Prolific Projects was \$3.31 million. So for two out of three periods, Beta purchased assets worth considerably more than the average value of projects for Prolific Projects as a whole.

Figure 17 – Number and Value of Projects per Time Period - Beta



While there was a difference in the total value of each procurement project, a statistical test is needed in order to determine whether this difference is statistically significant or not. Consequently, an Analysis of Variance (ANOVA) was conducted in order to test whether there was a significant change in the average value of projects over time. The ANOVA showed that there was no statistical difference in the average [log] value of projects over time, nor in the [log] of tenders nor of the [log] of time taken between tender and contract.

4.6.1 RQ 1 – WHAT SORT OF VARIETY EXISTS IN PROCUREMENT ROUTINES?

As with Alpha Case Study, exploration of the different types of variety: adaptive, stable, varied and dynamic are made in this case study. Firstly, diversity is examined.

Table 43 – Varieties of Routines in Use – Beta

Variant #	Scope of Works	Contract	Tender Process	Approach to Market	2000 to 2004	2005 to 2006	2007 to 2009	Total	Extension (*)
2	Design, manufacture and test	Major Supply	Registration -> RFO/Tender	Closed	1			1	
4	"	"	RFO/Tender	Closed	1			1	*
5	"	"	"	Sole Tender	2			2	*
6	"	"	"	Open Tender	1	1		2	
13	Provide services	Engineering and Civil Works	RFO/Tender	Sole Tender			1	1	
30	Construction	Alliance	RFO/Tender	Open Tender			2	2	
47	"	Engineering and Civil Works	RFO/Tender	Open Tender			2	2	
57	"	Major Supply	RFO/Tender	Sole Tender		1	1	2	
58	"	"	"	Open Tender	1			1	
67	"	Minor Works	RFO/Tender	Open Tender			1	1	
90	Supply and install	Major Supply and	RFO/Tender	Open Tender			1	1	
92	"	Minor Supply	RFO/Tender	Open Tender		1		1	

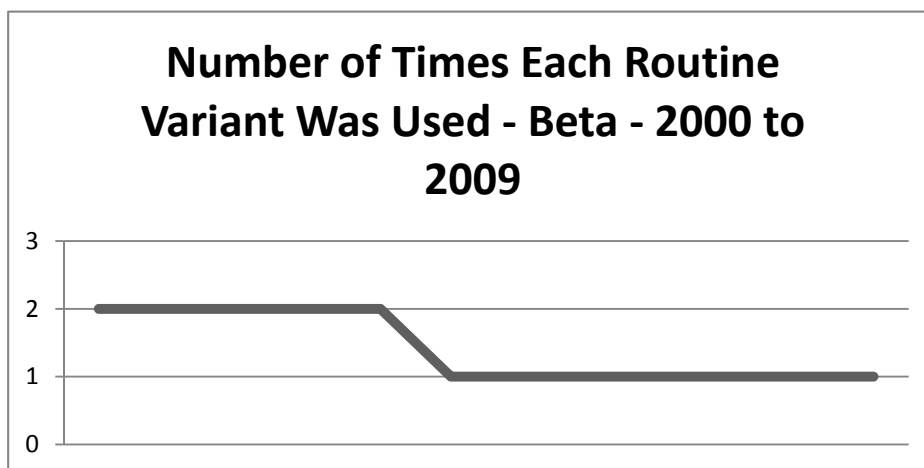
* Initial contract was extended beyond original end date – rather than going to market again

Evidence of Type II Variety – Diverse – Beta case

This section presents evidence for diversity in organisational routines, by identifying the set of routine variants implemented by Beta. A total of 12 different variants of the routine were implemented by Beta over a 10 year period (See Table 43). 12 routines amount to approximately 10.5% of all routines in use by Prolific Projects (although this is only 1.19% out of the total 1008 theoretical combination of sub-routines which could have been implemented). A contingency table of all routines for the case is set out above.

Table 43 shows that only a few variants of the routine were used. Only three types of contract (Major Supply and Install, Engineering and Civil Works and Alliances were used) and two types of tendering (RFO/Tender and Registration → Tender), 4 Scope of Works (Design, manufacture and deliver; Provide services, Construction and Supply and Install) and 3 approaches to market were used (Closed, Open and Sole Tender). That said, the variants are quite sparse, with every variant only being used once or twice. Consequently, there was no single dominant routine during this time period, partly because the number of projects was also quite small – only 17 projects conducted over a 10 year time period. While 12 routine variants were implemented during this time period, each was only implemented either once or twice (see Figure 18).

Figure 18 – Number of Times Individual Routines Variants Were Used – Beta Case

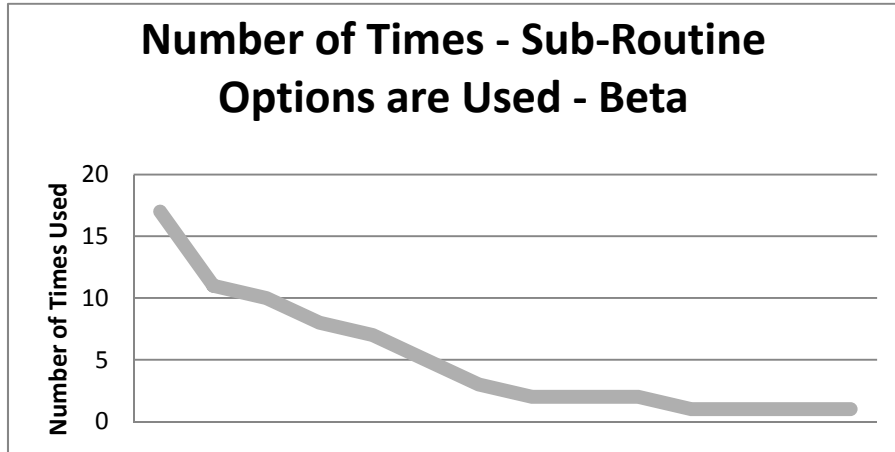


As there is more than one routine variant in use, even with the low numbers, there is a heterogeneity, albeit comparatively small, of varieties of procurement routines. A preliminary answer to the first research question, then is there is a diversity of routine variants, although this diversity is less than in the Alpha study.

As noted in the introduction, each routine is comprised of four sub-routines, and each sub-routine has a number of options which can be selected. It is the specific combination of these four sub-routines which creates an individual variant of a routine. A simple graph (Figure 19 below) displays

the number of times each sub-routine option was used over the ten year period (ranked left to right in order of the number of times used). The distribution follows a Pareto curve, with some sub-routine options used clearly more than others.

Figure 19 – Number of Times each Sub-Routine was used by Beta over a ten year period - Beta



Thus at both the routines and sub-routine level, there is a heterogeneity of variants. In other words, there were a number of routine variants and sub-routine options which were used. Additionally, each option and variant was used to a different extent (although this is less evident for Beta at the routine level). While routine variants were used either once or twice, sub-routine options were used a number of times while others were used just once. Thus there is diversity in Beta’s procurement routines. The next section considers whether there is any evidence of stability in Beta’s procurement routines.

Evidence of Type I Variety – Stable – Beta Case

Analysis of Table 43 shows that no variant of the routine was used in every time period, although 2 variants of the routine (#6 and #67) are used in consecutive time periods. However, in a similar fashion to Alpha, a few projects were extended (Variant #4 and Variant #5). Interestingly the value of these two variants was over \$110 million, which is a significant proportion of the total expenditure over the ten year period. Additionally, these contracts, which started in the first time period, were still underway when the research was undertaken. In other words, the contract has not closed and the project is still being completed. Thus, in one sense, this variant has continued over time.

However, in a similar fashion to Alpha, Beta had a greater level of consistency at the sub-routine level, compared to the routine level. This can be seen in Table 44 below. Five sub-routine options are used in each time period: Construction scope of works, Major Supply and Install Contract, RFO/Tender, Sole Tender and Open Tender.

Table 44 – Sub-Routine Options in Use – Beta

Sub Routine	Option	2000 to 2004	2005 to 2006	2007 TO 2009	Total
Scope of Works	Design, manufacture and test	6	1		7
	Provide Services			1	1
	Construction	1	1	6	8
	Supply and Install		1	1	2
Contract	Alliance			2	2
	Engineering and Civil Works			3	3
	Major Supply and Install	6	2	2	10
	Minor Supply		1		1
	Minor Works			1	1
Tender	Registration	1			1
	RFO/Tender	6	3	8	17
Approach to Market	Closed tender	2			2
	Sole Tender	2	1	2	5
	Open Tender	3	2	6	11

As pairs of subroutine options have been found in the Alpha study to co-occur, a chi squares analysis of all sub-routine options were undertaken. Such a test shows whether the co-occurrence of two sub-routine options happens in a statistically significant manner.

Chi squares

While chi squares were requested for each time period, no significant results were found. A likely case for this is the rather low numbers, which made even chi square correlations not possible. Consequently additional Chi squares was conducted for the entire 10 year time period for Beta and a single correlation was found between Design / Manufacture and Test and Major Supply contracts [$\chi^2(1, 17)=6.491, p=.035, \phi=.618$]. Thus Design-Manufacture-Test scope of works and Major Supply and Install contracts were correlated in a statistically significant sense.

In terms of stability, no single variant of the routine is used in each time period, however a number of sub-routine options were used in each time period, and two variants of a routine occur in consecutive time periods. Additionally there is one combination of a pair of sub-routines which is significantly associated with each other.

Thus there is evidence for stability in the variants of procurement routines, and the options of sub-routines.

Evidence of Type III Variety – Adaptive – Beta Case.

Table 44, above, outlines the sub-routine options used in each time period. The first time an option was used is highlighted in **bold** in the table. In Time Period 2, 2 new sub-routine options were introduced (Supply and Install Scope of Works and Minor Supply contract), and in Time Period 3, 4 new sub-routine options were introduced (Provide Services scope of works, Alliance contract, Engineering and Civil works contract, and Minor Works Contracts).

Thus there were a number of sub-routine options which were introduced, which had not been used previously by Beta. Interviewees provide some of the reasons for the introduction of these new sub-routines which are noted in the section on adaptation below (Section 4.6.3).

In answer to the research question then, while there is stability and diversity, there is also adaptation of sub-routine options.

Evidence of Type IV Variety – Dynamic – Beta Case

As there is some evidence of stability, diversity and adaptability in organisational routines, the question remains about whether there is evidence of dynamic type of variety in procurement routines.

Principal Component Analysis

A matrix of the co-occurrence of sub-routine options for this case was undertaken. This provided a simple count of the number of times each sub-routine option occurred with other sub-routine options in a specific variant, with non-occurrence coded as a '0'. A Principal Component Analysis (PCA) was requested from SPSS on the matrix of the co-occurrence of sub-routines for all projects implemented by Beta. PCA with Oblique rotation and Kaiser Normalisation was used to examine the relationship of the covariance matrix of sub-routine co-occurrence data. Analysis of the scree plot suggested that there were two components, which was confirmed by the extraction sums of squared loadings (see Table 45).

Table 45 – Total Variance Explained

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	56.626	76.870	76.870
2	11.169	15.161	92.031

The PCA found that there were two components in the data, which together explained 92% of the variance. In other words there was a relatively simple structure in the data which accounted for most of the correlations between sub-routine options. The rescaled component matrix is set out below. As per Alpha case, only loadings of .71, or greater, are given credence due to the sparse nature of the binary data.

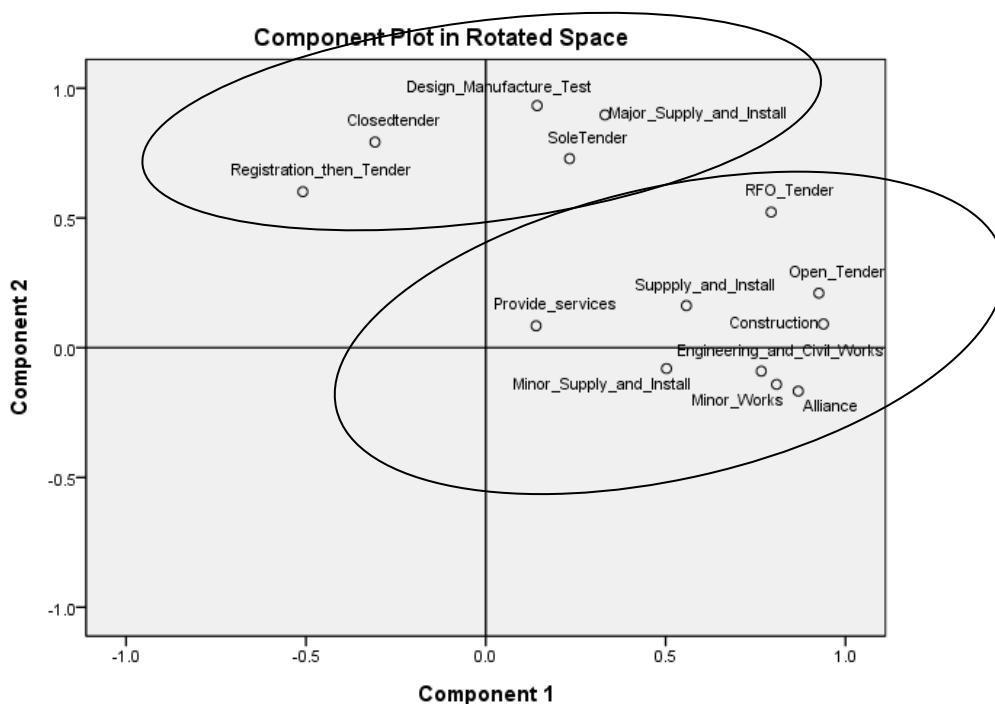
Table 46 – Principal Component Analysis – Beta – 2000 to 2009

	Rescaled Component	
	1	2
↩ Open Tender	0.95	0.314
✂ Construction Scope of Works	0.949	0.196
⓪ RFO Tender	0.852	0.611
📁 Alliance Contract	0.85	-0.07
📁 Minor Works Contract	0.793	-0.051
📁 Engineering and Civil Works Contract	0.756	-0.005
✂ Supply and Install Scope of Works	0.576	0.225
📁 Minor Supply and Install Contract	0.493	-0.024
✂ Provide Services (Scope of Works)	0.149	0.1
✂ Design Manufacture Test (Scope of Works)	0.247	0.949
✂ Major Supply and Install	0.432	0.934
↩ Closed Tender	-0.219	0.758
↩ Sole Tender	0.315	0.755
⓪ Registration → Tender	-0.441	0.544

Legend: ✂ Scope of Works 📁 Contract ⓪ Tender Process ↩ Approach to Market

Component 1 relates to construction types of activities, with Construction scope of works, and Alliance, Engineering and Civil Works, and Minor Works contracts, called for under an Open Tender, and RFO/Tender process, and explains approximately 77% of the variance. The second component involves the design, manufacture and testing of equipment under a major supply and install contract, which was called for from Sole Tenders and Closed Tenders, and explains approximately 15% of the variance. Thus the two components related to different types of assets being purchased – component one around procurement of construction or delivery of existing machinery, and component 2 around the design and manufacture of new items of very expensive machinery. This is perhaps more easily demonstrated if the results were visualised. Figure 20 displays the PCA for Beta with each component in rotated space.

Figure 20 – Principal Component Analysis – Beta – 2000 to 2009



There are two distinct components in the data. The second component contains the two variants which were extended, and the two sub-routine options which were significantly correlated. It also explains the least amount of variance. This of course makes sense as it is comprised of the more stable sub-routine options. In contrast, the first component comprises a wide array of options which were selected together, and explains more of the variance in the data.

This finding is important as it confirms the centrality findings, although the most central sub-routines are split over the two components. Secondly, the simple structure (Thurstone 1954) of the PCA means that amidst all of the variety, there are in the end, two main sets of sub-routines which together explain approximately 92% of the variance in the routines. Thus amidst the variety there is significant structure in the data. Moreover, there is far less cross loading for Beta than for Alpha, with two separate sets of sub-routine options being found.

As has been discussed in the previous sections, Beta case study showed some stability in routine variants, but also in the sub-routine options. Additionally, there is evidence of heterogeneity and adaptation as new sub-routine options were introduced. The PCA showed that there are two clear components to the data, with one more stable component focused on procurement of very expensive machinery (design, manufacture and testing of equipment with a Major Supply and Install contract) and the other more varied component around the purchasing of construction and more standard equipment.

In answer to the research question, there are two coherent components (sets of sub-routine options) used by Beta over a ten year period. Thus while there is variety in routines, and change over time in the repertoire of sub-routines and the way the sub-routines are combined (recombination) a number of sub-routine options are consistently central. Additionally, PCA has shown that there are two distinct sets of sub-routines which account for the majority of variety in the procurement process in this case study. There is thus stability in the midst of variety, and adaptation over time. As there is stability, heterogeneity and adaptability, all occurring at the same time, it would seem by definition that there is also a dynamic form of variety in Beta case.

Thus all four types of variety are evident in the Beta case.

4.6.2 RESEARCH QUESTION 2: SELECTION AND VARIETY- BETA CASE

In order to analyse the selection of organisational routines, counts were made from the contingency table of routines implemented in each time period (as set out in Table 43) of the number of routine variants in use, and the number of new routine variants which were created through recombination of existing sub-routine options. Each routine is made up of four sub routines, and each sub-routine contains a number of options. Selection then, involves the choice of one of the options for each sub-routine for inclusion in the overall routine variant.

As set out in Table 47 (below) the number of routines variants is the total count of variants in use in each time period. Number of new routine variants, which were due to recombination, means that the routine variants are new, but each of the sub-routine options from which it was comprised were present in the previous time period. That while the routine variant is new, it is new due to recombination of existing sub-routine options, rather than introduction of a new sub-routine option.

Table 47 – Change in Routine Variants Over Time – Beta Case Study

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in use	5	3	6
Number of new routine variants from recombination	-	1 (33%)	2 (33%)

Table 47, based on the full set of routine variants for Beta (Table 43) shows that there was a set of different routine variants in each time period. Of all of these variants, 1 in Period 2 (3%) and 2 in Period 3 (33%) were created by recombination of the existing pool of sub- routine options. This was determined manually, by considering only those routines which were comprised of sub-routines which occurred in the first time period.

The interviews provided a useful insight into these processes of selection of individual sub-routines.




Reasons for Selection of Sole Tendering

As noted in the discussions above, Sole Tendering as an approach to market was used increasingly over time in the Beta case study. Indeed, Sole Tendering was used nearly 30% of the time by Beta (compared to only 15% in Alpha). Interviewees confirmed this:

*Asset 1s were all done on a sole supplier negotiation basis or contract extension
[Interview 11]*

The database also supported this, with 2 sole tenders and one extension to a contract (see Table 26 below).

Table 48 – Approach to Market for Asset #1

Asset	Approach to Market	2000 to 2004	2005 to 2006	2007 to 2009
#1	 Sole Tender		1	1
	 Open Tender (with extension)	1		
Legend:  Approach to Market Subroutine Option				

Over time, the approach to Market from Asset#1 moved from an Open Tender Process to a Sole Tender process – where only one company was invited to tender, instead of putting a call out to the whole market. One key reason given for this was time as an open tender process took longer to complete than a sole tender process:

So that's the concept stage, once we've got through a bit more of the planning, often it would result in um, you know a procurement strategy and that might either be tendering or it could be that we will go to a sole supplier because they are the only ones that can do what we need in the timeframe.... If you go to public tender, you will add six months to it, because it will take you awhile to prepare the documents, got to give them time to tender, you've got to evaluate it, you've got to award it, so it is at least six months you put into that process [Interview 10]

Thus time was given as the key reason for moving to a sole supplier arrangement.

In order to confirm this, an ANOVA was taken on the various forms of approach to market against time between tender and contract in order to see if there was a statistically significant difference in time between the two forms of tendering. While the ANOVA did not report a statistically significant difference, descriptive statistics did show that the average time for a sole tender was 83.4 days, closed tender was 88.5 days while open tenders were 272.88 days for Beta. While perhaps not statistically significant (probably due to the low sample), the difference in time between tender methods would be significant in a project management sense. Thus the database corroborates the interview data that sole tendering processes took much less time to process, than open tender processes. In terms of selection, when projects needed to be started under time pressure, using a sole tender arrangement may reduce the overall time taken to commence the project.

Reasons for selecting 'Design' Scope of Works

Chi square analysis also showed a significant correlation for the whole period between Asset 1 and 2 and Major Supply Contracts [$\chi^2(1, 17) = 4.958, p = .044, \phi = .540$]. Thus for these two assets (which are expensive machinery), the same type of contract was used to purchase both. However, there were differences in the tendering process for these two assets. Internal factors appear to be behind the different variants of the procurement routines used to purchase these two assets.

As noted by an interviewee:

Asset 1 contracts are designed and built ... Asset 2, we normally go out with our design so it is just a build contract [Interview 9]

Thus while major supply contracts tended to include design this was not the case for Asset 2s.

Another interviewee explained why this occurred:

we chose 15 maybe 20 years ago to actually bring the design in-house because we were just having too many problems with the external design so we actually trained people to do it and over time what we have been able to do is incrementally improve that design and take advantage of any number of things to

the extent that certainly a couple of years ago we had by far the most efficient Asset 2 design. [Interview 10]

Thus apart from the approach to market, the other difference between the routines used to purchase Asset #1 and Asset #2 is whether there was internal capability to deliver the process. In the case of Asset #2 there was a deliberate investment by the firm to develop design capability for Asset #2, whereas for Asset #1 this capacity did not exist. Consequently, variation in routines is also related in part by the internal capability of the firm.

Selection of processes in Beta is thus driven by a range of different criteria – project related factors, such as time, can influence selection – as some tender arrangements can be resolved much quicker than others. Choice about other factors, such as whether to tender for design as well as manufacture, is more related to internal capability than to anything else.

Interview data thus corroborates the Chi Square and Principal Component Analysis which indicates that selection is a non-random process. There would appear to be a set of internal and external factors involved in selecting sub-routine options. Indeed, selection seems to operate from the repertoire of sub-routine options level, with specific internal and external conditions affecting which contract is chosen, which tender method is used, and which approach to market was deployed.

4.6.3 RESEARCH QUESTION 3: ADAPTATION AND VARIETY – BETA CASE

While selection can create new variants through the recombination of existing sub-routines, this was not the case for every new routine variant. Table 49 provides the number of new routine variants in each time period which were due to adaptation (taking Period One as the base line).

Table 49 – Number of New Routine Variants due to adaptive processes (Beta case)

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in Use	5	3	6
Number of new routine variants from adaptation	-	1	3
% of new routine variants as a result of adaptation	-	33%	50%

As Table 49 shows, there was 1 new routine variant in Period 2, and 3 routine variants in Period 3, which were as a result of adaptation. The number of new routines due to adaptation was determined by identifying the new variants, and verifying that at least one of its component sub-routine options was *not* present in the previous time period. In other words the new variety is as the result of adaptation, not just simply recombination of existing sub-routine options. Table 50 provides the number of sub-routine options which were new in each time period.

Table 50 – New Sub-Routine Options due to adaptation – Beta Case study

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	8	8	10
Number of new sub-routine options	-	2 (25%)	4 (40%)

For Beta the number of novel sub-routine options increased both in numeric and percentage terms over time, with 25% of all routine variants in Period 2 being new, and 40% in Period 3 being new.

Table 49 and Table 50 together show that in Period 2, there was 1 new variant of the routine which included 2 new sub-routine options not used previously. In Period 3, there were three new routine variants, which included the four new sub-routine options not previously used. Thus the introduction of new sub-routine options enabled the creation of new routine variants.

Thus adaptation appears to increase variety by providing new sub-routine options which can be selected for inclusion in the routine variants. Following the language of routines, adaptation increases variety by increasing the repertoire of sub-routine options. Increasing the repertoire of sub-routine options increases the total options available for selection, and subsequent combination into routine variants.

Reasons for adaptation of sub-routine processes

A number of adaptations were found in the Beta case study. These adaptations are discussed in detail below.

Introduction of New contracts

Firstly, one new contract was introduced in Period 2 (Minor Supply) and three new Contracts were introduced in Period 3 (Alliance, Engineering and Civil Works, and Minor Works). Of these, interviewees discussed the introduction of the alliance contract.

We've only used the alliance once and that was where we had um a particularly high risk project and a particularly short timeframe...so we went through the process and ... established an appropriate risk/reward curve so that they could make sure that they were doing to achieve something that their shareholders were happy with and we could understand um you know what we were paying. That worked out well, we obviously had a relationship with that company and in that case it was an alliance and it worked... If the risk and reward is appropriate, it has really got to be about that, because you are in it together and it has got to be win/win for both parties, so you've got to see what both want and how can you share [Interview 10]

Alliance contracts were thus appropriate for high risk, short timeframes with an approach that went beyond a purchaser provider relationship – aiming to establish a sharing relationship which aimed for win/win outcomes. Table 43 and Table 44 confirm interview data, that an Alliance contract was only used once by Beta.

In addition to the introduction of new forms of contract, there were larger changes in the overall approach to procurement within Beta Case Study. This shift is not recorded in the database.

While the database contained information on the specific choices made in tendering (e.g. Registration → Tender), it did not contain details of the content of such arrangements. Three adaptations were noted to the process of procurement (with the introduction of a set of ‘gates’ to the procurement process), the planning for assets which drove procurement, and the artefacts related to these changes to planning processes – the master plan and tender specifications.

Change to project approval process

Where once the approval process was driven in response to winning contracts:

There is a new process brought in at the corporate level that investment proposals have to go through, essential a stage gating process, so you go through several three uh stages of getting the capital investment approved. [Interview 11]

The reason for the stage gating in the approval process was to introduce more rigour into the approval process. A key decision here is on the justification of why the new assets should be purchased. Part of the justification for all projects is driven by the development of a master plan for the organisational assets, which took into account a range of factors:

... the critical assets master plan drives procurement, it makes assumptions about utilisation um and to a fairly reasonable degree it drives a whole raft of assumptions about how this business will work in the future.[Interview 30]

Another interviewee explained the process of what had to be considered when developing the master plan:

as an asset intensive business, there are some significant applications for either being over capitalised having too many assets or the wrong sort of assets, and likewise there are some significant implications of being under-capitalised, having the wrong resources or not enough resources. So the biggest and first question to get right is the strategic alliance piece of what level of asset, what types of assets, positioned where in the supply chain make the most sense strategically. [Interview 28]

So the first aspect is around ensuring there is the right amount of assets – not too few or too many to run the business. While this may seem straight forward, the way that asset demand is ascertained has also recently changed:

You are predicting what your volume will be, to predict what your volume will be you are predicting two things, one what demand will be in the market, and two, what of that demand you will capture. This business only used to have to predict what demand would be there and assumed that it would cater for it all because it was a monopoly. [Interview 30]

In other words – there has been a change in the external environment of the firm with the entrant of a competitor which has affected the way that the organisation now determines the need for

assets, market demand and market share – which determines how many assets are needed. Thus some of the process innovations implemented by Beta involved the introduction of a series of ‘gates’ to the project management which are aimed at ensuring the proposed investment made sense financially. As part of this process an extensive planning process had been implemented in order to provide estimates of the most appropriate level of capital investment in assets. Part of the need for this is to provide appropriate planning; however, the entrance of a competitor to Beta made this process more challenging and also more imperative. This points to change in the planning process of procurement routines. Instead of simply purchasing assets in order to deliver contracts (a reactionary response), a far more strategic and deliberative approach to determining the need for new assets was developed.

Changes to Specifications

Whenever an asset was purchased, some specification of the performance of the asset was determined and provided to potential suppliers. This specification document is an artefact which was sent out as part of the tender process. According to interviewees, this specification has changed for some assets over time:

Asset 1, as I said we would have a performance spec, that would then get developed into a specification. Now a performance spec, maximum of ten pages, a specification, 500 pages, but it specifies a hell of a lot more and then we would go to tender with that specification. Now what would happen is the suppliers would come back and they wouldn't meet certain parts of the spec ... and it took a long, long time before we could officially award a contract to a supplier to go and develop that Asset 1 or whatever. ... but then what we introduced instead of doing that, we went straight up with expressions of interest of suppliers that were interested in meeting a performance spec and then the suppliers would come back with what they thought they could do for us ... it actually put a bit more of the performance of the Asset 1 back on the supplier, because the supplier is now delivering a product to meet a performance spec, rather than a detailed specification that we used to produce. That helped us fast track getting Asset 1s into service. [Interview 9]

Thus the adaptation was not so much in the process chosen, but in one of the artefacts used to generate the tender – the specification document. While this was initially a highly prescriptive text, this moved to a performance specification: the asset simply needed to perform to a certain level, rather than specifying exactly how this was to be achieved. This resulted in reduced time for the assessment of tenders and shifted some of the performance risk back on the supplier.

Change in ostensive (Rationale for action)

Not only have there been changes in the artefacts and the performative, but also in the ostensive. Historically, Prolific Projects was an organisation which focused more on efficiency or technical proficiency, rather than on business focus, partly due to the monopoly position– noted earlier. This change in thinking is supported by a number of interviewees:

No, we have different Beta systems that have different yields or margins associated with them, because if there is differential prices for delivering Beta in different systems, so it is about aligning our assets to optimize the delivery of Beta with a financial mindset, not necessarily an operations or cost mindset. [Interview 28]

Another interviewee described this as a business focus – rather than engineering focus:

One of the things we have been trying to do over the last twelve months is to start to get more business focused and more business driven behind the program [Interview 11]

This shift in thinking is reflected in the development of business plans which take into account the demand in the market and market share, noted in Interview 30 on the previous page, and again in the following quote:

We are focusing in the business on driving and growing our revenue, quality by improving the contracts that we sign relative to the risks we take and that that is a key element of improving performance of the business [Interview 30]

While this indicates a shift purely to profit, the same interviewee suggested that in fact there was a tension between efficiency and profit:

What is the primary concern: is it that the critical assets [are] used efficiently or is it that the customer gets what they want? That is the primary tension. [Interview 30]

Thus there is the need to manage assets effectively – ensuring they run well, and there is the need to make a profit, as well as planning needed to ensure there are adequate assets to meet customer demand. These set of tensions can be summed up in the following quote:

Look I think so, and I think that the procurement initiative speaks for itself, in that the business wants to change the way it does procurement, but procurement is so intertwined with the engineering, be it business planning, it is so intertwined with so many things that to talk just one lever at the procurement level, is really quite challenging [Interview 28]

This quote underscores the reality that procurement routines are enmeshed in a range of additional organisational routines within the organisation. While not explored as part of the thesis, it is important to acknowledge that these wider set of routines exist.

Structural change – Intra-organisational

While there have been changes at an ostensive and artefact level, there have also been changes structurally within the organisation over time. For example, the need to develop a strategic plan for the procurement of assets, rather than one driven just by winning contracts, meant that new groups had to be established, which negotiated across the division to produce the plan itself:

we call them our supply chain planning group and one of the key elements that they do is integrate the different perspectives across our business so whether they are a market, customer, Beta system, or asset perspective, they try to integrate those different perspectives and manage and balance the competing tensions

between those different perspectives and one of the outputs or products that they tend to produce is the critical assets master plan which is an attempt by the business to um, set an aggregate level demand for assets after balancing out all of those different competing perspectives. [Interview 28]

And finally, while Beta had historically purchased just their own assets, they now worked collaboratively with other divisions inside Prolific Projects on procurement, in order to better plan assets across the whole organisation:

I guess the good news in terms of critical assets procurement is that the two groups have now developed a mechanism for sharing information at the high level, so if Beta is buying some new critical assets, then they might have something that they can cascade out of their business, so that that can go into Gamma's plan, if in fact they need it, so there is this overall concept of a Plan.[Interview 10]

Thus in terms of change, there is evidence of changes at the level of the artefact (with the creation of new forms of contract and master plans), ostensive (which is the shift from operations and cost based purchasing to more business based thinking and planning) and the performative levels – shifts to the actual process, such as stage gating project funding approvals, and instead of purchasing based on winning contracts, to comprehensive planning. There were also structural changes in order to implement some of these changes.

Thus in answer to the research question, there is evidence of adaptation in Beta at the performative, ostensive and artefact elements of the procurement routine. A number of new sub-routine options were introduced which increased the repertoire of options available for selection.

4.6.4 RESEARCH QUESTION 4: RETENTION AND VARIETY – BETA CASE

As noted in the literature review, retention involves the retaining in memory of organisational processes (Nelson and Winter 1997). As outlined in the methods section, one way of determining this, is to simply count the number of routine variants continuing and discontinuing from one time period to the next (see Table 51 below).

Table 51 – Number of Routine Variants Retained (Continued) - Beta

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in Use	5	3	6
Number of Routine variants Continued	-	1 (33%)	1 (17%)
Number of Routine variants Discontinued	-	4	2

In terms of retention, a number of routine variants were continued (1 in Period 2, and 1 in Period 3) between time periods, although, as noted earlier, no single routine was present in every time period. However a number of routine variants were *not* retained between time periods with 4 in Period 2 and 2 in Period 3, not continuing from period to period. The story is slightly different at the sub-routine level, however (see Table 52 below).

Table 52 – Number of sub-routines options retained - Beta

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	8	8	10
Number of sub-routine options continued	-	6 (75%)	6 (60%)
Number of subroutine options discontinued	-	2	2
Number of subroutine options re-introduced	-	-	-

In terms of retention, a number of sub-routine options were discontinued (2 in Period 2, and 2 in Period 3). Discontinuation means that the sub-routine option was in use in one time period, but not in the second. However, a larger number were retained and used in subsequent time periods (6 in Period 2, and 6 in Period 3).

Thus at a sub-routine level, in each period there are new sub routine options introduced, existing sub-routine options which are continued, and a number which are discontinued. Compared to variants of routines, there is a much stronger retention of sub-routine options over time.

To answer the research question then, retention affects variety by the net number of routine varieties and sub-routine options which are retained from period to period. If all routine variants (or sub-routine options) were kept from one period to the next, and adaptive processes continued to add new ones, there would be a net increase in the number of routines (which for this case would have meant $5+1+3 = 9$ routine variants, and $8+2+4 = 14$ sub-routine variants). However, not all routines, or sub-routines are retained, and thus the total pool of routines and sub-routines in use in the final period was less than at other time periods. This does not mean that these options have been 'forgotten', as they may still exist in organisational memory.

4.6.5 SELECTION, ADAPTATION AND RETENTION IN RELATION TO THE OSTENSIVE, PERFORMATIVE AND ARTEFACT ELEMENTS OF ROUTINES

In terms of the ostensive, performative and artefact elements of routines (Feldman and Pentland 2003; Pentland and Feldman 2005) the interviews above show that selection appears to come from the ostensive element of routines, is performed, and is recorded in the database (artefact). There were considerable changes in the ostensive – particularly a more business-like approach to procurement. With both selection and adaptation there is a mental understanding of what is intended to happen (Miles and Huberman 1984b), which is in the ostensive. As with the previous case study, while adaptation often follows a reflection on how to improve performance, the alliance contracts were introduced in anticipation of need, not just as an incremental improvement of process. Retention also appears to have occurred in the ostensive as the stage gate process and planning are termed in the current tense – in other words the changes are in place and continue into future operations.

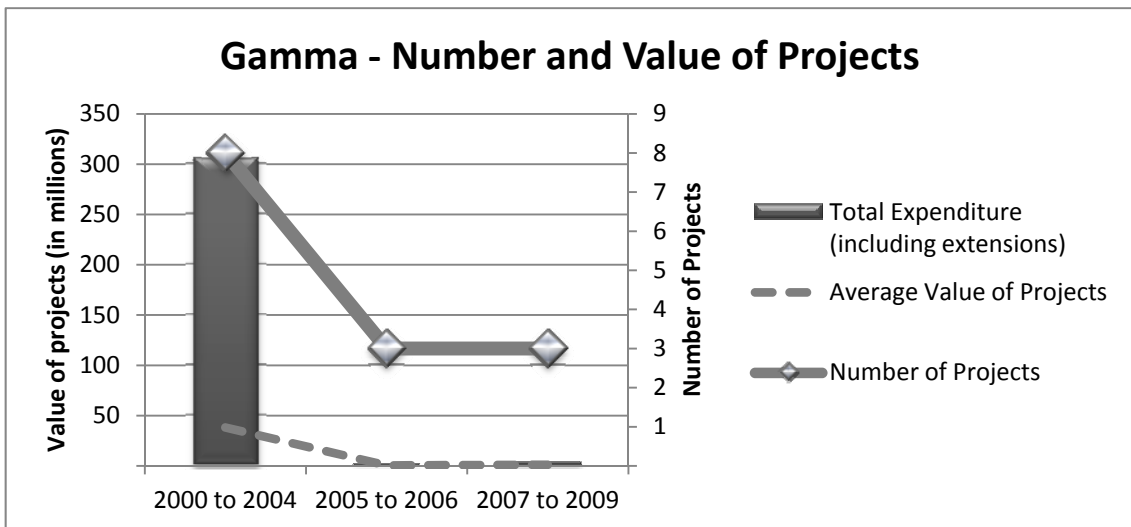
4.6.6 SUMMARY – BETA CASE

In summary, there is evidence of stability, variety, adaptability in organisational routines examined in Beta case. Additionally, selection has been shown to increase variety through the recombination of sub-routine options to create new variants of the routine. Adaptation increases variety through the introduction of new sub-routine options, which then become available for selection in new variants of the routine. And finally, retention increases variety by the decision to retain (keep) or no longer use, specific routine variants and sub-routine options.

4.7 GAMMA CASE STUDY

Gamma implemented a total of 14 projects over a 10 year period, with a total value of close to \$40 million. There was a difference in both the amount of expenditure for projects over time, and the number of projects over the time periods. In Period 1 (2000 to 2004) Gamma commenced 8 projects, worth \$305 million, in Period 2, 3 projects worth 1.55 million and in Period 3, 3 projects with 3.5 million. Thus the value of projects in Period 1, were exceptionally more than those in Periods Two and Three (see Figure 21 below).

Figure 21 – Number and Value of Projects per Time Period - Gamma



An ANOVA was conducted to test to see whether this difference in value of projects over time was significantly different. This showed that there was a significant difference in the value of projects over time [$F(2,11)=3.993, p=.05$] (log of values was used). The effect size (eta squared) was 0.42 which is a large effect. Posthoc comparisons using Tukey HSD test indicated that the Mean Score for Period 1 ($M=1.33, SD=1.96$) was much higher than Period 2 ($M=-2.29, SD=2.48$). Thus the average value of projects was significantly higher in Period 1 compared to Period 2 and the effect size was large.

One reason for the large column of expenditure in the first time period, is that there were a small number of very high value projects in this time period. This is exacerbated as expenditure in projects is coded against the time period in which they were first tendered. As some of the high value projects were extended instead of re-tendered, the expenditure which actually occurred in other time periods, was coded in the database as if it had occurred in the first time period. Consequently, the expenditure showing as occurring in Period One is at least partly an outcome of the way expenditure was coded in the database.

4.7.1 RQ 1 – WHAT SORT OF VARIETY EXISTS IN PROCUREMENT ROUTINES?

As with the two previous case studies, the various types of variety are examined: adaptive, diverse, varied and dynamic. Firstly, diversity is examined.

Evidence of Type II Variety – Diverse – Gamma case

The first research question seeks to examine what type of variety: stable, diverse, adaptable or dynamic is in existence. As a first stage in examining this, a contingency table of all routine variants for the case will be established in order to demonstrate variety.

Total of 8 different routine variants were implemented by Gamma over a 10 year period (see Table 53 below). 8 variants amount to approximately 7% of all variants in use by Prolific Projects (although this amounts to only 0.79% of the total 1008 possible). Only one routine variant was implemented in each time period (#111). There were also a relatively small number of projects undertaken by Gamma overall (13). The specific varieties of routines in use by Gamma for each time period, are listed below:

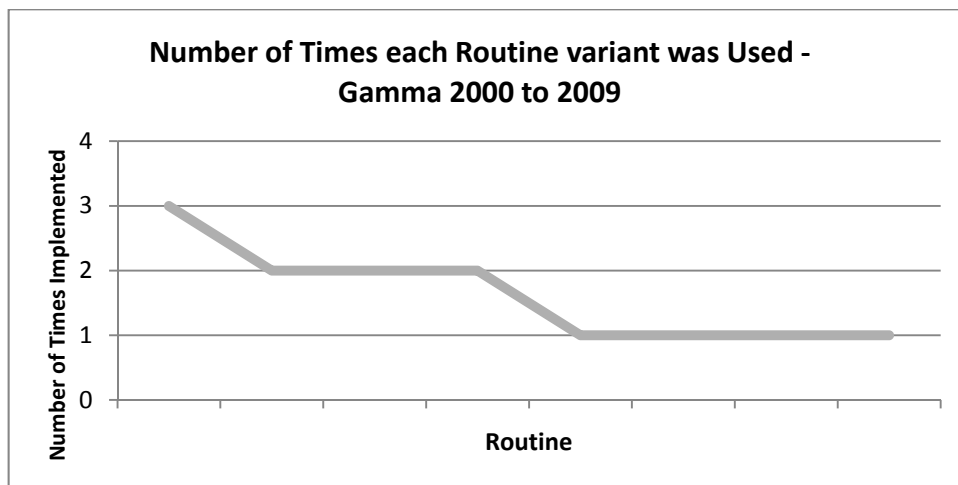
Table 53 – Routine variants Implemented by Gamma in a 10 Year Period

Variant #	Scope of Works	Contract	Tender	Approach to Market	2000 to 2004	2005 to 2006	2007 to 2009	Total	Extension to original contract
5	Design Manufacture and Test	Major Supply and Install	RFO/Tender	Sole Tender	2			2	* (1)
19	Provide services	Service Contract	RFO/Tender	Open Tender	2			2	
66	Construction	Minor Works	RFO/Tender	Sole Tender		1		1	
69	"	Repairs contract	RFO/Tender	Sole Tender			1	1	* (1)
76	Supply and Deliver	Major Supply and Install	RFI/EOI -> Tender	Open Tender	1			1	
90	Supply and install	Major Supply and Install	RFO/Tender	Open Tender	1		1	2	* (1)
92	"	Minor Supply and Install	RFO/Tender	Open Tender		1		1	
111	Supply and load	Major Supply and Install	RFO/Tender	Open Tender	1	1	1	3	

Only one variant of the routine (#111 - Supply and Load scope of works, major supply and install contract, RFO/Tender and Open Tender) was used in each time period.

A graph was constructed of the number of times each routine variant was implemented (ranked in order of use from highest to lowest) which is shown in Figure 22 below.

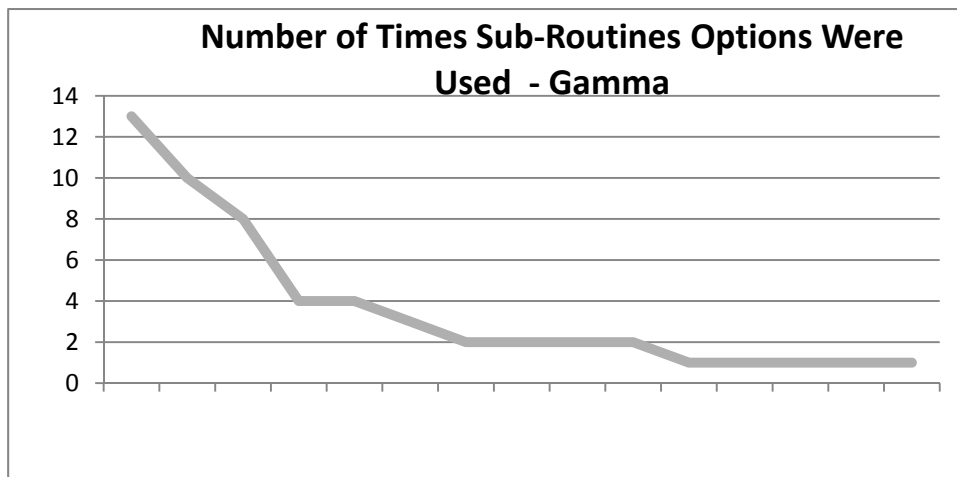
Figure 22 – Number of Times Individual Routine variants Were Used – Gamma Case



As there are a number of variants of the routine in use, diversity is present in this case. However, as compared to other cases, the extent of variety is quite low due to the low number of procurement events, although the value of some of these projects was very significant.

As all routines are comprised of sub-routines, an examination of the extent of variety in sub-routine options was also undertaken (see Figure 23 below), with the distribution following a Pareto curve, again with a rather long tail.

Figure 23 - Number of Times each Sub-Routine Option was Used- Gamma



Thus at a routine and sub-routine level there is variety, although there is greater variety of sub-routines options available than routine variants for Gamma, given the low number of routines overall. While routines were used between three times and once, sub-routines options varied from 13 times to single use.

Evidence of Type I Variety – Stable – Gamma Case

While only one routine variant was used consistently throughout the period, Table 54 shows that at the sub-routine level, there is a much greater level of consistency over time, with 6 sub-routine options in use in each time period. Only 1 sub-routine option was used in two consecutive time periods, and 1 routine was used in Period 1 and then again in Period 2.

In order to test the significance of the co-occurrence of sub-routines, a series of chi square analyses were requested.

Chi squares

No significant correlations were found between sub-routine options in each time period, partly because RFO/Tender became the only tendering method used in Time Periods 2 and 3. Consequently a chi square was requested for the entire time period.

Chi square analysis was undertaken (with Fisher’s Exact test and Phi test for effect), in order to test for correlation between sub-routine options.

Significant associations were found between:

- Provide Services Scope of Works and Services Contracts [$\chi^2(1, N=7) = 7.000, p = .048, \phi = 1.000$].

Significant negative correlations found between:

- Provide Services and Major Supply [$\chi^2(1, N=7) = 7.000, p = .048, \phi = -1.000$].





Thus Provide Services Scope of Works and Services Contracts were correlated as being used together in a statistically significant sense and this is unlikely to have occurred by chance. Provide services and Major Supply were negatively correlated and therefore were not used together.

Thus there is stability at a routine level, with a variant and a number of sub-routine options used in each time period. Additionally RFO/Tender became a constant to every procurement activity in time periods 2 and 3. Finally there were significant positive and negative correlations between sub-routine options. Thus there is evidence of stability in the procurement routines implemented by Gamma.

Evidence of Type III Variety – Adaptation – Gamma Case

Table 54 includes a summary of the sub-routine options used in each of the three time periods, drawn from the database. In order to determine adaptation, the first instance that a sub-routine option is used in each time period is indicated in bold below.

Table 54 – Sub-Routine Options in Use – Gamma

Sub-Routine	Option	2000 to 2004	2005 to 2006	2007 TO 2009	Total
Scope of Works	Design, Manufacture and Test	2			2
	Provide services	2			2
	Construction		1	1	2
	Supply and Deliver	1			1
	Supply and install	1	1	1	3
	Supply and load	2	1	1	4
Contract	Major Supply	5	1	2	8
	Minor Supply		1		1
	Minor Works		1		1
	Repairs			1	1
	Services	2			2
Tender	RFI/EOI then Tender	1			1
	RFO/Tender	7	3	3	13
Approach to Market	Sole Tender	2	1	1	4
	Open Tender	6	2	2	10

As can be seen in each time period there is a set of new sub-routine options introduced. Construction scope of works, Minor supply and minor works contracts are introduced in Period 2. Repairs contract is introduced in Period 3. Thus in answer to the research question, there is evidence of adaptation in Gamma, with the introduction of a number of new sub-routine options.

Evidence of Type IV Variety – Dynamic – Gamma Case

This first part of the case study has shown that there is both variety and adaptation in routine variants and sub-routine options. As there is both adaptation and diversity, then a dynamic form of variety can be concluded. However in order to test this, a PCA was requested.

Principal Component Analysis

A matrix of the co-occurrence of sub-routine options for this case was undertaken. This provided a simple count of the number of times each sub-routine option occurred with other sub-routine options in a specific variant, with non-occurrence coded as a '0'. A Principal Component Analysis (PCA) was requested from SPSS on the matrix of the co-occurrence of sub-routines for all projects implemented by Gamma. PCA with Oblique rotation and Kaiser Normalisation was used to examine the relationship of the covariance matrix of sub-routine co-occurrence data. Analysis of the scree plot suggested that there were two components, and the extracted sums of squared loadings also confirmed the existence of two components in the data (see Table 55).

The adjacency matrix of co-occurrence of each sub-routine was used to assess the incidence of co-occurrence of each sub-routine with each other. As there were only 2 components, a relatively simple structure (Thurstone 1954) was found (see Table 55 below).

Table 55 – Total Variance Explained –Gamma PCA

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	33.525	79.032	79.032
2	4.448	10.486	89.518

The structure matrix of the principal component analysis revealed more information, see Table 56 below.

Table 56 – Structure Matrix of the Rescaled Component –Gamma PCA

	Rescaled Component	
	1	2
↩ Open Tender	0.998	-0.047
✂ Supply deliver load	0.899	0.067
① RFO / Tender	0.886	0.387
📦 Major Supply and Install	0.872	0.29
✂ Supply and Install	0.818	0.022
📦 Minor Supply and Install	0.584	-0.108
Services	0.573	-0.165
✂ Provide Services	0.573	-0.165
✂ Supply Deliver Commission	0.368	-0.321
① RFI/ EOI → Tender	0.368	-0.321
↩ Sole Tender	0.078	0.986
✂ Construction	-0.116	0.811
✂ Design Manufacture and Test	0.228	0.81
📦 Minor Works	-0.106	0.738
📦 Repairs	-0.106	0.738

Legend: ✂ Scope of Works 📦 Contract ① Tender Process ↩ Approach to Market

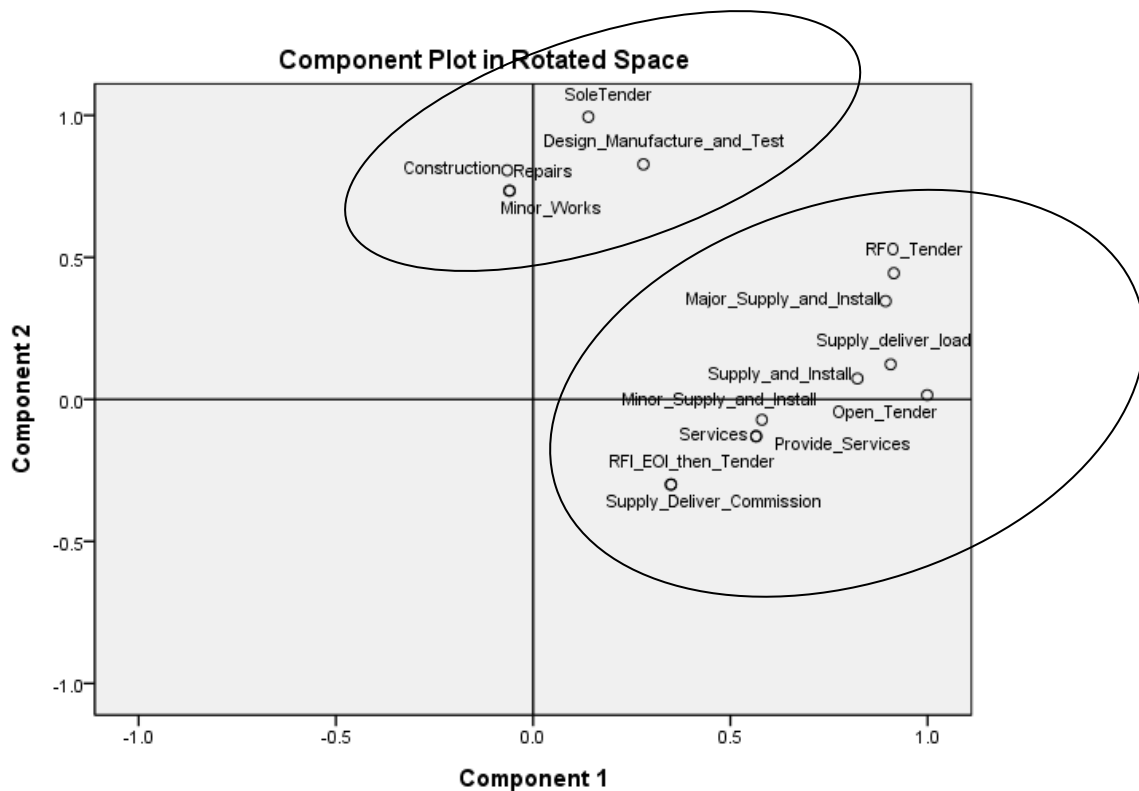
As with the other cases, only sub-routine options which load over .71 are considered.

Two Principal Components were found, which together explain 90% of variance in the sub-routines. Component one involves the supply, delivery and loading of assets, under two forms of contract (Major supply and supply and install) which were both tendered under Open Tender approach to market following an RFO/Tender process. Component Two was a different set of activities as it involved design, manufacturing and testing and construction types of activities, which were requested under Minor Works or Repairs contracts, called for under Sole Tender approaches to market.

Thus PCA has identified two components which a) are distinct from each other and b) are responsible for the majority of variety in routines implemented by Gamma. The components load around whether an open tender or sole tender is used.

In terms of the research question, PCA identified a simple structure (Thurstone 1954) with two components - two sets of highly related sub-routines, which together account for most of the variety in routines. This is made clearer in the plot of these components in rotated space (circles highlighting the components are mine):

Figure 24 – Plot of Sub-Routine Options in Rotated Space – Gamma



In summary this section had provided evidence that there is some stability in procurement routines, particularly at the sub-routine level, with a number of sub-routine options in use in every time period, and one pair of sub-routine options statistically correlated with each other. Additionally one sub-routine option (RFO/Tender) becomes the only form of tendering used in the last two time periods. There is also evidence of variety with a number of variants of routines found in each time period, as well as a number of sub-routine options. A number of new sub-routine options were also introduced. Finally, principal component analysis has identified a small number of sub-routine options which are highly correlated to each other, while a larger set of sub-routine options account for most of the variety in the relationships. In summary, there is evidence of stability, adaptability, and diversity in routines. Therefore, as there is both diversity and adaptation, there is also a dynamic form of variety involved in Gamma case. In fact all four types of variety are evident.

4.7.2 RESEARCH QUESTION 2: SELECTION AND VARIETY- GAMMA CASE

As argued in the literature review, selection involves the choice of various options. In each time period there were a set of routines chosen. Routines, as shown earlier in the case study, are comprised of a set of sub-routines. Each routine is made up of four of each of these sub routines. Selection then, is the process by which one of the sub-routines is chosen for inclusion in the overall routine. The specific set of routines chosen in each time period, is shown in Table 57 below.

Table 57 – Number of routines in each time period – Gamma study

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in Use	5	3	3
Number of new routine variants from recombination	-	0	0
% of Routine variants due to recombination	-	0%	0%

Table 57 (based on the full contingency Table 53) shows that there was a set of different routines in each time period. Of all of these routines, none were as the result of recombination of existing sub-routines. Table 53 has already shown that one routine was constant in every time period.

While a two stage tendering process (RFI → Tender) was only used once according to the database, one interviewee indicated there were good reasons for undertaking tendering in two stages:

... you would be able to trigger to get some recourse if there is some problem with supply or the use of IP. It is doubtful whether you could actually get legal redress or recovery. But you can try and minimise that process by making a two stage process, minimum two stage, by only releasing limited information, enough to price on, and so your standard drawings and a bit more, but anyway a minimal enough to quote on, to shortlist down to one or two or a smaller number of players who you then issue detailed design drawings to for final costing before you go to negotiations. So doing it that way, you are limiting the number of players if you get detailed drawings. If you think you have actual IP in those drawings. If there is not really a lot of IP, don't go to two stage, don't worry about the loss of IP go to a single stage process and then use a weighted evaluation criteria model to um make your decision.

Interview 27

Thus a key reason for using a two stage tendering process would be if there was significant IP involved in the drawings developed by the organisation. By limiting the number of outside parties who are given access to those drawings the IP of the organisation can be protected, rather than attempting some legal recourse after the fact. On the other hand, if there is no IP, then the single stage IP is acceptable.

As Table 53 and Table 54 indicate, throughout each time period, Gamma used both open tender and sole tender sub-routine options. Some interviewees provided reasons for selecting such sub-routines:

... a lot of stuff that you procure for [Prolific Projects] is very specialised equipment, so there tends to be a limited number of suppliers who would be able to maintain their reputation in the industry, they're the companies that survive and the ones you go to, to get a price from ... it is limited market of companies that they can sell to.

Interview 18

This information on the number of suppliers was determined by a research project on the size and scope of market:

We did some work, it was more than desktop, we did desktop research on how we buy Asset 1s now, what the size of the market is for those Asset 1s, like where can we buy from, even globally, so we did desktop research, we did a history of what we have been doing in PP for many years and we also approached suppliers nationally, only via phone, and we have a lot of relationships with the industry given who we are, to ascertain and build up knowledge of where we could procure Asset 1s from. Some of the issues that we came up with were, in the market, there is a very limited supply

Interview 27

It is this constrained market that determines the use of closed or sole supplier arrangements:

We go straight to a tender, because basically we know there are only two suppliers and we know their capabilities. We go straight to tender, once those tenders close there is basically a review and recommendation process, but that also involves seeking additional clarification of information from the tenderers, and we will get both companies in and go through the same questions, to give them an equal opportunity to push their barrow as such.

Interview 18

As with other case studies the issue of internal capability came up in interviews for Gamma:

You're right, I don't think you can procure unless you have the knowledge of what you are procuring, or at least a reasonable understanding you're right, because if you don't know what you are buying, well how can you buy it, so you need to retain um a level of in-house knowledge, particularly in a business like this, it is a critical asset,

Interview 18

The technical ability of its staff in understanding assets enables Gamma to procure effectively, as this technical knowledge enables them to know what they were buying.

Interview data thus corroborates the Chi Square and Principal Component Analysis which indicates that selection is a non-random process. There would appear to be a set of factors involved in selecting sub-routine options. Indeed, selection seems to operate from the repertoire of sub-routines level, with specific external conditions affecting which approach to market was deployed.

In this case study, selection involved choosing from an existing pool of sub-routine options. However, due to small numbers, no new varieties were evident due to recombination. Selection was based on the specific sub-routine achieving specific outcomes.

4.7.3 RESEARCH QUESTION 3: ADAPTATION AND VARIETY – GAMMA CASE

While no new routine variants were created due to recombination, this was not the case for every new routine. Table 58 provides the number of routine variants due to adaptation

Table 58 – Number of New Routines due to adaptive processes (Gamma case)

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	11	9	8
Number of new sub-routine options	-	3	1

As Table 58 shows, there were 2 routine variants in Period 2 and 1 in Period 3 which were as a result of adaptation. The number of new routine variants due to adaptation was determined by identifying the new variants, and verifying that at least one of its component sub-routine options was *not* present in the previous time period. In other words, the new variety is the result of adaptive processes, not just simply recombination of existing sub-routine options. Table 59 provides the number of sub-routine options which were new in each time period.

Table 59 – Change in Sub-Routine options over time – Gamma Case

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routines in Use	5	3	3
Number of new routines from adaptation	-	2	1
% of new routines as a result of adaptation	-	66%	33%

Comparing the data from Table 58 and Table 59 shows that in Period 2, there were 2 new routine variants which included at least one of the 3 new sub-routine options which had not been in used previously. In Period 1, there was one new routine variant, which included the single new sub-routine option introduced.

Thus adaptation increases variety by providing new sub-routines options which can be selected for inclusion in the variants routines. Following the language of routines, adaptation increases variety by increasing the repertoire of sub-routine options. Increasing the repertoire of sub-routine options increases the options available for selection, and subsequent recombination.

While interviewees were asked about the introduction of new organisational processes, the focus was not so much on the contracts, but on the constrained nature of the market which they are purchasing in.

The external market and economic situation was something which drove Gamma to re-evaluate some of their processes, particularly the Global Financial Crisis (GFC):

It maybe that the GFC had a role in here where they cut everybody's profit margins, once margins start to slim down they tend to have a long hard look at how they operate and the various organisations are performing [Interview 29]

One of the changes to procurement was in the planning phases where some additional processes were added:

to get capital approved now um, there is a stage gating process where you have got to put up a concept submission and that entitles you to talk to the suppliers and then we go back with a pre feasibility submission and that entitles you to go to tender and then once you've got your tender worked out and contract signed, you go back with your final submission and say here is the contract, please sign on the bottom line [Interview 29]

The same interviewee explained further:

Well when we did those 12 Asset 1s we had the funding and we were left to our own devices to run the tender, negotiate the contract and the next one we went back to anyone senior it was with a contract signed. All done and dusted, yeah, now you would have to stage gate it and actually justify each part of the contract, decision why this is included or why it is not, how this contract compared with other offers and so forth, actually demonstrate that this is the best commercial outcome [Interview 29]

This notion of commercial value is reflected more broadly in the approach to procurement, where once the main focus was on technical performance, now commercial performance has become important:

But I think now what we've done and with these particular ones is um taken a bit more of a commercial focus than in the past and probably little projects, in the past have been a little more engineering... more interested in the technical aspects of the project, [they are] still interested in technical aspects, but they are evaluated not in terms of their technical functioning but in terms of their commercial or financial contribution [Interview 29]

Another change in the planning process, and included in the stage gate processes, is to question whether the answer to the organisational need is in fact a set of new assets, or whether better utilisation of the existing set of assets can be achieved:

say we've got a Beta contract, we need you know 15 Asset 1s and 400 Asset 2s and you know they went out and got purchased, rather than no one was really asking the questions like well do we really need 15, what does it look like, can we get by with 12, are there any others around the place, or can we make current operation work better and free up some asset that way [Interview 29]

One of the drivers of improved commercial outcomes was to obtain better tender offers from suppliers. While the constrained market had resulted in Gamma not using open tender arrangements for those assets with fewer suppliers, Gamma has also begun to consider ways in which to proactively improve the issue of supply:

Given the scale of the market in Complete Quadrant should we align ourselves more with one supplier, the existing supplier and push for improvements there, an

alliance type arrangement if you will, or should we support the entrance of another player to the market to promote competition, but with the numbers we are talking about between us and Beta, are the numbers big enough to have two players, will we get any benefits or not, these were the questions we were asking ourselves.
[Interview 18]

Another strategy was not to actually engage with new companies, but simply to threaten to do so:

... we had no choice but to go to the incumbent monopoly provider and negotiate a price. What we did there was, introduce the threat of competition by speaking to others and letting that party know that we were speaking to others, because the industry is not that big and that enabled us to push the price down quite significantly for the order that we have currently got with them now **[Interview 27]**

Thus adaptation creates variety by introducing new sub-routines into the repertoire which can be combined with existing sub-routines to create a new routine. However as the quote above suggests, there are additional processes under way which seek to ask whether procurement is the answer to asset needs (by seeking better asset utilisation instead) and by negotiating with the main supplier. This adaptation involved not just the formal and mechanical aspects of procurement which has been the focus of this study, but thinking through how to handle the market itself.

4.7.4 RESEARCH QUESTION 4: RETENTION AND VARIETY – GAMMA CASE

As noted in the literature review, retention involves the retaining in memory of organisational routines (Nelson and Winter 1997). In a similar way, to the previous sections, a count was made of routine variants continuing from one time period to the next (see Table 60 below).

Table 60 – Number of Routines variants Retained (continued) in organisational memory- Gamma

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in Use	5	3	3
Number of Routine variants Continued	-	1 (33%)	1 (33%)
Number of Routine variants Discontinued	-	4	2
Number of Routine variants Re-Introduced	-	-	1

In terms of retention then, a number of routines were continued (1 in Period 2, and 1 in Period 3) between time periods. In other words the pattern of action remained largely unchanged between these times (although as noted earlier in the case, only one routine variant remained in used for each of the three time periods). However a number of routine variants were *not* retained between time periods with 4 in Period 2 and 2 in Period 3, not continuing from period to period. 1 sub-routine option was reintroduced in period three from Period 1, while not used in Period 2. This provides support for the notion that routines involve organisational memory, as the sub-routine option was not forgotten, but reintroduced when deemed appropriate.

The story is slightly different at the sub-routine level, however (see Table 61 below).

Table 61 – Number of sub-routines retained in organisational memory - Gamma

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	11	9	8
Number of sub-routine options continued	-	6 (66%)	7 (87.5%)
Number of subroutine options discontinued	-	5	2
Number of subroutine options re-introduced	-	-	-

In terms of retention, a number of sub-routine options were discontinued (6 in Period 2, and 7 in Period 3). Discontinuation means that the sub-routine option was in use in one time period, but not in the second. However, a larger number were retained and used in subsequent time periods (9 in Period 2, and 8 in Period 3).

Thus at a sub-routine level, in each period there are a number of new sub routines options introduced, continued, and discontinued. Compared to variants of a routine, there is a much stronger retention of sub-routines over time.

To answer the research question then, retention affects variety by the net number of routines variants and sub-routine options which are retained from period to period. If all variants (or options) were kept from one period to the next, and adaptive processes continually added new ones, there would be a net increase in the number of routine variants (which for this case would have meant $5+2+1=8$ routines, and $11+3+1 = 15$ sub-routine options). However, not all routine variants, or sub-routine options are retained, and thus the total pool of variants and sub-routine options in use in the final period was less than at the final time period compared to the first.

4.7.5 SELECTION, ADAPTATION AND RETENTION IN RELATION TO THE OSTENSIVE, PERFORMATIVE AND ARTEFACT ELEMENTS OF ROUTINES

In terms of the ostensive, performative and artefact elements of routines (Feldman and Pentland 2003; Pentland and Feldman 2005) selection seems to occur in the ostensive element of the routine, as there is an intellectual understanding about what sub-routine options would be suitable for different situations, which is then enacted, and recorded in the database. Thus choice occurs in the ostensive element of the routine. There is a change in the ostensive too, with a shift from a technical approach to procurement to a more commercial approach. In terms of retention, again retention occurs in the ostensive element of the routine, as what is kept, beyond a record of what happened, is a shared intellectual understanding of the different options and what they achieve for the organisation.

4.7.6 SUMMARY – GAMMA CASE

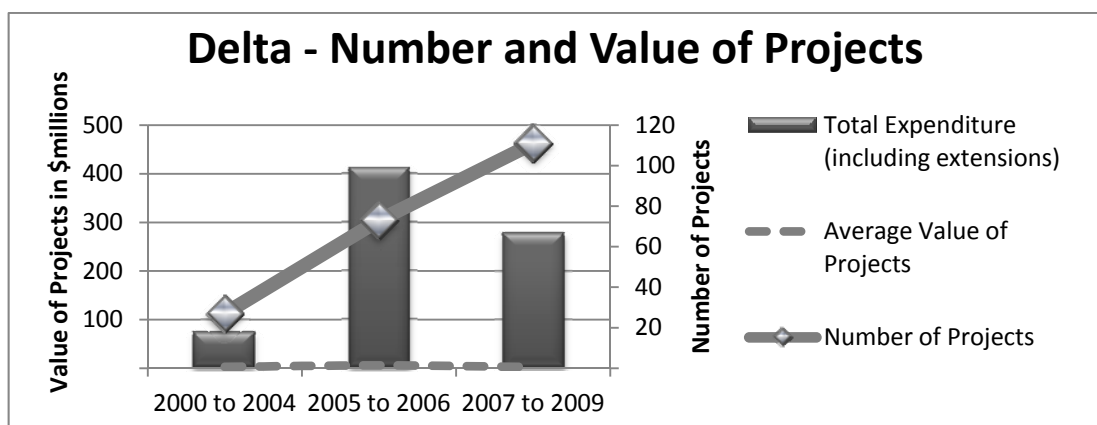
This case study has examined variety in organisational routines and its causes. The case study found that there is stability, diversity, adaptation, and dynamic variety in organisational routines. While selection did not appear to cause recombination in this study (possibly due to the low number of projects undertaken), selection was undertaken for a set of rational reasons. Variety was caused due to the introduction of new sub-routines options which increased the overall repertoire available for selection. Retention processes were also at work as some sub-routine options were retained in use in each time period, some were not used after an initial attempt, and others were reintroduced after a break. Together, selection adaptation and retention seemed to account for the variety of routines in use in the Gamma study.

An important additional finding is that amidst the variety there is centrality at an individual sub-routine level. Indeed there are a specific set of sub-routines which are more important as multiple tests showed that they are central to the procurement activities of Gamma, and that this centrality held over time.

4.8 DELTA CASE STUDY

Delta implemented a total of 216 projects over a 10 year period, with a total value of \$766 million. There was a difference both in the expenditure and number of projects across the periods. In Period 1, Delta had a small number (27) of smaller value projects (\$74 million in total); in Period 2 there was a larger number (78) of high value projects (over \$412 million in total), and in Period 3 a higher number of projects (111) valued at \$280 million (see Figure 25 below).

Figure 25 – Number and Value of Projects per Time Period – Delta



An ANOVA was conducted to test whether the average procurement expenditure by Delta was statistically different between each of the three time periods. This showed that there was a significant difference in the [log] expenditure over time [$F(2, 208)=9.864, p<.001$]. The effect size

(η^2) was .47, which is a large effect. While the total expenditure was higher in Period 2 and 3, so was the number of projects. Posthoc comparisons using Tukey HSD test indicated that the mean score for Time Period 1 ($M=1.29$, $SD=0.49$) was significantly more than both Time Period 2 ($M=0.60$, $SD=0.64$) and Time Period 3 ($M=0.77$, $SD=0.71$), Thus the average value of tenders was significantly higher in Period 1 compared to Time Period 2 and Period 3, and the effect size was large.

4.8.1 RQ 1 – WHAT SORT OF VARIETY EXISTS IN PROCUREMENT ROUTINES?

As with each of the previous case studies, the specific types of variety are examined in turn: adaptive, varied, stable and dyanmic. Firstly diversity is examined.

Evidence of Type II Variety – Diverse – Delta Case

A total of 52 different routine variants were implemented by Delta over a 10 year period (as set out in Table 62 on the next page). 52 variants amount to approximately 46% of the total number of variants implemented by Prolific Projects (although this amounts to only 5.16% of the total 1008 potential variants which could have been implemented). 6 variants (7.68%) were implemented in every time period (#42, #45, #47, #65, #90, and #95), while 14 were used twice and the rest once.

Table 62 – Varieties in Use – Delta – 2000 to 2009

Variant #	Scope of Works Cluster ✖	Contract 📄	Tender ①	Approach to Market 🗣️	2000 to 2004	2005 to 2006	2007 to 2009	Total	Extension
6	Design, Deliver and Test	Major Supply and Install	RFO/Tender	Open Tender			5	5	* (3)
8	Provide Services	Consultancy	RFO/Tender	Sole Tender		1		1	
9	"	"	"	Open Tender	1			1	
11	"	Engineering and Civil Works	Registration -> RFO/Tender	Sole Tender			1	1	* (1)
12	"	"	"	Open Tender	1			1	
13	"	"	RFO/Tender	Sole Tender			1	1	
14	"	"	"	Open Tender	1		1	2	
19	"	Service Contract	RFO/Tender	Open Tender			3	3	* (2)
21	"	Maintenance services	RFO/Tender	Closed			1	1	
24	"	Major Supply and Install	RFO/Tender	Open Tender		1		1	* (1)
25	"	Minor Works	RFO/Tender	Closed	1			1	
26	"	"	"	Sole Tender			1	1	
27	"	"	"	Open Tender			2	2	
28	Construction	Alliance	Registration -> RFO/Tender	Open Tender		5	3	8	* (1)
30	"	"	RFO/Tender	Open Tender			7	7	
34	"	Consultancy	RFO/Tender	Open Tender	1			1	
38	"	Design and Construct	RFO/Tender	Open Tender			2	2	
39	"	Engineering and Civil Works	Registration -> RFO/Tender	Closed	1	4		5	
40	"	"	"	Pre-Qualification		1	1	2	
41	"	"	"	Sole Tender		1	4	5	
42	"	"	"	Open Tender	3	7	2	12	* (3)
44	"	"	RFO/Tender	Closed		1	4	5	
45	"	"	"	Pre-Qualification	6	12	12	30	* (2)
46	"	"	"	Sole Tender		2	7	9	* (1)
47	"	"	"	Open Tender	1	6	10	17	* (2)
51	"	Supply	RFO/Tender	Sole Tender		1		1	
52	"	"	"	Open Tender	1		1	2	
59	"	Minor Supply and Install	RFO/Tender	Sole Tender			2	2	
62	"	Minor Works	Registration -> RFO/Tender	Sole Tender			1	1	
63	"	"	"	Open Tender			2	2	* (1)
65	"	"	RFO/Tender	Closed	1	5	1	7	
66	"	"	"	Sole Tender		3	4	7	
67	"	Minor works (cont)	RFO/Tender (cont)	Open Tender	1		10	11	* (1)
68	"	Services Panel	RFO/Tender	Closed			1	1	

Variant #	Scope of Works Cluster ✖	Contract 📄	Tender ⓘ	Approach to Market 🗣️	2000 to 2004	2005 to 2006	2007 to 2009	Total	Extension
74	Supply, deliver and commission	Engineering and Civil Works	Registration -> RFO/Tender	Sole Tender			1	1	
79	"	Minor Supply and Install	RFO/Tender	Open Tender		1		1	
80	Supply and Install	Engineering and Civil Works	Registration -> RFO/Tender	Sole Tender		1		1	* (1)
81	"	"	"	Open Tender		1		1	
84	"	"	RFO/Tender	Open Tender		6	3	9	
85	"	Supply	RFO/Tender	Sole Tender			1	1	
88	"	Major Supply and Install	RFO/Tender	Closed	1			1	
89	"	"	"	Sole Tender			1	1	
90	"	"	"	Open Tender	3	3	1	7	* (6)
91	"	Minor Supply and Install	RFO/Tender	Closed		1		1	* (1)
93	"	Minor Works	Registration -> RFO/Tender	Open Tender	1		1	2	
95	"	"	RFO/Tender	Closed	2	1	3	6	
96	"	"	"	Sole Tender		1	2	3	
97	"	"	"	Open Tender		6	5	11	* (1)
99	Supply and Load	Engineering and Civil Works	Registration -> RFO/Tender	Open Tender		1		1	
107	"	Supply	RFO/Tender	Open Tender			1	1	
109	"	Major Supply and Install	RFO/Tender	Closed		1		1	
114	"	Minor Supply and Install	RFO/Tender	Open Tender			1	1	

* Extension projects are projects which have been extended without going back to market. In other words the original contract included an option to extend and provide more work to the company.

In order to analyse the data in Table 40, a simple count was taken of the number of times each routine was used (ranked in order from highest to lowest use), which is reported in Figure 26 below.

Figure 26 – Number of Times Individual Routine variants Were Used - Delta

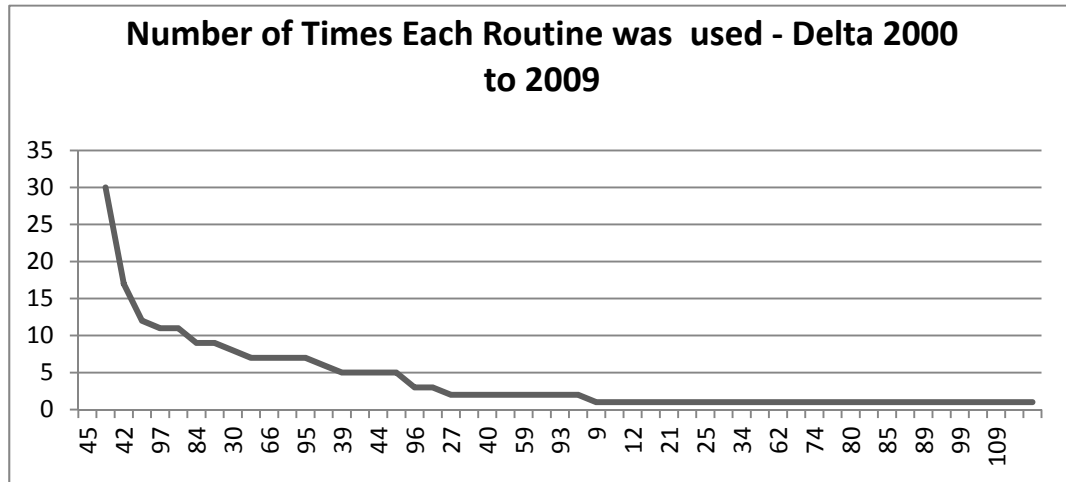
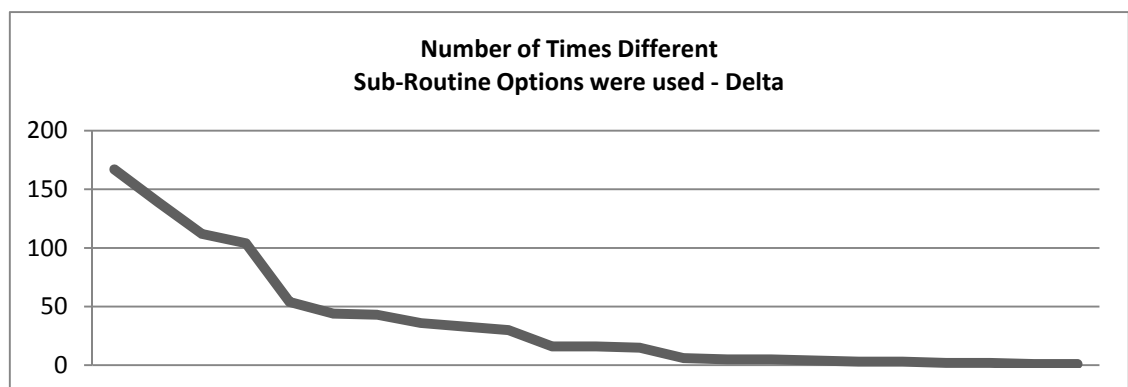


Figure 26 demonstrates that the usage of routine variants was not linear, but rather follows a Pareto distribution, with a number of variants used extensively with a rather long tail which were used hardly at all.

According to the database, 23 different sub-routine options were implemented by Delta over the ten year period (see below). Thus while Table 48 did not show a great deal of consistency over time with only six routine variants used in every time period, 12 sub-routine variants were used in every time period.

In terms of the number of times each sub-routine option was used, see Figure 27 below.

Figure 27 – Number of times each sub-routine option was used by Delta



The distribution of the number of times each sub-routine option was used by Delta also follows a Pareto curve. While the number of times routines were used varied from 30 times over a ten year period to once, the number of times each sub-routine was used varied from nearly 170 instances to a single use.

What each of these figures show is that there is a significant amount of variety demonstrated in the case study. In terms of Research Question 1, there are 78 routine variants, and the extent of use of these (in terms of number of times used, and number of time periods used) also varies. Thus in terms of what sort of variety exists, there is evidence of diversity.

Evidence of Type I Variety – Stable – Delta Case

6 routine variants (#42, #45, #47, #65, #90, #95) and 12 subroutine options were used in each time period. 10 routine variants and 5 sub-routine options were in use in two consecutive time periods, while 4 routine variants and 1 sub routine options were introduced after a break. 32 routine variants and 4 sub-routine options were used only once.

Examining Table 59 above, there are 12 sub-routines used in every time period (52.17%). These were

- *Scope of Works*: Provide Services, Construction, Supply and install;
- *Contracts*: Engineering and Civil Works, Supply, Major Supply and Install, Minor Works;
- *Tender*: Registration → Tender, and RFO/Tender; and
- *Approach to Market*: Closed Tender, Pre- Qualification, and Open Tender.

Thus while there is not a single dominant routine variant used to the exclusion of any other there are individual variants of a routine and sub-routine options which are used in each and every time period. Thus there is a measure of consistency over time for individual routine variants and sub routine options. Additionally, as with other cases, a number of contracts were simply extended.

In order to test whether or not pairs of sub-routine options were associated together in a significant manner, a number of Chi Squares analyses were conducted.

Chi squares

Chi square Delta - 2000 to 2004

Chi square analysis was undertaken (with Fisher's Exact test and Phi test for effect), in order to test for correlation between sub-routine options.

Significant positive correlations were found between:

- Construction Scope of Works and Engineering and Civil Works Contracts [χ^2 (1, N=26)=7.721, $p=.015$, $\phi=.545$];
- Supply and Install Scope of Works and Major Supply Contracts [χ^2 (1, N=26)=12.831, $p=.002$, $\phi=.703$].

Significant and Negative correlations were found between

- Construction scope of Works and Major Supply and Install Contracts [$\chi^2(1, N=26)=6.446, p=.022, \phi=-.498$];
- Supply and Install Scope of Works and Engineering and Civil Works Contracts [$\chi^2(1, N=26)=9.579, p=.005, \phi=-.607$].

Chi Square Delta - 2005 to 2006

Chi square analysis was undertaken (with Fisher's Exact test and Phi test for effect), in order to test for correlation between sub-routine options.

Chi square calculations showed that there were significant positive were found between:

- Provide Services Scope of Works and Consultancy Contracts [$\chi^2(1, N=73)=35.993, p=.005, \phi=.702$];
- Construction Scope of Works and Engineering and Civil Works Contracts [$\chi^2(1, N=73)=8.240, p=.006, \phi=.336$];
- Supply, Deliver and Commission Scope of Works and Minor Supply and Install Contract [$\chi^2(1, N=73)=35.993, p=.005, \phi=.702$];
- Supply and Install and Minor Works Contracts [$\chi^2(1, N=73)=5.263, p=.030, \phi=.269$];
- Alliance Contract and Registration → Tender [$\chi^2(1, N=73)=13.291, p=.001, \phi=.427$];
- Minor Works and Tender [$\chi^2(1, N=73)=8.275, p=.004, \phi=-.337$].

Chi square analysis also showed significant negative correlations between:

- Construction Scope of Works and Major Supply and Install Contracts [$\chi^2(1, N=73)=10.306, p=.004, \phi=-.376$];
- Alliance Contract and Tender [$\chi^2(1, N=73)=13.291, p=.001, \phi=-.427$];
- Minor Works and Registration → Tender [$\chi^2(1, N=73)=8.275, p=.004, \phi=-.337$].

Chi Square Delta - 2007 to 2009

Chi square analysis was undertaken (with Fisher's Exact test and Phi test for effect), in order to test for correlation between sub-routine options.

Significant positive correlations were found between:

- Design, deliver and Test scope of works and Major Supply Contracts [$\chi^2(1, N=110)=77.075, p<.001, \phi=.837$];
- Provide Services Scope of Works and Services Contracts [$\chi^2(1, N=110)=30.841, p=.001, \phi=.530$];
- Construction scope of works and Alliance Contracts [$\chi^2(1, N=110)=5.133, p=.029, \phi=.216$];
- Construction and Engineering and Civil Works Contracts [$\chi^2(1, N=110)=11.660, p=.001, \phi=.326$];
- Supply and Install Scope of Works and Minor Works Contracts [$\chi^2(1, N=110)=12.364, p=.001, \phi=.335$];

Negative correlations were found between:

- Construction Scope of Works and Major Supply and Install Contract [$\chi^2 (1, N=110)=16.019, p<.001, \phi= -.382$];
- Construction scope of works and Services Contracts [$\chi^2 (1, N=110)=6.609, p=.030, \phi= -.245$];
- Supply and Install Scope of Works and Engineering and Civil Works Contracts [$\chi^2 (1, N=110)=5.522, p=.031, \phi= -.224$];
- RFO/Tender and Sole Tender [$\chi^2 (1, N=110)=4.197, p=.056, \phi= -.195$].

Thus in terms of stability of organisational routines, a number of variants of the routine were consistently used in every time period, as were a number of sub-routine options. Additionally, chi squares showed a large array of correlations between sub-routine options.

Thus there is evidence of stability in procurement routines.

Evidence of Type III Variety – Adaptation – Delta case.

Table 63 sets out the sub-routine options used in each time period.

Table 63 – Sub-Routine Options in Use – Delta

Sub-Routine	Options	2000 to 2004	2005 to 2006	2007 to 2009	Total
Scope of Works ✳	Design, Deliver, Test	1		5	6
	Provide services	4	2	10	16
	Construction	15	48	76	139
	Supply, deliver, commission		1	1	2
	Supply and Install	7	20	17	44
	Supply and Load		2	2	4
Contract 📄	Alliance		5	10	15
	Consultancy	2	1		3
	Design and Construct			2	2
	Engineering and Civil Works	13	43	48	104
	Supply	1	1	3	5
	Maintenance			1	1
	Major Supply	4	5	7	16
	Minor Supply		2	3	5
	Minor Works	6	16	32	54
	Services Panel			1	1
Services			3	3	
Tender ①	Registration → Tender	6	21	16	43
	RFO/Tender	21	52	94	167
Approach to Market 📣	Closed tender	6	13	11	30
	Pre-Qualification Process	6	13	14	33
	Sole Tender		10	26	36
	Open Tender	15	37	60	112

Where a new sub-routine option has been introduced for the first time, this is indicated in bold on the table.

Thus in Time Period 2, 5 new sub-routine options were introduced (Supply, deliver, commission; supply and load; Alliance contract; Minor supply contract; sole tender) and 4 in Time Period 3 (Design and Construct contact; maintenance contract; services panel and services contact).

Thus there is evidence of adaptive variety as new sub-routine options are introduced in each time period.

Evidence of Type IV Variety – Dynamic – Delta Case

As there is both diversity and adaptation of routines, it is reasonable to conclude that a dynamic form of variety is also present. However to test this, a PCA was undertaken.

Principal Component Analysis

A matrix of the co-occurrence of sub-routine options for this case was undertaken. This provided a simple count of the number of times each sub-routine option occurred with other sub-routine options in a specific variant, with non-occurrence coded as a '0'. A Principal Component Analysis (PCA) was requested from SPSS on the matrix of the co-occurrence of sub-routines for all projects implemented by Delta. Principal Component Analysis with Oblique rotation and Kaiser Normalisation was used to examine the relationship of the covariance matrix of sub-routine co-occurrence data. Analysis of the scree plot suggested three components, which was confirmed with the extracted sums of squared loadings, confirming the existence of three components in the data.

Table 64 – Total variance Explained – Delta

Component	Extraction Sums of Squared Loadings		Rotation Sums of Squared Loadings
	% of Variance	Cumulative %	Total
1	79.851	79.851	3884.619
2	9.846	89.698	2793.629
3	4.563	94.261	1256.043

The PCA indicated that there were three components in the data, and together these three components accounted for 94% of the variance in the data. As with other cases, only when loadings had over .71 loading where they given credence (see Table 65 below).

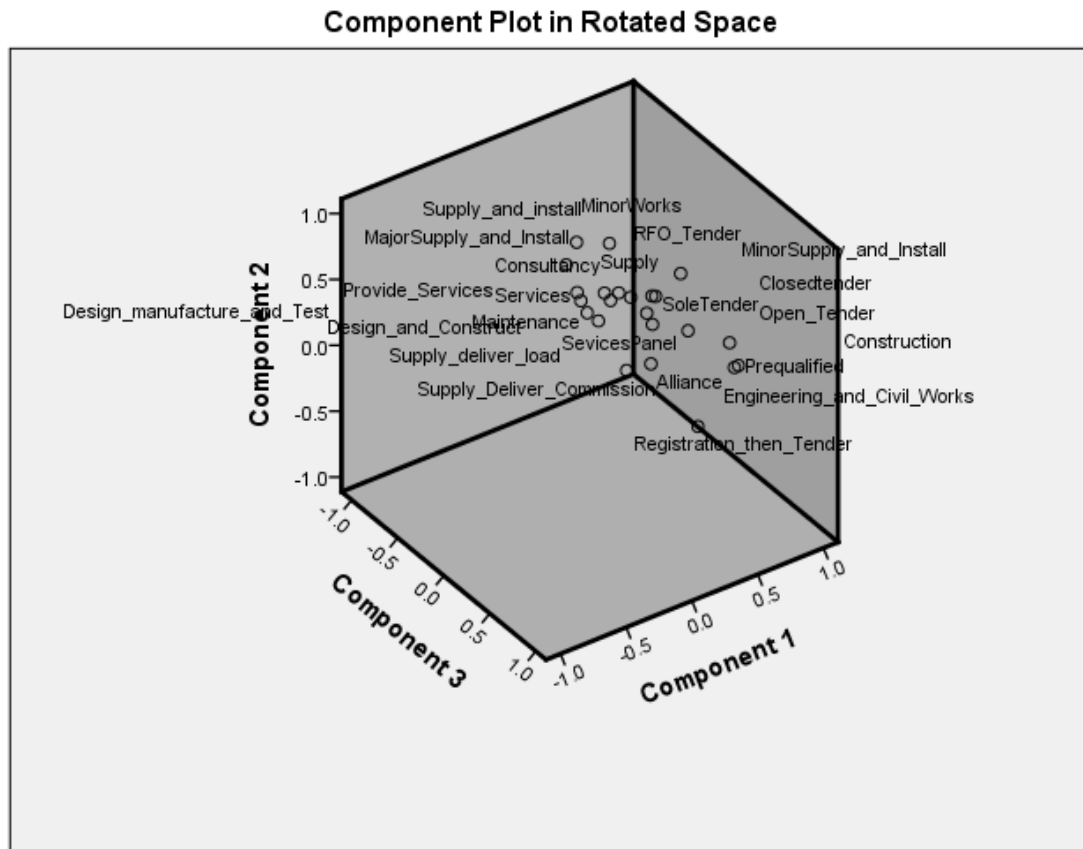
Table 65 – Principal Component Analysis – Delta

	Rescaled Component		
	1	2	3
✂ Construction	0.892	0.517	0.53
↔ Prequalified supplier	0.882	0.187	0.295
① RFO/Tender	0.878	0.804	0.218
📦 Engineering and Civil Works	0.861	0.39	0.581
↔ Sole Tender	0.748	0.326	0.103
↔ Closed Tender	0.694	0.453	-0.078
📦 Services Panel	0.571	0.275	-0.05
↔ Open Tender	0.553	0.876	0.553
✂ Supply and install	0.368	0.871	-0.043
📦 Minor Works	0.578	0.847	-0.056
📦 Major Supply and Install	0.218	0.738	-0.009
✂ Design and Construct	0.499	0.619	0.345
✂ Design Manufacture and Test	0.17	0.618	0.106
✂ Provide Services	0.35	0.586	0.071
✂ Supply	0.496	0.576	0.109
📦 Services	0.166	0.554	0.098
📦 Consultancy	0.364	0.53	0.067
📦 Minor Supply and Install	0.466	0.501	-0.054
✂ Supply deliver load	0.189	0.482	0.206
① Registration → Tender	0.331	0.179	0.891
📦 Alliance	0.289	0.481	0.672
✂ Supply Deliver Commission	0.18	0.19	0.298
📦 Maintenance	0.24	0.206	-0.297

Legend: ✂ Scope of Works 📦 Contract ① Tender Process ↔ Approach to Market

Two main components were identified, those which were focused around construction type activities and those which were focused on machinery, and a third around a particular form of tendering. Together 94% of variance is explained through each of these components (shown in Figure 28 below).

Figure 28 – Plot of principal components in rotated space - Delta



In answer to the first research question, there is dynamic form of variety in organisational routines, as there is both variety and change involved in routines over time. Additionally amidst this adaptive variety, there is evidence of stability.

Thus it would appear that all four types of variety are present in the data.

How the dynamic processes of selection adaptation and retention might affect variety is discussed in the sections that follow.

4.8.2 RESEARCH QUESTION 2: SELECTION AND VARIETY- DELTA CASE

As argued in the literature review, selection involves the choice of various options. In each time period there were a set of routines chosen. Routines, as shown earlier in the case study, are comprised of a set of sub-routines. Each routine is made up of one of each of these sub routines. Selection then, is the process by which one of the sub-routines is chosen for inclusion in the overall routine. Counts were made of the number of routines in each period, and the number of new routines which were created from the existing repertoire of sub-routines. The findings are presented in Table 66 below.

Table 66 – Number of Routine Variants due to recombination processes – Delta

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routines in Use	16	25	37
Number of new routines from recombination	-	6	14
% of Routines due to recombination		24%	38%

Table 66 (based on the full contingency table in Table 62 shows that there was a set of different routine variants in each time period. Of all of these variants, 6 in Period 2 (56%) and 14 in Period 3 (60%) were not as the result of new processes, but were created by recombining the existing pool of sub-routines options. This was determined manually, by considering only those variants which were comprised of sub-routine options which occurred in the first time period. Taking the first time period as a base line, 24% (Period 2) and 38% (Period 2) of new varieties of procurement routines were created due to the recombination of existing routines.

The interviews provided a useful insight into these processes of selection of individual sub-routines:

One of the key issues in deciding between three forms of contract appears to be in order to manage the design of the asset:

In a traditional delivery the client really has the most influence on the designs and the constructor has no influence on the design. You might be able to convince us to change minor things, but generally you build it in accordance with its design. In a design and construct model, the client gets the specifications and says this is the principles of what we want to give us and so the constructor has got some rules that he has to follow but then he will deliver the most cost effective solution that he can, and influence the design accordingly, so they may have the main influence. In an Alliance, all three parties work together in developing the design. [Interview 6]

Thus a traditional delivery of a project would be used where the design had been completed, a design and construct would be used where some specifications or preliminary drawings had been completed, and in an alliance the owner and constructor work together. Other interviewees corroborated this understanding, firstly of traditional construction arrangements:

civil procurement is fairly easy. Predominantly for the smaller projects we will do design internally and then we will go out for construction contracts [Interview 25]

Alliances

Another relatively new form of contract brought in and managed by Delta was that of the Alliance. While the reasons for the innovation are examined below, a number of interviewees were able to articulate the typical situations in which an Alliance contract might be used. As noted earlier – one key advantage with an alliance is that there is no need to have a completed design before commencing building:

Yeah, you don't have to do full documentation, you can actually start building it quicker, you can start building before you've finished the design and you've done the selection process upfront. In a traditional model you've got to have a list of reference design, document it altogether and then go through a selection process. In an Alliance, you do your selection process upfront and then you can start working on your final design, almost straight away [Interview 6]

Other interviewees identified other situations in which you might use an alliance style of contract:

There are places where you should use alliances: where the risks are high, it is where the stakeholder management is really complicated, or uncertain as to what you've got to build, all those things make it hard to get a competitive hard dollar price and [omitted] everybody accept that a job that fits those criterias, alliances are probably well suited for, but if you've got a clearly defined scope, the risks aren't extraordinary, they are just normal construction risks, you should go and deal with the market to determine the best price [Interview 17]

The reason why the alliance is useful in situations of higher risk, is that the risk is shared between owner and constructor:

size generally brings something with it, so maybe ... a large program of works needed to be done in a short period of time, therefore it has got risks in it of a certain magnitude that we as an owner would prefer not to take 100% of those risks, but to share them with the contract. Yeah risks is one, complexity is one, so those types of issues [Interview 19]

As the alliance is about working together on the design and delivery of large, complex, risk laden projects, the modus operandi of the projects is different from a normal construction arrangement:

so Alliancing is about the partnership between the owner and non-owner participants, the designers and contractors all sitting equally around the table, working with the best of project outcomes [Interview 19]

This influences the tendering and selection process of identifying potential suppliers in an alliance contract:

you go out to market and go through a selection process, based upon non cost selection basis, what their expertise is, what is their capability of collaboratively working together as a team. [Interview 19]

However, there are certainly costs involved in setting up Alliances:

When you set the Alliance up for five or ten years, if the work comes down then you have a huge set up cost, ongoing cost then you will wonder what is the right way of terminating, so certainly unless you have a proper termination agreement, what is the right time? If you delay it, then you are paying a huge amount of money for the Alliance, and if you break it and the market changes tomorrow then you are looking at another set of costs again to do it again [Interview 7]

But then again, cost is not necessarily the key deciding factor in Alliances, it is ensuring the project is delivered on time:

In the Alliance, they work out the price afterwards, and you might be able to get the price down. How you know that is a better price if you have got another major contractor involved, you have to make the assumption that all of the contractors will charge you about the same amount of money, the real driver here is not the money, it is being delivered on time, and we believe that this contracting model will deliver it to us on time, sure we will pay a little bit extra possibly [Interview 21]

So the extent to which design had already been completed, together with the complexity of the project and how best to manage risks were key influences in making decisions about which form of contract to use. However, internal capability and resources also played a role in the selection process:

Internal resources / capability

As with other case studies internal resources and capability affect what is contracted out to market:

D and C yeah. We do variations on that, sometimes we might put the whole design and construct, sometimes we might put the design out, because bearing in mind we have a construction arm internally so it can vary sometimes how we mix and blend that, depending on what is available. . [Interview 24]

In terms of design work, sometimes the internal design staff were overloaded and this was the reason for putting this to market:

So one [project] rolled into two, we were getting busy, another one came along, oh we were getting very busy, then there was three and four, so at this stage, we were swamped so we started using consultants to do the design. Still a traditional approach of design and construction, but at this stage we were swamped and it was out of control [Interview 21]

As with other case studies, sometimes work was deliberately not tendered out in order to maintain organisational capability:

We have delivered a small number of in-house projects, um you know and the main purpose of that was to retain competency but you know we will only commit to

that if we have um if we have the resource base to deliver the portfolio, yeah, we prefer to work on sorting the constraints and possible solutions that we need as opposed to doing too much detailed design because we have limited resources. .
[Interview 23]

Part of this capability is around technological expertise in the asset itself:

It is always an interesting question for us, to what extent we need to maintain the depth of capability internally but at the moment my belief is that retaining some capability allows us to make informed asset procurement decisions, so it is difficult as a client to make informed decisions if you don't have some depth of asset knowledge. [Interview 25]

Thus the reason why design might be outsourced in the first place (which as noted above is a key determinant in certain contracting choices) is also partly determined by internal company capability and resources. So selection is at least partly driven by project related issues (risk, complexity, amount of design to be completed) but also by internal resourcing issues – the availability and capability of staff. Without the internal construction and design capability, then Delta would have little choice but to contract this work out. With the capability they are able to exercise choice.

For the design and construct contract, the design being completed by the contractor was underscored:

Design and Construct (D and C)

The D and C, the owner has less control over the design because it is being influenced strongly by the constructor, but you get a more efficient design in terms of construction. So the positive of the d and c, is that you should get a lower construction price, but the risk is that the owner has less influence, you make a cheaper design [Interview 17]

So for design and construct arrangements, most of the design work is undertaken by the contractor, with the advantage that you might get a lower construction prices, but control of the design is undertaken by the contractor.

Interview data thus corroborates the Chi Square and Principal Component Analyses which indicates that selection is a non-random process. There would appear to be a set of internal and external factors involved in selecting sub-routine options. Indeed, selection seems to operate from the repertoire of sub-routines options level, with specific internal and external conditions affecting which contract is chosen, which tender method is used, and which approach to market was deployed. While some of these sub-routine options were chosen more often, the specific combinations sub-routine options which are selected create the variety in the over-all procurement routine.

In this case study, selection creates variety by choosing from an existing pool of sub-routine options and recombining these in order to create new varieties. Choosing new combinations of sub-routines creates variety.

4.8.3 RESEARCH QUESTION 3: ADAPTATION AND VARIETY – DELTA CASE

While a number of routine variants were due to recombination, this was not the case for every new routine. Table 67 provides the number of routines due to adaptation

Table 67 – Number of New Variants due to adaptive processes (Delta case)

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routines variants in use	16	25	37
Number of new routine variants from adaptation	-	12	4
% of new routine variants as a result of adaptation	-	48%	11%

As Table 67 shows, there were 12 routine variants in Period 2 and 4 in Period 3 which were as a result of adaptation. The number of new variants due to adaptation was determined by identifying the new variants, and verifying that at least one of its component sub-routine options was *not* present in the previous time period. In other words the new variety is as the result of adaptive processes, not just simply recombination of existing sub-routines. Table 68 provides the number of sub-routines which were new in each time period.

Table 68 – Change in Sub-Routine Options Over Time – Delta Case

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	14	18	22
Number of new sub-routine options	-	5	4

Comparing the data from Table 67 and Table 68 shows that in Period 2, there were 7 new routine variants which included at least one of the 5 new sub-routine options which had not been in used previously. In Period 3, there were four new variants, which included the four new sub-routine options.

Thus adaptation increases variety by providing new sub-routine options which can be selected for inclusion in the routine variants. Following the language of routines, adaptation increases variety by increasing the repertoire of sub-routine options. Increasing the repertoire of sub-routine options increases the options available for selection, and subsequent recombination.

As noted earlier a number of new contracts were implemented by Delta over the 10 year period, particularly alliances, panel contracts and various tendering arrangements. As one interview noted:

in the past ten years or so ago, we were fairly traditional, design in-house and going through the traditional stream to construction and ownership, but really in the last five years we have become far more flexible in the types of models we use
[Interview 19]

This is supported by descriptive statistics from the database, which is summarised in Table 66 below. As Table 66 indicates, alliances were first used in 2005; while Design and Construct contracts and Services Panels were both first used in the 2007 to 2009 time period.

Table 69 – Use of Various Forms of Contract – Delta – 2000 to 2009

	2000 to 2004	2005 to 2006	2007 to 2009
Alliance			
Consultancy			
Design and Construct			
Engineering and Civil Works			
Service Contract			
Supply			
Maintenance services			
Major Supply and Install			
Minor Supply and Install			
Minor Works			
Services Panel			

The key reason for implementing one of the new contract forms (alliances) was due to market forces and availability of resources to undertake projects:

back in 2004 there was a significant resource shortage and a significant number of other large infrastructure projects about to come on board ... the industry was struggling to get people to actually tender for works, there was a shortage of construction resources, and we went out and consulted with industry about that issue, and what would be the best way for us to secure the resources that we needed to deliver the program of works that we had, and that consultation resolved that the best way was to form a program alliance. **[Interview 17]**

This is corroborated by another interview:

we discovered that it was an overheated market, there was a shortage of design and construction resources and we also discovered that the top of town contractors were um, moving away from um, traditional hard dollar contracts, they didn't like the risk profile from their perspective for those jobs, and there was a move towards Alliance projects. So our objective was to secure resources, because we needed to deliver these projects and we felt that the best way to do that would be to enter an Alliance arrangement with suitable partners to deliver a number of these projects
[Interview 6]

This move to Alliance projects also resulted in additional changes in the tendering process, not coded in the database:

It [tendering] is much more like a recruitment process, so we went through a um, it was very much like a recruitment process, they applied for the role, answered the selection criteria and then ran through a multiple work-shopping arrangement with them, to test some of the things they said against the selection criteria, so we did a short list and started off with this proposal. We shortlisted it to four or five and we had some work-shopping and then listed it down to two or three, and then did another workshop. . [Interview 17]

The other change that introduction of alliances required, was in the way that Delta staff approached working with the alliance partners. As noted above, alliances are collaborative arrangements, which are different to more adversarial style of contractual arrangements.

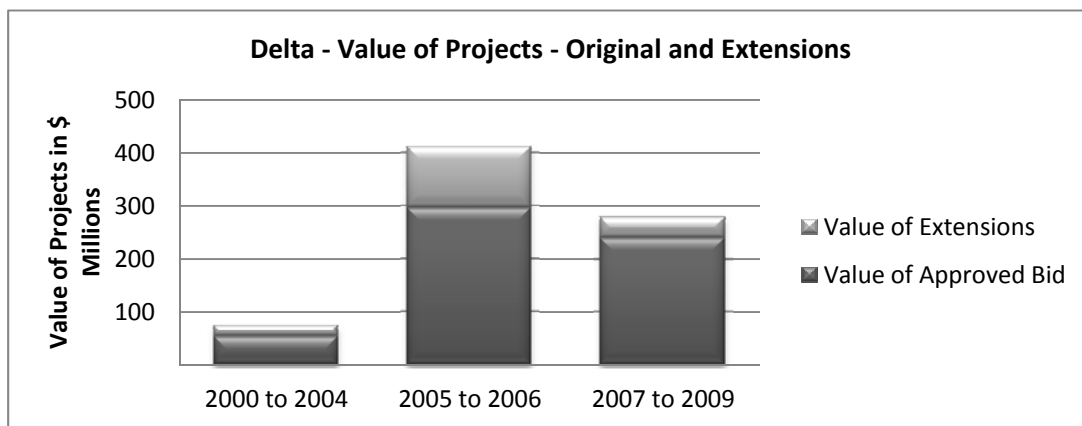
people as I say who are really experienced in contracts, just can't get their mind around changing from adversarial to co operative. They just can't believe it, whereas other people are saying this is what we have wanted all our working lives, actually working with these people instead of against them ... But you have to get it. You have to go through a change to get it. [Interview 17]

In other words, to be effective alliances required a different way of working with suppliers – from adversarial to cooperative approach to procurement, and some individuals were able to change their thinking to accommodate this, while others found this difficult.

Early contractor involvement (involving extensions)

As set out in Table 62, there were 27 projects which were ‘extended’. An extended project means that the original contract included an option to request more work from the company without going back through a formal tender process. For Delta, 5 contracts were extended in Period 1, 12 in Period 2, and 11 in Period 3. These extensions increased the total value of the projects compared to their initial value (see Figure 29 below), with the greatest increase in value occurring in Period 2. Effectively, an extension is an alternative type of routine as, rather than going back to market, an existing contract for an asset is extended.

Figure 29 – Original and extended values of projects



There is no statistical association between Delta and the use of extensions. One key reason for using an extension is due to time, as one interview explained:

Now there is a mismatch in timeframes ... once you've won a contract and the two years that it takes to manufacture the asset ... So that mismatch of time has of recent times been reflected in rolling over of existing contracts and giving extensions to contract quantities, rather than the competitive calling of new contracts. [Interview 26]

However, this was not the only reason as Delta used extensions for the same reason for originally considering alliances – to lock in scarce resources:

Virtually an extension of the existing tender for a number of parcels of work, but benchmarked against his current rates....Oh that was the other reason why we went into that arrangement, was because we wished to lock in the construction resources over a long period of time. Because at that time we had the construction boom and we were desperate to ensure that contractors would bid for our jobs, so by offering them the potential for the rolling contract of several, three or four pieces of work, they could see this wasn't just a \$30 million job, this was potentially \$90-100 million over a couple of years, so it actually gave them the incentive of continuity of work, not just one job. . [Interview 19]

Panel Contract

If we go back ten years, we used to do mainly supply and install contracts Back in those days the vendors used to have dedicated installers of their own, but what we found started to happen was that we were just subbing it out to them, and we were finding we had to train up the subbies every time they came in to how they are installed now, to our standards, so what we decided to do about two years ago was to call a panel contract for installers. So in my area, we have two companies on panel contract. . [Interview 22]

A similar process involves standing supplier arrangements

I guess the third thing that we have done is that we have entered into a number of standing contracts with key suppliers. We have pre selected some of the equipment suppliers that we have based on experience and compliance with specs and commercial conditions so that we can streamline the procurement process [Interview 23]

These processes of panel and standing supplier arrangements are important for Delta, as compared to other case studies, they retained the use of Registration → Tender and Pre-Qualification arrangements for their tender arrangements. The final area of change was the increased use of single tender arrangements:

Use of Sole tender

Principal component analysis identified (see Table 62 above) the increased use of Sole Tender arrangements in the principal component in Period 3 (2007 to 2009). Interviewees provided some insight into this:

we realised a number of years ago that it was crazy to continue the lowest price competitive tender, because what we were ending up with was quite a number of vendor's equipment ... When you look at that from a whole of life cost that was the wrong way to go. So we focused on buying one vendor's equipment in particular areas. [Interview 22]

A key reason for this adaptation was due to internal capability:

Then probably more critically, when one of those [assets] fails, having a technician who has knowledge in how to fix it, so you might send a guy out and he goes, well I don't know anything about that, I only know this other brand. I don't know that brand, so it might take him a while to fix it and if that is causing Critical assets delays it is costing the organisation lots of money, so we made the decision a few years ago to just procure one vendors' equipment for particular parts [Interview 22]

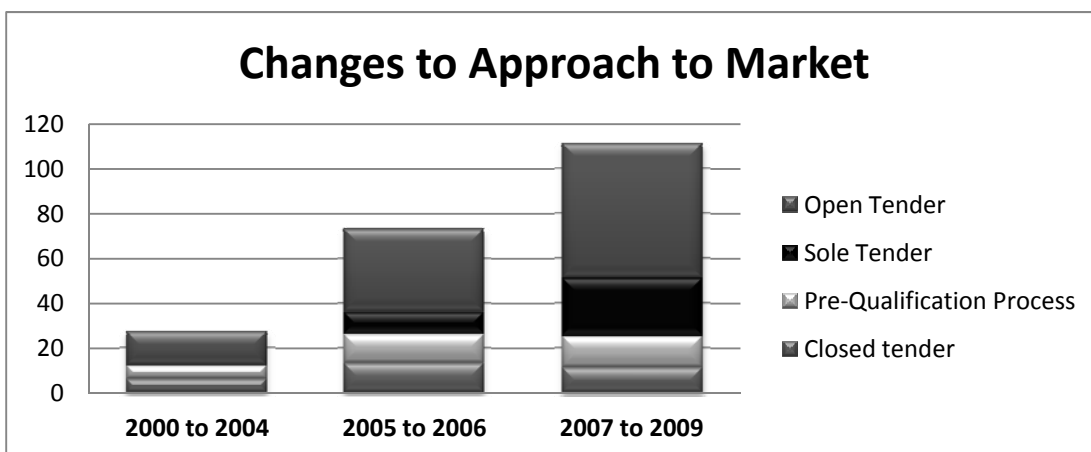
Thus the internal capability to effect repairs, and the whole of life costs associated with having multiple different pieces of equipment resulted in increased use of the single tender arrangement.

However, for some assets, there were also very few suppliers:

It is not quite a monopoly but it is very close to a monopoly and a monopsony, one buyer, one seller. [Interview 26]

This is supported with descriptive statistics from the database, which show that the use of single supplier (as a percentage of total projects) commenced in the 2005 to 2006 period and increased over time (see Figure 30 below).

Figure 30 – Changes to tendering processes over time - Delta



Thus descriptive statistics (Figure 30) show increased used in Sole Tender arrangements over time, and Principal Component Analysis (Table 65) included sole tender in the primary component in Period 3.

Better Utilisation

There have also been changes underway in the planning processes related to procurement. Rather than simply going out and buying more assets there is a shift towards taking an enterprise wide view on assets, and attempting to improve the utilisation of existing assets. As the following interview indicates:

I think the issue of availability and utilisation is another one, and to me, availability is out of the total number of assets which ones you have available to use as in not in maintenance or out of service for some reason and utilization is out of those which ones actually get used on a given day. I think there has been an understanding that was an important thing to focus on and to achieve. We haven't been achieving it and what has happened in the last few months I think is that there has been an appreciation that one of the key reasons we haven't been achieving it is that everyone is off doing their own thing whereas there is no ... no enterprise view on how one achieves it, and that is the shift, you might see it as a more centralized view, it was a totally decentralised view and I think there is an appreciation that that pendulum swung too far [Interview 26]

Change to the Procurement Decision Making Process

As outlined in the theory section, procurement processes are set in motion after an organisation decides that it will not, or cannot, deliver the asset internally (the make/buy decision). There are signs that this logic is being reassessed within Delta:

Yeah our traditional thinking is very much, can we do it ourselves? No, how are we going to do it? As opposed to, how should we do this, to get the best outcomes for the business and the project ... So there is probably a level of commercial maturity that we are getting but we are just not there yet ... [Interview 25]

Thus adaptation increases variety by increasing the repertoire of sub-routine options available for selection into routine variants. This increase was driven by the nature of the market – particularly the number of suppliers which were available and the need to secure resources for major projects.

4.8.4 RESEARCH QUESTION 4: RETENTION AND VARIETY – DELTA CASE

As noted in the literature review, retention involves the retaining in memory of organisational processes (Nelson and Winter 1997). In a similar way, to the previous sections, a count was made of routine variants continuing from one time period to the next (see Table 70 below).

Table 70 – Number of Routines Retained (continued) in organisational memory - Delta

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routine variants in Use	16	25	37
Number of Routine variants Continued	-	4 (16%)	5 (14%)
Number of Routine variants Discontinued	-	8	11

In terms of retention then, a number of routine variants were continued (4 in Period 2, and 5 in Period 3) between time periods. However a number of routine variants were *not* retained between time periods with 8 in Period 2 and 11 in Period 3, not continuing from period to period. The story is slightly different at the sub-routine level, however (see Table 71 below).

Table 71 – Number of sub-routines retained in organisational memory – Delta

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	14	18	22
Number of sub-routines options	-	12 (66%)	12 (54%)
Number of subroutines options discontinued	-	5	5
Number of subroutines options re-introduced	-	-	1

In terms of retention, a number of sub-routines were discontinued (5 in Period 2, and 5 in Period 3). Discontinuation means that the sub-routine was in use in one time period, but not in the second. A larger number were retained and used in subsequent time periods (12 in Period 2, and 12 in Period 3). Interestingly, sub-routine from Period 1 is reintroduced in Period 3. In other words the routine was reintroduced after a break in use. This provides support for the notion that routines involve organisational memory, as the sub-routine was not forgotten, but reintroduced when deemed appropriate.

One of the major innovations in Delta was the use of Alliances. Having implemented a number of these, some reflection was evident in the strengths of this form of contract, as opposed to other forms of contract:

The only issue with the Alliances generally has been value for money and justification thereof, there are still a lot of issues ,but you know as you tell people you can have a hard dollar contract and a whole lot of variations ... risk, whatever you want to call it, will raise its’ ugly head or you can have an alliance open book where you know what the costs are, you know it is a 30% mark up, but it is visible to you and at the end of the day there is a pain/gain share. Whatever happens there, you can’t have both. Project managers want that, they want the hard dollar contract and visibility with no variations and all those sort of things, but you can’t have that, it is not the way it works. [Interview 24]

This reflection process is echoed in a number of other interviews, who offered the following in relation to the continued use of alliance contracts (which were introduced in Period 2 for Delta):

Now that we’ve got more experience with alliances, we might do it for other reasons, more about the other ones I was talking about, the stakeholder management, the uncertain risk, now that we are more comfortable with alliancing, we may consider them more in the future [Interview 6]

[We] learnt that the Alliances do consume a lot more owner resources and input and time and pain and heartache, so you do gain financially um, and you do gain for all sorts of reason in delivery, but that has come at a lot of effort. They are not easy vehicles to use, because of the inputs needed to make them work [Interview 19]

Thus at a sub-routine level in each period there are new sub routine options introduced, existing sub-routine options which are continued, and a number which are discontinued. There is a much stronger retention of sub-routine options over time (71% and 86%) compared to routines (25% and 33%).

In answer the research question then, retention affects variety by the net number of routine varieties and sub-routine options which are retained from period to period. If all routines (or sub-routines) were kept from one period to the next, and adaptive processes added new ones, there would be a net increase in the number of routine variants (which for this case would have meant $16+12+4 = 32$ routine variants, and $14+5+4 = 23$ sub-routines options). However, not all routines, or sub-routines are retained, and thus the total pool of routines was higher in the final period, while the total number of sub-routines was less than at other time periods. The reintroduction of the sub-routine after an absence of a couple of years holds interesting questions about how big the actual repertoire of sub-routines options really is, a matter which will be followed through the other case studies.

4.8.5 SELECTION, ADAPTATION AND RETENTION IN RELATION TO THE OSTENSIVE, PERFORMATIVE AND ARTEFACT ELEMENTS OF ROUTINES

In terms of the ostensive, performative and artefact elements of routines (Feldman and Pentland 2003; Pentland and Feldman 2005) selection occurs first from the ostensive, is performed and is then recorded in the database (artefact). Adaptation also seems to occur at the ostensive level initially. Retention also appears to occur at the ostensive level, beyond the record. The clearest example of this is alliances, where there is a rationale for the circumstances in which an alliance should be used, for the introduction of the alliances, and the review which has happened and the decreased likelihood of using alliances in the future. Here the iteration between the ostensive, performative and artefact is most interesting.

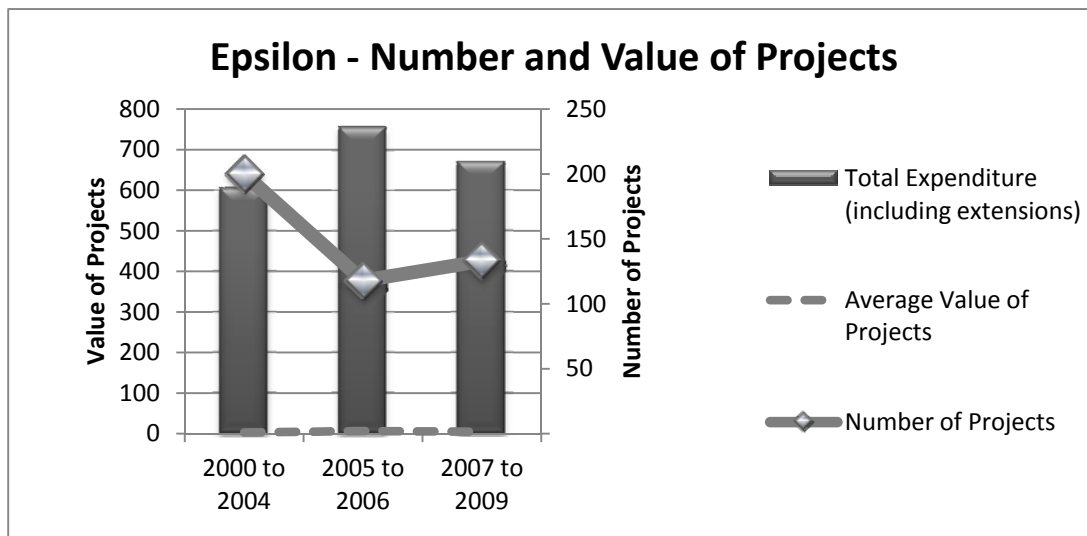
4.8.6 SUMMARY – DELTA CASE

This case study has examined variety in organisational routines and how selection adaptation and retention might contribute to the creation of variety. Over all a case has been that all four types of variety were present. Selection –adaptation –retention creates variety by introducing new sub-routine options, retaining old sub-routine options and recombining existing sub-routine options in new ways, thus creating new varieties of routines.

4.9 EPSILON CASE STUDY

Epsilon implemented a total of 427 projects over a 10 year period, with a total value of more than \$2,000 million. There was a different rate of expenditure over this time period, and a different number of projects. In Period 1, Epsilon had 188 projects, valued at \$605 million; in Period 2, 115 projects valued at \$757 million, and in Period 3, 124 projects valued at \$670 million (see Figure 31 below).

Figure 31 – Number and value of Projects per Time Period for Epsilon



While there was a difference in the value of projects over time, a statistical test is needed to determine whether this difference is statistically significant or not. Such analysis is important as previous case studies have shown that the value of contracts influences selection, and therefore variety in the procurement process. Consequently, an Analysis of Variance (ANOVA) was conducted in order to test whether there was a significant change in the average value of projects over time. The ANOVA showed that there was a significant difference in the value of contracts [$F(2,444)=5.041$, $p=.007$]. The effect size using η^2 was 0.02 which is a small effect. Posthoc comparisons showed that the average value of the log of contract values in Period 1 ($M= 13.29$, $SD=1.4$) was higher than Period 2 ($M=12.66$, $SD=2.04$). (The actual – non-standardised average value was \$3 million more for Period 2). Thus the average value of the projects in period two was much higher, and this may have an effect on selection processes.

4.9.1 RQ 1 – WHAT SORT OF VARIETY EXISTS IN PROCUREMENT ROUTINES?

As noted in Figure 31, Epsilon undertook a significantly higher number of projects than other Cases examined to date (approximately 450). One key reason for this is that Epsilon undertook procurement activities on behalf of other divisions, which at least partially explains its higher level of projects, compared to other cases. Additionally as Epsilon employed legal staff and undertook much

of the tendering process on behalf of other divisions, they tended to have a role in providing advice to other Cases examined previously. As one interviewee explained:

Epsilon often manages the projects[they] also had a high degree of involvement in the strategy and making sure that the procurement strategy meshed with their project delivery objectives, so they were often delivering a project that was multi-disciplined that needed procurement ... in a co-ordinated manner [Interview 15]

This was confirmed by another interview:

We might be dealing with for instance, the Alpha area or a Delta. They are traditionally the two main areas that we purchase for [Interview 2]

Evidence of Type II Variety – Diverse Variants – Epsilon case

As with each of the previous studies, the different types of variety are examined first: adaptive, stable, varied and dynamic. A total of 83 different routines varieties were implemented by Epsilon throughout the 10 year period. 83 variants amounts to approximately 73% of the total number of variants implemented by Prolific Projects (although 83 routines are only 8.23% of the total 1008 theoretical combinations of sub-routines which could have been implemented. In order to analyse the data from the full contingency table (See Table 72 below), a simple count was taken of the number times each routine was used, which is reported in Table 72 below. The usage of routines was not linear but follows a Pareto curve, as a small number of routines were used a significant number of times and a large number of routines are used hardly at all.

Table 72 – Varieties in Use – Epsilon

Variant #	Scope of Works Cluster	Contract	Tender	Approach to Market	2000 to 2004	2005 to 2006	2007 TO 2009	Total	Extension
4	Design, deliver and Test	Major Supply and Install	RFO/Tender	Closed	1	1	2	4	* (2)
5	"	"	"	Sole Tender	3	2	2	7	* (1)
6	"	"	"	Open Tender	4	3	3	10	* (1)
7	Provide services	Consultancy	RFO/Tender	Closed			2	2	
8	"	"	"	Sole Tender			1	1	
9	"	"	"	Open Tender			1	1	
10	"	Engineering and Civil Works	Registration -> RFO/Tender	Closed			1	1	
12	"	"	"	Open Tender	1			1	
13	"	"	RFO/Tender	Sole Tender	1	2	2	5	
14	"	"	"	Open Tender	4			4	
15	"	Service Contract	Registration -> RFO/Tender	Open Tender			2	2	* (1)
16	"	"	RFI/EOI -> Tender	Open Tender	2			2	
17	"	"	RFO/Tender	Closed	2	1		3	* (1)
18	"	"	"	Sole Tender	1	2		3	* (1)
19	"	"	"	Open Tender	2	1	1	4	* (1)
20	"	Maintenance services	Registration -> RFO/Tender	Closed	1			1	* (1)
23	"	Major Supply and Install	RFO/Tender	Closed	1			1	
25	"	Minor Works	RFO/Tender	Closed	1			1	
27	"	"	"	Open Tender			1	1	* (1)
29	Construction	Alliance	RFO/Tender	Sole Tender			1	1	
31	"	Construction Management	RFO/Tender	Closed		1	1	2	
32	"	Consultancy	RFI/EOI -> Tender	Sole Tender			1	1	
33	"	"	RFO/Tender	Closed		2	1	3	
35	"	Design and Construct	Registration -> RFO/Tender	Closed			2	2	* (1)
36	"	"	RFO/Tender	Closed			1	1	
37	"	"	"	Sole Tender	1			1	
39	"	Engineering and Civil	Registration ->	Closed	3	2		5	

		Works	RFO/Tender						
42	"	"	RFO/Tender	Open Tender	12		1	13	
43	"	"	RFI/EOI -> Tender	Closed			1	1	
44	"	"	RFO/Tender	Closed	3	1	1	5	
45	"	"	"	Pre-Qualification	14	2		16	
46	"	"	"	Sole Tender	1		1	2	
47	"	"	"	Open Tender	7	3	3	13	
49	"	Service Contract	RFO/Tender	Open Tender		3	2	5	* (1)
50	"	Supply	RFI/EOI -> Tender	Open Tender	1			1	
52	"		RFO/Tender	Open Tender	2			2	
53	"	Maintenance services	RFO/Tender	Open Tender	1	1	1	3	* (1)
54	"	Major Supply and Install	RFI/EOI -> Tender	Sole Tender	1			1	
55	"	"	"	Open Tender		1		1	
56	"	"	RFO/Tender	Closed	1	2	1	4	* (3)
57	"	"	"	Sole Tender			3	3	
58	"	"	"	Open Tender	3	1	2	6	* (1)
60	"	Minor Supply and Install	RFO/Tender	Open Tender		1		1	
61	"	Minor Works	Registration -> RFO/Tender	Closed		1	1	2	
64	"	"	RFI/EOI -> Tender	Open Tender		1	1	2	
65	"	"	RFO/Tender	Closed	13	14	4	31	* (1)
66	"	"	"	Sole Tender	4	1	3	8	* (1)
67	"	"	"	Open Tender	20	22	29	71	
70	"	Other	RFI/EOI -> Tender	Open Tender	1			1	
71	"	"	RFO/Tender	Closed	1			1	
72	"	"	"	Sole Tender			1	1	* (1)
73	"	"	"	Open Tender	4			4	
75	Supply, deliver and commission	Engineering and Civil Works	RFO/Tender	Open Tender		1		1	
76	"	Major Supply and Install	RFI/EOI -> Tender	Open Tender	2			2	* (1)
77	"	"	RFO/Tender	Sole Tender	2		1	3	
78	"	"	"	Open Tender	3	4	5	12	* (3)
79	"	Minor Supply and Install	RFO/Tender	Open Tender		1		1	
81	Supply and Install	Engineering and Civil	Registration ->	Open Tender		1		1	

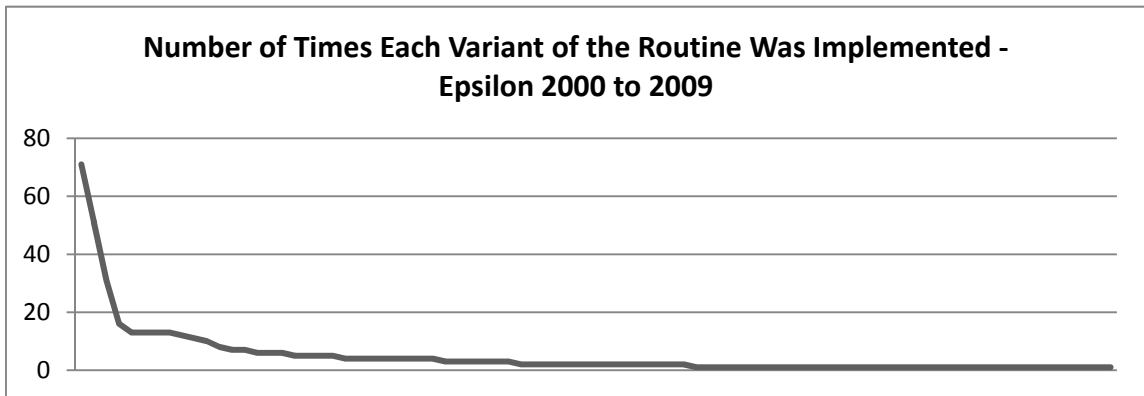
		Works	RFO/Tender						
82	"	"	RFI/EOI -> Tender	Open Tender	1			1	
83	"	"	RFO/Tender	Closed	1			1	
84	"	"		Open Tender	6		1	7	
86	"	Supply	RFO/Tender	Open Tender	1			1	
87	"	Major Supply and Install	Registration -> RFO/Tender	Open Tender			1	1	* (1)
88	"	"	RFO/Tender	Closed		1	1	2	
89	"	"	"	Sole Tender			1	1	
90	"	"	"	Open Tender	3		1	4	* (1)
91	"	Minor Supply and Install	RFO/Tender	Closed		2		2	
92	"		"	Open Tender		1		1	
94	"	Minor Works	RFI/EOI -> Tender	Open Tender			1	1	
95	"	"	RFO/Tender	Closed	8	2	3	13	* (1)
96	"	"	"	Sole Tender	2	9	2	13	* (1)
97	"	"	"	Open Tender	1	1	4	6	* (1)
100	Supply and Load	Engineering and Civil Works	RFO/Tender	Closed	1		1	2	
101	"		"	Sole Tender		1		1	
102	"	"	"	Open Tender	26	15	10	51	* (15)
105	"	Supply	Registration -> RFO/Tender	Closed	1			1	* (1)
108	"	Major Supply and Install	RFI/EOI -> Tender	Closed	2			2	
109	"	"	RFO/Tender	Closed	11			11	
110	"	"	"	Sole Tender			1	1	
111	"	"	"	Open Tender			4	4	
112	"	Minor Supply and Install	RFO/Tender	Closed		1	3	4	
113	"	"	"	Sole Tender			1	1	
114	"	"	"	Open Tender		3	3	6	* (1)

* (x) these projects were extended

In order to analyse the data in Table 72, a simple count was taken of the number times each routine variant was used, which is reported in Figure 32 below.

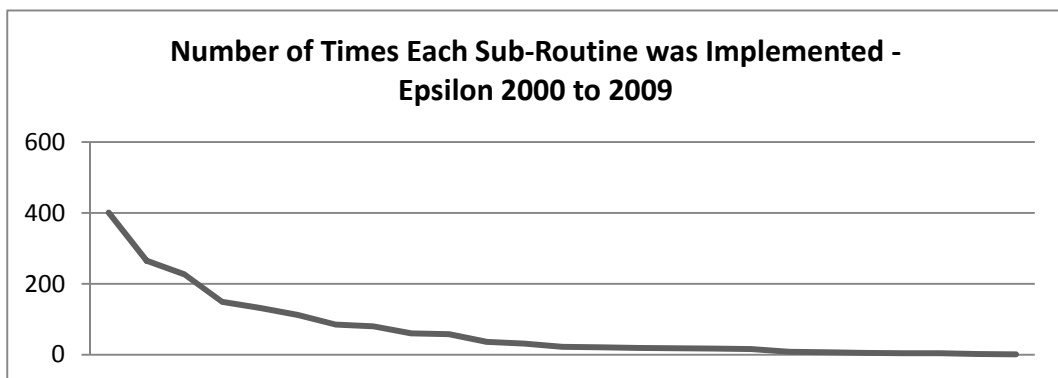
What this figure shows is that there is a significant amount of variety in the routines implemented by Epsilon. In terms of the research questions – RQ1 – Variety in routines, then in this case study there is 83 different routine varieties implemented, and the extent to which these routines are used, in terms of the number of times used, and the number of time periods used, there is also considerable variety.

Figure 32 – Number of Times each Variant of the routine was used - Epsilon



Given that one of the possible causes of variety is the way that specific combinations of sub-routines are combined together, the analysis of sub-routines is important in order to understand variety. A simple graph details the specific number of times each sub-routine was used (ranked left to right in order of the number of times used). The distribution follows a shallow Pareto distribution (See Figure 33 below).

Figure 33 – Number of times each sub-routine option was implemented - Epsilon



Thus there is variety in the number of routine varieties and sub-routines options in use. In answer to the research question, there is diversity evident in procurement routines.

Evidence of Type I Variety – Stable – Epsilon Case

Analysis of Table 72 shows that there were 18 variants of the routine which is in use in every time period, while 17 sub-routine options are in use in every time period. 11 routine variants and 4 sub-routine options are in use in 2 subsequent time periods. 6 routine variants and 2 sub-routines options were periodically reintroduced following a break in use. 47 routine variants and 3 sub-routines were used only once in the 10 year period. Thus there is variation not just in the number of times used, but also in the periodicity of the use. Specifically a number of individual variants of a routine and sub-routine options exist in every single time period, demonstrating a stable implementation over time.

However there is also evidence that there is stability evident too. In order to test this however, a number of Chi Square tests were undertaken.

Chi squares

Chi square Epsilon - 2000 to 2004

Chi square analysis was undertaken (with Fisher's Exact test and Phi test for effect), in order to test for correlation between sub-routine processes, and thereby and verify the co-occurrence of sub-routine options.

Significant associations were found between:

- Design, Deliver and Test and Major Supply and Install Contracts [$\chi^2(1, N=188) = 34.100, p < .001, \phi = .426$];
- Provide Services cluster of works and Services Contracts [$\chi^2(1, N=188) = 78.160, p < .001, \phi = .645$];
- Construction scope of works and Minor Works Contracts [$\chi^2(1, N=188) = 17.980, p < .001, \phi = .309$];
- Construction scope of works and other forms of contract (prepared by organisations outside of PP) [$\chi^2(1, N=188) = 6.331, p = .013, \phi = .184$];
- Supply, Deliver and Commission and Major Supply and Install Contracts [$\chi^2(1, N=188) = 29.672, p < .001, \phi = .397$];
- Supply and Install Scope of works and Minor Works Contracts [$\chi^2(1, N=188) = 6.440, p = .020, \phi = .185$];
- Supply, deliver and load and Engineering and Civil Works Contracts [$\chi^2(1, N=188) = 11.085, p = .001, \phi = .243$];
- Supply, deliver and load scope of works and Major Supply and Install contracts [$\chi^2(1, N=188) = 4.798, p = .028, \phi = .160$];
- Engineering and Civil Works contracts and Registration → Tender Tendering Process [$\chi^2(1, N=188) = 17.0313, p < .001, \phi = .301$];
- Major Supply and Install Contract and RFI/EOI → Tender [$\chi^2(1, N=188) = 6.142, p = .027, \phi = .181$];

- Minor Works contracts and RFO/Tender [$\chi^2(1, N=188) = 11.598, p = .001, \phi = .248$];
- Services Contracts and RFI/EOI → Tender [$\chi^2(1, N=188) = 7.806, p = .046, \phi = .204$];
- Engineering and Civil Works RFO/Tender [$\chi^2(1, N=188) = 4.170, p = .061, \phi = .149$]; and
- Minor Works RFI/EOI → Tender [$\chi^2(1, N=188) = 3.723, p = .066, \phi = -.141$].

Significant negative correlations were found between:

- Design, Deliver and Test and Engineering and Civil Works contracts [$\chi^2(1, N=188) = 6.325, p = .011, \phi = -.183$];
- Construction scope of works and Major Supply and Install [$\chi^2(1, N=188) = 23.823, p < .001, \phi = -.356$];
- Construction scope of works and Services Contracts [$\chi^2(1, N=188) = 7.118, p = .014, \phi = -.195$];
- Supply, deliver and Commission scope of works and Engineering and Civil Works Contracts [$\chi^2(1, N=188) = 5.504, p = .020, \phi = -.171$];
- Supply, deliver and load scope of works and Minor Works Contracts [$\chi^2(1, N=188) = 18.484, p < .001, \phi = -.314$];
- Engineering and Civil Works Contracts and RFI/EOI → Tender [$\chi^2(1, N=188) = 4.715, p = .045, \phi = -.158$];
- Major Supply and Install Contracts and Registration → Tender [$\chi^2(1, N=188) = 4.878, p = .026, \phi = -.161$];
- Minor Works contracts and Registration → Tender [$\chi^2(1, N=188) = 7.017, p = .004, \phi = -.193$];
- Engineering and Civil Works Contracts and RFI/EOI → Tender [$\chi^2(1, N=188) = 4.715, p = .045, \phi = -.158$].

Epsilon - 2005 to 2006

Chi square analysis was undertaken (with Fisher's Exact test and Phi test for effect), in order to test for correlation between sub-routine processes, and thereby and verify the co-occurrence of sub-routine options.

Significant correlations were found between:

- Design, Deliver and Test and Major Supply and Install Contract [$\chi^2(1, N=115) = 42.202, p < .001, \phi = .606$];
- Provide Services Scope of Works and Services Contracts [$\chi^2(1, N=115) = 40.640, p < .001, \phi = .594$];
- Construction Scope of Works and Minor Works Contracts [$\chi^2(1, N=115) = 23.232, p < .001, \phi = .449$];
- Supply, deliver and commission scope of works and Major Supply and Install Contracts [$\chi^2(1, N=115) = 12.780, p = .005, \phi = .333$];
- Supply and Install scope of works and Minor Works Contracts [$\chi^2(1, N=115) = 5.566, p = .032, \phi = .220$];
- Supply, deliver and load scope of works and Engineering and Civil Works Contracts [$\chi^2(1, N=115) = 38.529, p < .001, \phi = .579$];
- Supply, deliver and load scope of works and Minor Supply and Install Contract [$\chi^2(1, N=115) = 4.974, p = .048, \phi = .208$];
- Engineering and Civil Works Contracts and Registration → Tender [$\chi^2(1, N=115) = 5.692, p = .045, \phi = .223$].

Significant negative correlations were found between:

- Design, Deliver and Test scope of Works and Minor Works Contracts [$\chi^2(1, N=115) = 5.044, p = .033, \phi = -.209$];
- Provide Services and Minor Works Contracts [$\chi^2(1, N=115) = 5.044, p = .033, \phi = -.209$];
- Construction and Engineering and Civil Works Contracts [$\chi^2(1, N=115) = 8.732, p = .005, \phi = -.276$];
- Construction Scope of Works and Minor Supply and Install Contracts [$\chi^2(1, N=115) = 6.314, p = .015, \phi = -.234$];
- Supply, deliver and commission scope of works and Minor Works Contracts [$\chi^2(1, N=115) = 5.940, p = .017, \phi = -.227$];
- Supply, deliver and load scope of works and Minor Works Contracts [$\chi^2(1, N=115) = 19.293, p < .001, \phi = -.410$];

Epsilon - 2007 to 2009

Chi square analysis was undertaken (with Fisher's Exact test and Phi test for effect), in order to test for correlation between sub-routine processes, and thereby and verify the co-occurrence of sub-routine options.

Significant positive correlations were found between:

- Design, deliver and test and Major Supply and Install contract [$\chi^2(1, N=124) = 24.436, p < .001, \phi = .453$];
- Provide services scope of works and Consultancy contracts [$\chi^2(1, N=124) = 26.053, p < .001, \phi = .458$];
- Provide Services scope of works and Services Contracts [$\chi^2(1, N=124) = 16.848, p = .005, \phi = .369$];
- Construction scope of works and Minor Works contract [$\chi^2(1, N=124) = 24.598, p < .001, \phi = .445$];
- Supply deliver and Commission scope of works and Major Supply and Install Contract [$\chi^2(1, N=124) = 21.617, p < .001, \phi = .418$];
- Supply and Install scope of works and Minor Works Contract [$\chi^2(1, N=124) = 5.263, p = .027, \phi = .206$];
- Supply, deliver and load scope of works and Engineering and Civil Works Contract [$\chi^2(1, N=124) = 17.512, p < .001, \phi = .376$];
- Supply, deliver and Load scope of works and Minor Supply and Install Contract [$\chi^2(1, N=124) = 32.578, p < .001, \phi = .513$];
- Design and Construct contract and Registration → Tender [$\chi^2(1, N=124) = 18.470, p = .011, \phi = .386$].

Significant negative correlations were found between:

- Design, deliver and Test scope of works and Minor Works Contracts [$\chi^2(1, N=124) = 4.847, p = .041, \phi = -.198$];
- Provide Services scope of works and Minor Works Contracts [$\chi^2(1, N=124) = 4.675, p = .049, \phi = -.194$];
- Construction and Major Supply and Install Contract [$\chi^2(1, N=124) = 11.810, p = .001, \phi = -.309$];
- Construction scope of works and Minor Supply and Install contracts [$\chi^2(1, N=124) = 7.419, p = .013, \phi = -.245$];
- Supply, deliver and load and Minor Works contracts [$\chi^2(1, N=124) = 18.449, p < .001, \phi = -.386$];
- Design and Construct Contracts and RFO/Tender [$\chi^2(1, N=124) = 11.423, p = .025, \phi = -.304$];

- Provide services and Major Supply and Install contract [$\chi^2(1, N=124) = 3.521, p=.068, \phi = -.169$];
- Supply, deliver and commission scope of works and minor works contract [$\chi^2(1, N=124) = 4.119, p=.080, \phi = -.182$];
- Services contract and RFO/Tender [$\chi^2(1, N=124) = 5.481, p=.073, \phi = -.210$];
- Registration → Tender and Closed Tender [$\chi^2(1, N=133) = 3.969, p=.068, \phi = .173$].

Negative correlations indicate that the two sub-routine options were statistically unlikely to occur together.

Statistical associations were found in each time period between:

- Construction scope of works and Minor Works Contracts
- Design, Deliver and Test and Major Supply and Install Contracts
- Provide Services cluster of works and Services Contracts
- Supply and Install Scope of works and Minor Works Contracts
- Supply, Deliver and Commission and Major Supply and Install Contracts
- Supply, deliver and load and Engineering and Civil Works Contracts
- Supply, deliver and load scope of works and Major Supply and Install contracts

In answer to the research question there is stability evident in procurement routines.

Evidence of Type III Variety – Adaptation – Epsilon case.

In order to determine whether there was adaptive variety, a table was created in SPSS to show when each sub-routine option first appeared. This is reported in Table 73 below.

Table 73 – Sub-Routine Options in Use – Epsilon

Sub-Routine Option	Cluster	2000 to 2004	2005 to 2006	2007 to 2009	Total
Scope of Works	Design, deliver and Test	8	7	7	22
	Provide services	17	6	13	36
	Construction	100	61	66	227
	Supply, deliver and commission	8	7	6	21
	Supply and Install	26	17	17	60
	Supply, deliver and load	41	20	24	85
Contract	Alliance			1	1
	Construction Management		1	1	2
	Consultancy		2	6	8
	Design and Construct	1		3	4
	Engineering and Civil Works	81	29	22	132
	Supply	5			5
	Maintenance	2	1	1	4
	Major Supply and Install	37	15	28	80
	Minor Supply and Install		9	7	16
	Minor Works	49	51	49	149
	Services	7	7	5	19
	Other	6		1	7
Tender	Registration → Tender	19	4	8	31
	RFI/EOI → Tender	12	2	4	18
	RFO/Tender	169	111	121	401
Approach to Market	Closed tender	52	31	29	112
	Pre-Qualification Process	15	2		17
	Sole Tender	16	18	24	58
	Open Tender	117	67	81	265

As Table 73 shows, a number of sub-routine options are introduced in Time Period 2 (construction management and consultancy and minor supply and install. Thus in terms of the research question, there is adaptation involved in Epsilon.

Evidence of Type IV Variety – Dynamic – Epsilon Case

As there is both adaptation and variety shown to exist, then it is reasonable to conclude that there is a dynamic form of variety. However in order to confirm this, a PCA was requested.

Principal Component Analysis

As with other case studies, Principal Component Analysis is a method of analysing variance and determining if there were sets of sub-routines options which are related to each other.

A matrix of the co-occurrence of sub-routine options for this case was undertaken. This provided a simple count of the number of times each sub-routine option occurred with other sub-routine options in a specific variant, with non-occurrence coded as a '0'. A Principal Component Analysis

(PCA) was requested from SPSS on the matrix of the co-occurrence of sub-routines for all projects implemented by Epsilon. Principal Component Analysis with Oblique rotation and Kaiser Normalisation was used to examine the relationship of the covariance matrix of sub-routine co-occurrence data. Analysis of the scree plot showed an ‘elbow’ in the data which suggested two components, which was confirmed by the extraction sums of the squared loadings.

Table 74 – Principal Component Analysis of Sub-Routine Options – Epsilon

Component	Total Variance Explained		
	Extraction Sums of Squared Loadings		Rotation Sums of Squared Loadings
	% of Variance	Cumulative %	Total
1	82.394	82.394	17452.28
2	7.395	89.79	13857.67

A simple structure was found, which together accounted for nearly 90% of the variance.

Table 75 – Structure Matrix

	Rescaled Component	
	1	2
↻ Open Tender	.967	.604
① RFO/Tender	.912	.798
📄 Engineering and Civil Works	.897	.336
✂ Supply Deliver Load	.841	.205
📄 Major Supply and Install	.621	.408
📄 Minor Supply and Install	.579	.300
✂ Supply Deliver and Commission	.579	.228
📄 Maintenance	.550	.510
✂ Supply	.549	.409
Prequalified	.518	.455
✂ Provide Services	.513	.254
Services	.493	.321
✂ Design Manufacture and Test	.480	.293
① Registration → Tender	.358	.229
① RFI/EOI → Tender	.294	.191
📄 Minor Works	.630	.956
✂ Construction	.744	.903
Closed Tender	.421	.794
📄 Construction Management	.311	.644
📄 Other	.572	.589
↻ Sole Tender	.423	.576
✂ Supply and Install	.543	.570
📄 Design and Construct	.140	.522
📄 Alliance	.313	.522
📄 Consultancy	.310	.505

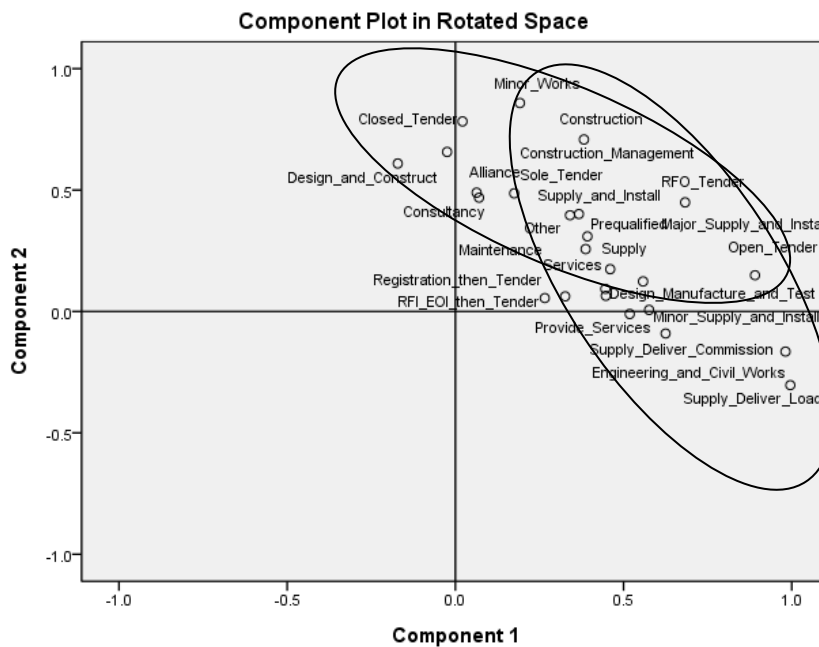
Legend: ✂ Scope of Works 📄 Contract ① Tender Process ↻ Approach to Market

The structure matrix reveals that there is some cross loading between components – particularly RFO/Tender and Construction.

PCA identified two main components: the first around larger projects (Engineering and Civil works, and Supply Deliver and Load) which use Open Tender processes; and the second around smaller projects (Minor Works) which use a closed tender. Both components had very strong cross loading on both RFO/Tender and Construction Scope of Works. 89.51% of all variance is explained in these two Components.

The loading plot in rotated space was not as clean as previous case studies (See Figure 34 below).

Figure 34 – Principal Component Analysis of Sub-routines in Oblimax Rotation - Epsilon



Thus as there is stability, variety, diversity and adaptivity, all four types of variety is present in Epsilon.

4.9.2 RESEARCH QUESTION 2: SELECTION AND VARIETY- EPSILON CASE

In order to analyse the selection, adaptation and retention processes, counts were made from the contingency table of routine variants implemented in each time period, as set out in Table 72, of the number of routine variants in use, the number of new routine variants and the number of routine variants which continued from previous time period unchanged.

As set out in Table 76 below, the number of routines is the total count of routine variants used in each time period. “Number of New Routines from Recombination” is a count of the number of new routine variants which were created from the set of sub-routine options which were present in the previous time period. Thus while the routine is new, the repertoire of sub-routine options from which it is selected is not new. The variety is due to the recombination of the existing set of sub-routines, not through the introduction of something totally new.

Table 76 – Number of New Routines Due to Recombination Over Time – Epsilon Case Study

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routines in Use	48	38	51
Number of new routines from recombination	-	9	26
% of Routines due to recombination	-	24%	51%

Table 76 (drawn from the full contingency Table 72) shows of all of these routine variants, 9 in Period 2 (24%) and 17 in Period 3 (27%) were not as the result of new processes, but were created by recombination of the existing repertoire of sub- routines options. This was determined manually, by considering only those routines which were comprised of sub-routine options which occurred in the first time period.

In terms of the reason for selecting a particular tendering option, this was due to an understanding of how many companies were available to deliver the project on behalf of Prolific Projects. As one interviewee noted:

Tendering

a straight public [open] tender, ad in the paper, any Joe Bloggs around the country or world can tender for this job...then there is a restricted [closed] tender: you might not want to have to evaluate twenty or thirty tenderers, from Dodgy Brothers to the ones you know can do the job, so you will go out to six contractors that you know can do this type of work, so it will be a restricted tender. You could have a process of a two step tendering process in which you basically have the initial step which is to shortlist, might call it an expression of interests, pre-registration or pre-qualification and then you select out of a pool through that tendering process, the ones that you are going to go and ask them to price the job... All those combinations, you need to choose one of each of those and then come up with the final thing. **[Interview 1]**

Request for information or Expression of Interest

One specific form of approach to tendering was to undertake expressions of interest, particularly when Epsilon wanted to purchase something, but were unsure of the nature of the market:

For example if we don't know who the potential vendors are, it will go through an EOI or an RFI - Request for Information or Expression of Interest. [Interview 2]

Interviews with Epsilon provided far more data than is possible to reproduce within suitable word limits on the tendering processes. This is particularly true, as noted earlier, the Epsilon group provided services to other groups – particularly the tender system. Hence they had a strong and detailed knowledge of when and where to use a particular form of tendering. A summary of the interview data is provided below (Table 74), which indicates when specific forms of tendering should be used. In order to validate the tabulation of interview data, member checking of the table was undertaken, which validated the options and when they would be used.

Contract Options

Again, as Epsilon provided support to other divisions and had professionals with legal and contractual expertise, considerable information was available on when to use specific forms of contract.

Consequently, like tender, a table of the various forms of contract is provided below, which indicates when it was to be used and the types of values associated. As the full text form would take multiple pages, the following is a summary of the interview data (for the full table, please see Appendix D)²². The values indicated in the interviews are checked against the values in the database in order to triangulate results, and member checking was undertaken to strengthen validity of results.

²² The findings of this table were sent back to interviewees to check the accuracy of the data, and triangulation was possible from the database in order to confirm some of the information (e.g. range of the value of contracts). Due to space restrictions, the full table cannot be provided here. Please refer to Appendix D for the full table.

Table 77 – Summary of Contracts and Their Average Values

Value of Contract	Alliance	Construction	Services	Equipment	Supply
Over 1 Million	Alliance	Construction Management (\bar{x} =13.4 million) Design and Construct (\bar{x} =3.9 million) Engineering and Civil Works (\bar{x} =1.7 million)	Service Contract (\bar{x} =1.9 million)	Major Supply and Install (\bar{x} =20.4 million)	-
Less than 1 Million	-	Minor Works (\bar{x} =0.3 million)	Consultancy (\bar{x} =0.7 million) Maintenance (\bar{x} =0.5 million)	Minor Supply and Install (\bar{x} =0.2 million)	Supply (\bar{x} =0.4 million)

Thus in terms of selection, there is a set of options for both tendering and contracting – and each of these options would be selected for specific situations and purposes. Most of the reasons are entirely pragmatic decisions – what is the nature of the market for tendering, what sort of work is it, what is the value of the work for contracts. Viewing the table above, it is evident that for a specific scope of work (e.g. construction) there are a number of types of contract (Engineering and civil works, minor works) which could be used – and the selection is based on the type and value of work to be completed. Additionally, the type of tendering selected would depend on how well known the market was, and the time issues in relation to completion.

Interview data thus corroborates the chi square and Principal Component Analysis which indicates that selection is a non-random process. There would appear to be a set of internal and external factors involved in selecting sub-routines. Indeed, selection seems to operate from the repertoire of sub-routines level, with specific internal and external conditions affecting which contract is chosen, which tender method is used, and which approach to market was deployed. While some of these sub-routines were chosen more often, the specific combinations sub-routines which are selected create the variety in the over-all procurement routine.

Table 78 – Logic of choice behind selection of specific tender and approach to market options

	When the number of suppliers is unknown	When it is known that there are a number of available suppliers	When it is known that there are a limited number of suppliers	When it is known that there are only one or two suppliers
Tender	EOI or RFI → Tender RFO/Tender	RFO / Tender Registration → Tender	Registration → Tender RFI/EOI → Tender	RFO / Tender
Approach to Market	Open tender	Open Tender Pre-Qualification (only used with RFO/Tender)	Closed Tender Open Tender	Closed Tender Sole Invitee Open Tender

In this case study, selection creates variety by choosing from an existing pool of sub-routine options and recombining these in order to create new varieties. Such selection however, is non-random and follows a logical process.

4.9.3 RESEARCH QUESTION 3: ADAPTATION AND VARIETY – EPSILON CASE

While a number of routine variants were due to recombination, this was not the case for every new variant. Table 79 provides the number of routine variants due to adaptation.

Table 79 – Variants in use due to adaptation

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routines variants in use	48	38	51
Number of new routine variants due to adaptation	-	7	1
% of new routine variants due to adaptation	-	21%	2%

As Table 79 shows, there were 8 routine variants in Period 2 and 1 in Period 3 which were as a result of adaptation. The number of new routine variants due to adaptation was determined by identifying new routine variants in a time period, and verifying that at least one of its component sub-routine options was *not* present in the previous time period. In other words the new variety is as the result of adaptive processes, not just simply recombination of existing sub-routine options, but involves the introduction of a new sub-routine option. Table 80 provides the number of sub-routine options which were new in each time period.

Table 80 – New Sub-Routine options due to adaptation – Epsilon

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	21	21	23
Number of new sub-routine options	-	3 (14%)	1 (4%)

Comparing the data from Table 79 and Table 80 shows that in Period 2, there were 7 new routine variants which included at least one of the 3 new sub-routines options which had not been in used previously. In Period 3, there was one new routine, which included the single new sub-routine introduced. There is also a greater stability of sub-routines over time with the number of sub-routines in use in each time period relatively stable (21, 21, 23) however the number of routines varied more extensively (48, 38, 51).

Several reasons were provided by interviewees for the introduction of new sub-routines options:

Introduction of Panel contracts

One of the reasons we have panels and SLAs is because we have found it to be easier, it is better than doing a whole pile of little transactions it is better than doing a pre-qualification process, it is something that sort of doesn't quite fit the usual tendering mould. [Interview 1]

Changes to planning and ostensive element

While planning had always been part of the procurement process, there are signs of increased rigour around the justification for new assets:

I think the bean counters right, are going to be a lot more involved with the delivery of projects and cost, and counting the cost all those sorts of things, which they haven't been... the business cases for request for additional expenditure and all the rest of it, and it is going to be gone over with a fine tooth comb, much more clarity and transparency. So I can see a much more commercial focus. [Interview 16]

This is supported by other interviews that indicated a change to the key drivers of procurement, away from technical to a more commercial focus in procurement:

Most times engineering are providing engineering support and the analysis to support the buying process, but not doing the buying process so there is a strong push to have a commercial process that is driving the procurement with engineering playing that technical supporting role, and not leading that process. [Interview 15]

Another aspect of change was that traditionally the organisation had simply accepted what the market provided in terms of supply, and now there is an increased effort to understand their suppliers better, and applying pressure on their suppliers to provide the best deal possible.

Threat of competition

The process for trying to get costing information out of the supplier is all about setting ourselves up to be in a better position of negotiation. So obviously, if you’ve got a shortlist of one, you don’t often have a fallback position, so the supplier knows they are the only one, they can play a fairly hard ball and it is hard to get them down but when we are able to say well thanks for your offer we don’t think it’s good enough, we are going to go off to Blue Quadrant um, it brings a lot more power back to us over the negotiation table. [Interview 15]

Thus, while like other case studies there is evidence of addition of new contracts, which increases variety, there is also evidence of more subtle changes in the process – including the threat of competition, early involvement of accountants in the planning process, and a more commercial focus, instead of a technical focus on procurement.

Thus adaptation increases variety by providing new sub-routine options which can be selected for inclusion in the routines. Following the language of routines, adaptation increases variety by increasing the repertoire of sub-routine options. Increasing the repertoire of sub-routines increases the options available for selection, and subsequent recombination.

4.9.4 RESEARCH QUESTION 4: RETENTION AND VARIETY – EPSILON CASE

As noted in the literature review, retention involves the retaining in memory of organisational processes (Nelson and Winter 1997). In a similar way, to the previous sections, a count was made of routine variants continuing from one time period to the next (see Table 81 below).

Table 81 – Number of Routines Retained (continued) in organisational memory – Epsilon

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of routines variants in Use	48	38	51
Number of Routine variants Continued	-	22 (38%)	24 (47%)
Number of Routine variants Discontinued	-	26	12

In terms of retention then, a number of routines variants were continued (22 in Period 2, and 27 in Period 3) between time periods. In other words 22 and 27 distinct varieties of sub-routines remained unchanged between these times. However a number of routine variants were *not* retained (discontinued) between time periods was 26 in Period 2 and 12 in Period 3.

The story is slightly different at the sub-routine level, however (see Table 82 below).

Table 82 – Number of sub-routine options retained in organisational memory – Epsilon

	Period 1 (2000 to 2004)	Period 2 (2005 to 2006)	Period 3 (2007 to 2009)
Number of sub-routine options in use	21	21	23
Number of sub-routine options continued	-	18 (86%)	20 (87%)
Number of sub-routine options discontinued	-	3	1
Number of sub-routine options reintroduced	-	-	2

In terms of retention, a number of sub-routine options were discontinued (18 in Period 2, and 20 in Period 3). Discontinuation means that the sub-routine option was in use in one time period, but not in the second. However, a larger number were retained and used in subsequent time periods (21 in Period 2, and 23 in Period 3). Additionally, 2 sub-routine options used in Period 1, were not used in Period 2 and reintroduced in Period 3. This implies that sub-routines are retained in organisational memory and even though not used for a period, may be reintroduced when appropriate.

Thus at a sub-routine level, in each period there are new sub routines introduced, existing sub-routines which are continued, and a number which are discontinued. Comparing Table 81 and Table 82, there is a much stronger retention of sub-routine options (86% and 87%) compared to routine options (38% and 53%) over time.

To answer the research question then, retention affects variety by the net number of routine variants and sub-routine options which are retained (and discontinued) from period to period. If all routine variants (or sub-routine options) were kept from one period to the next, and adaptive processes added new ones, there would be a net increase in the number of routines (which for this case would have meant $48+8+1 = 57$ routines, and $21+3+1 = 25$ sub-routines). However, due to discontinuation not all routines, or sub-routines are retained, and thus the total pool of routine variants and sub-routine options in use in the final period was less than at other time periods. The reintroduction of the sub-routine after an absence of a couple of years holds interesting questions about how big the actual repertoire of sub-routines really is.

This process of continuing and discontinuing use of a specific routine or sub-routine suggests that there may be a process of evaluation which occurs, considering the utility of specific sub-routines.

Review process

In terms of a process of review of outcomes as part of a retention process, one interviewee indicated that they were exactly about to do this:

At the end of all these contracts, you would think there is going to be some review, did they work or did they not, and that is about to happen I think. [Interview 16]

A few of the interviewees offered the following observations in relation to retention of various sub-routines by Epsilon. In particular, the alliance form of contract came up in interviews as being examined.

Review of Alliances

Then the fifth method we would use, probably won't use it anymore, probably won't use it for a long time is Alliancing which is basically um a type of delivery contract we use for the really big stuff... a big Alliance, that is big big big, you're talking over \$1 billion of civil and type works so to do that, to get the resources we needed, we needed to go to an Alliance.... So I'm not sure what the future of Alliancing is, if any. As I said I think it's got its' advantages and disadvantages, like hard dollar contracts have. Whether we will proceed with them or not is another matter, I don't know at this stage. [Interview 1]

And what we are finding now is the more parties you've got in the Alliance, the bigger the risk leak and suddenly ... it was never contemplated. It is interesting, you run a process for five years or so and then you see what comes out the other end.... It is like anything, you create structure and create process, and further down the road you find out the problems with that process or that structure [Interview 14]

Thus for alliances, there is a process of reflection and evaluation evident from the text of the interview, and a sense of deliberation about whether that process would be retained by the organisation. While the outcome is uncertain, the interesting evidence here is that processes are evaluated, and contemplation is given as to whether there should be future use of a particular sub-routine. This review process will assist in the retention process for routines.

4.9.5 SELECTION, ADAPTATION AND RETENTION IN RELATION TO THE OSTENSIVE, PERFORMATIVE AND ARTEFACT ELEMENTS OF ROUTINES

In terms of the ostensive, performative and artefact elements of routines (Feldman and Pentland 2003; Pentland and Feldman 2005), selection seems to occur at the ostensive level, is implemented in the performative, and recorded in the artefact (database). Adaptation occurs initially in the ostensive. Retention, apart from the database record, occurs in the ostensive as well. Alliance contracts provide the most interesting example of this, as the reasons for adaptation in the first place, reasons for selecting, and logic behind when or if they will be used in the future (retention) are evident in the interview data.

4.9.6 SUMMARY – EPSILON CASE

Thus all four types of variety are present in Epsilon with stability, diversity, adaptive and variety all present. Selection creates variety through the recombination of subroutine options into new variants. Adaptation increases variety through the introduction of new subroutine options which are then available for selection. Retention increases variety through the decision about which routine options to keep on using. To discard, or to retain in memory.

4.10 CONCLUSION

This chapter has provided a summary of the data analysis in response to each of the research questions. All cases demonstrated all four types of variety. Additionally, there is evidence in each case that selection, adaptation and retention is at work, and that the complex interplay between these dynamics is what causes variety in organisational routines.

The next chapter undertakes a cross case analysis of the findings, generates a series of findings and considers alternative explanations for causes for variety in organisational routines.

CHAPTER FIVE

5) CROSS CASE ANALYSIS

Each of the case studies in the previous chapter provided evidence regarding all of the research questions. In this chapter the similarities and differences between the cases, in relation to the findings, will be explored through a cross case analysis. As undertaking a cross case analysis is a key part of making a theoretical contribution (Eisenhardt 1989, 2002), this chapter forms a crucial bridge between the findings and discussion chapter.

This chapter is structured as follows: firstly the question on which type of variety was found in each of the cases is discussed. As will be shown, the longitudinal multilevel analysis enabled every type of variety identified in the theory chapter to be found. Secondly, the question about how selection creates variety, chiefly through recombination, as well as the similarities and differences between cases is examined. Thirdly how adaptation contributes to variety is examined, which is chiefly through the addition of new sub-routine options which can be selected, and thus create new varieties of routines. Fourthly, how retention creates variety is examined, which in each of the cases is chiefly by keeping existing sub-routine options in organisational memory.

5.1 RESEARCH QUESTION 1: WHAT SORT OF VARIETY EXISTS IN PROCUREMENT ROUTINES

As set out in the literature review, empirical examination found four different types of variety. These four types of variety have been set out in a typology in order to structure the analysis process (Figure 4). The first type of variety (Type I Variety - Stable) is where a single variant of the routine is stable over time. Type II Variety (Adaptive) is where there is often low number of routines (often a single routine), but this routine changes over time. Type III Variety (diverse), is where a number of variants of a routine co-occur. Type IV Variety (dynamic) is where both adaptation and variety both exist at the same time.

The way in which the various types of variety: stable, diverse, adaptive and dynamic have been found in each of the case studies is explored in the section that follows. Firstly, Type I - Stable variety is examined.

5.1.1 EVIDENCE FOR TYPE I VARIETY – STABILITY – ACROSS ALL CASES

Traditionally, routines were thought to exhibit considerable stability over time, and were considered resistant to change (Becker 2004). In each of the cases, the existence of stability was considered at a number of levels, at the overall pattern of action, at the individual variant level, and at the individual options of sub-routines in use. As outlined in the theory chapter, stability is judged to exist when a routine, or a component of a routine, is stable over time.

Stability in the pattern of action²³

Each of the cases demonstrated stability in the overall pattern of sub-routines which comprised the routine. Recall that at the highest level of a routine is not concerned with the performative aspect of the routine – the specific variants produced through the combination of different sub-routine options – but rather the overall repetitive pattern of action itself (Becker 2004, 2005a). In each and every case, there was evidence the routine was comprised of the same pattern of action which included each of the sub-routines:

- **Scope of works** (*what* was to be contracted was determined)
- **Contract** (a legal document which specified *how* the work was to be done, for what cost, and under what conditions)
- **Tender** (*when* the work could be tendered – up front, or only after completion of a first stage)
- **Approach to Market** (*who is* invited to tender).

While there were differences in the number of routine variants implemented, the overall pattern remained the same in each case study. In each case study, tables set out the overall pattern of action of the routine, as well as the specific variants which were used in each (Alpha - Table 34; Beta - Table 43; Gamma - Table 53; Delta - Table 62; Epsilon - Table 72). A summary of the pattern of action reported in each of these tables is provided in Table 83 below.

²³ This notion of a pattern of action differs from that of other authors (e.g. Pentland). Pentland tends to treat the sequence of sub-routine options as the pattern of action. I have viewed this as the specific variant of the routine, so changes in the composition of the sub-routine options in use indicates a new variant of the routine. However, the pattern of action is understood in this thesis as the overall pattern or steps involved in the procurement process.

Table 83 – Overall pattern of action in each case study

	Scope of works	Contract	Tender	Approach to Market
Alpha (Table 34)	✓	✓	✓	✓
Beta (Table 43)	✓	✓	✓	✓
Gamma (Table 53)	✓	✓	✓	✓
Delta (Table 62)	✓	✓	✓	✓
Epsilon (Table 72)	✓	✓	✓	✓

Thus in each of the cases, there is stability in the overall pattern of action, with each of the cases reporting the existence of the same set of subroutines. However, the situation was quite different in relation to the variants of the routine implemented.

Stability in the variants of the routine

Despite the volume of variants present in each case, the case studies did show some evidence of stability in individual variants of the routine (see Table 84 below). Remember that the definition of stability was that the variant was used repetitively in each time period, and thus were stable over time. In four out of five of the studies, at least one specific variant of the routine was used in each and every time period..

Table 84 – Stable variants of the routine – Each Case

	Variants Used in each time period
Alpha (Table 34)	#19
Beta (Table 43)	None (although variant #4 was extended and was still in operation)
Gamma (Table 53)	#111
Delta (Table 62)	#42, #45, #47, #65, #90, #95
Epsilon (Table 72)	#4, #5, #6, #13, #19, #44, #47, #53, #57, #58, #65, #66, #67, #78, #95, #96, #97, #102,

It is important to note that for Beta, while there was no single routine repeatedly used in each time period, there was one variant which was started 7 years ago, and this project was still in operation. Essentially there were very limited suppliers for a particular asset, and rather than repeatedly calling for tender and making contracts, the original contract was simply extended. Thus the stability was beyond a particular variant of a routine, and involved the continuation of a single specific procurement arrangement over a 7 year period. Thus in each of the cases, at least one variant of the routine was either implemented multiple times in each across all the time periods, or a single variant of the routine operated across all the time periods.

In terms of differences between the cases, it is important to note that stability was demonstrated in different variants of the routine. Three variants were stable in more than one case: #4 is used in two

cases (Beta and Epsilon), #19 is used in two cases (Alpha and Epsilon), and #95 is also used in two cases (Delta and Epsilon). In the whole though, different variants of the routine demonstrated stability in each of the cases.

There were also differences in the number of variants which were stable over time. Epsilon had the greatest number of routine variants used in each time period, followed by Delta. While only Gamma had one variant of the routine stable across each time period (#111), this variant accounted for 23% of all Gamma's procurement events, and the single stable variant used by Alpha (#19) accounted for 35% of all of Alpha's procurement events.

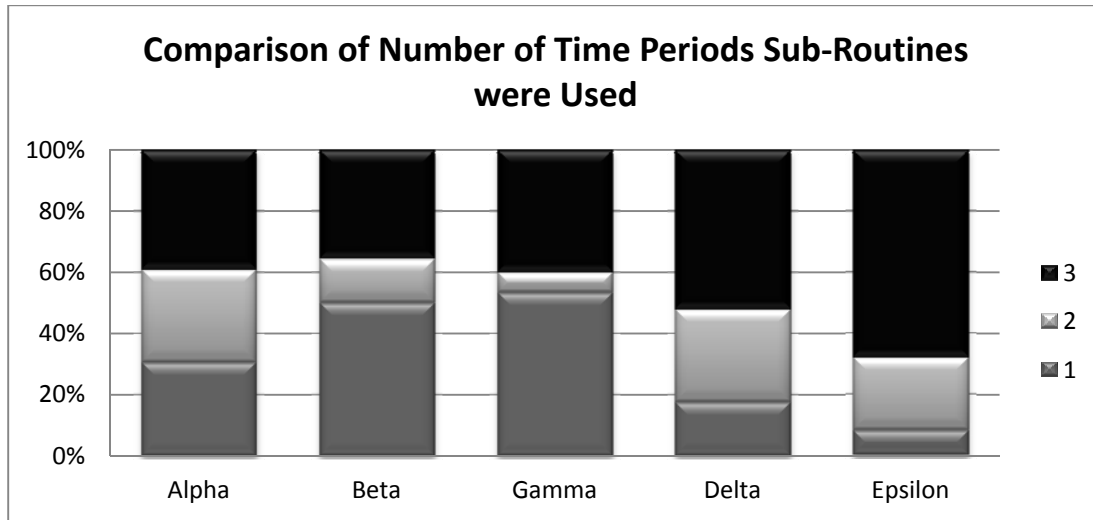
Thus while there were differences between each case study in terms of which variant demonstrated stability, the reality is most of the cases had a particular routine which remained in consistent use over time and thus demonstrated stability. The final level of analysis is at the sub-routine options.

Stability in Sub-Routine Options

In each of the case studies, the stability of the sub-routines in use in every time period, was far more often than that of the whole routine. In other words, there was greater stability at the sub-routine level than at the routine level, and this was evident across all case studies.

In order to demonstrate this, Figure 35 (below) provides a comparison of the proportion of sub-routines which were used in every time period by each of the case studies. Data for this graph is drawn from the tables detailing the sub-routine options in each case study (Alpha - Table 35; Beta - Table 44; Gamma - Table 54; Delta - Table 63; and Epsilon - Table 73). Percentages are used in order to allow for the difference in numbers between each case study, and therefore shows proportions instead of absolute counts.

Figure 35 – Number of Time Periods Each Sub-routine was used – Comparison across case studies



Firstly, the extent of stability in sub-routine options differs across the cases. The black portion of the graph, indicates the proportion of sub-routine options which were in use in all three time periods; light grey indicates that the proportion of sub-routine options which were in use in at least two time periods; and the dark grey indicates the proportion of sub-routine options which were used in only one time period. Figure 35 indicates, that there was between 35% (in Beta) and up to 65% (in Epsilon) of sub-routine options in use in every time period. However, regardless of the actual percentage, a significant proportion of sub-routine options are used in each and every time period in each and every case study. There is a far greater stability in sub-routine options, than at the variants over time, and this is true across all cases.

Summary

At the ‘pattern of action’ level, the same sub-routines are involved in each and every case study: Scope of Works, Contract, Tender, Approach to Market. While the case studies showed variance in the performance of these sub-routines, the same pattern of action was evident in each case.

At the variant level, four out of five cases used the same variant of a routine across multiple time periods, and one used the same variant, and same project, in each time period. As the definition of stability used throughout this study has been that the variant remains the same over time, then there is evidence of stability in most of the cases. Thus, even though the specific variant which was stable was different between the cases, nevertheless in a majority of cases at least a single variant of the routine demonstrated stability.

At the sub-routine option level a far greater degree of stability was noted in each and every case study. Between 35% and 65% of sub-routine options were used in each and every time period.

Therefore, a partial response to the first research question is that there is evidence of stability in organisational routines. However the extent of this is different depending on the level of analysis. The pattern of action remained the same over time; a limited number of individual variants of a routine remained stable over time; and a larger proportion of sub-routine options also remained stable over time.

However, as will be discussed below, there was also considerable diversity found in the case studies.

5.1.2 EVIDENCE FOR TYPE II VARIETY - DIVERSITY

Variety was defined in the literature review as were there was more than one variety of a routine in use over time, what Campbell (1974) referred to as the heterogeneity of variants.

Diversity in the Pattern of Subroutines

As noted in the previous section, there was stability at the overarching pattern which makes up the routine, with each case and each time period reporting: Scope of works, Contract, Tender, and Approach to Market. No variation in this overall pattern was noted in any of the cases.

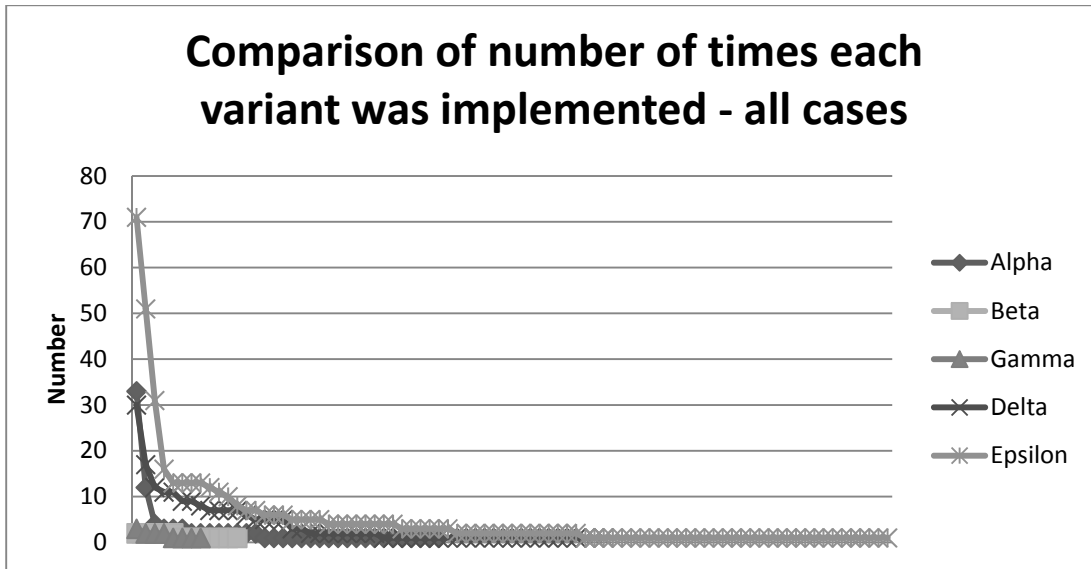
There were changes in the gaining of approval to undertake procurement, such as the stage gate process mentioned in Alpha and Gamma cases. However, this seems to be in order to better integrate with the wider organisational routines such as budgeting, and is discussed further in Section 5.1.3.

Diversity in the Variants of the Routine

A variant of a routine has been defined as a specific combination of sub-routines in his thesis. A single difference between variants in terms of the sub-routine options used (such as the contract) would mean that the variants are different.

In each of the cases, the number of times each variant was used was presented in a graph form. These graphs reported the number of varieties of routines ranked in order from left (most used) to right (least used) (Alpha - Figure 14; Beta - Figure 18; Gamma - Figure 22; Delta - Figure 26; Epsilon - Figure 32). This data is summarised in Figure 36 below:

Figure 36 – Comparison of number of times each variant of the routine was used



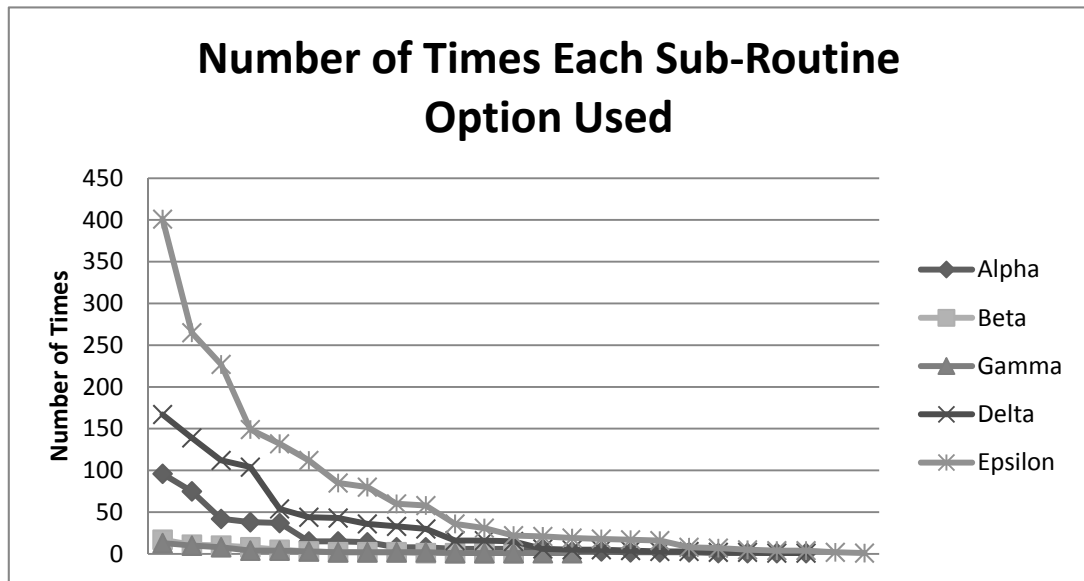
In each and every case, a small number of routine variants were used more often than others. This is most pronounced in Alpha and Epsilon, slightly less so in Delta. This still holds for Beta and Gamma, although the shape is different. For Alpha, Delta and Epsilon the number of times the routines are used follows a Pareto distribution, while for Beta and Gamma it is more of a step or gradual slope. Thus there is diversity in the number of routine variants in each and every case study in Prolific Projects.

While the numbers varied between each of the case studies, each case demonstrated variety in the number of routine variants implemented. This diversity holds for the sub-routine options level as well.

Variety at the sub-routine option level

In each and every case there were a number of sub-routines which were used more often than other options. In the cases a number of graphs reported the number of varieties of routines ranked in order from left (most used) to right (least used) (Alpha - Figure 15; Beta - Figure 19; Gamma - Figure 23; Delta - Figure 27; Epsilon - Figure 33). This data is summarised in Figure 37 below.

Figure 37 – Comparison of number of times each sub-routine option was used



In each and every case there a number of sub-routine options used more than other options. This is most pronounced in Epsilon, Delta, and slightly less so for Alpha. While also true for Beta and Gamma, there are far viewer options used. For Alpha, Delta and Epsilon the number of times the routines are used follows a Pareto distribution, while for Beta and Gamma it is more of a step or gradual slope, presumably due to the low numbers of procurement activity overall. While the actual numbers are quite different between the case studies, there is diversity in the number of sub-routine options in each and every case study in Prolific Projects.

Having considered stability and variety, the third type of variation (adaptation) in organisational routines is considered next.

5.1.3 TYPE III VARIETY - ADAPTIVE

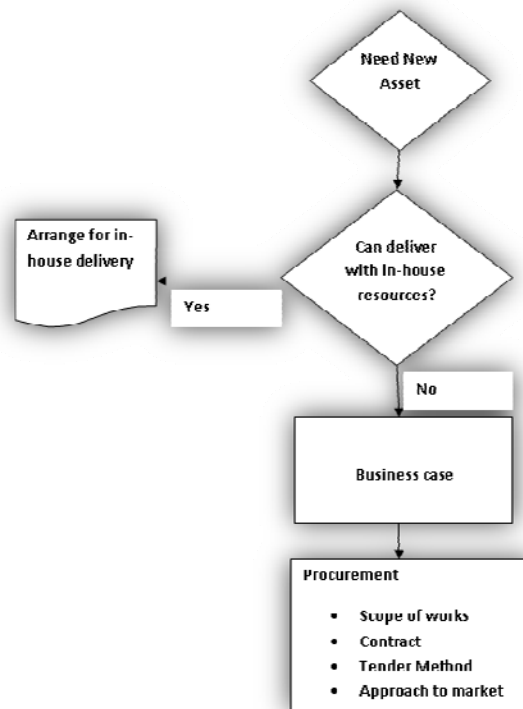
The third type of variety in the typology is where routines change over time. As with other case studies a multi-level analysis of this proves fruitful. Firstly, adaptation of the overarching pattern over time.

Adaptation of the Procurement Routine

As with variety, there was no evidence that there were changes to the overarching pattern itself (Scope of works → Contract → Tender → Approach to Market). However, some of the routines which surround procurement, changed.

Consider the traditional approach to procurement developed (see Figure 38) which was developed as part of the interviews and observations [Observation 24].

Figure 38 – Make Buy decision for procurement



In the historical approach to procurement within Prolific Projects as a whole the approach was basically a make/ buy decision. Once the need for the asset had been determined, the major choice was around whether the needed asset could be delivered in house (with existing workforce) or whether this needed to be purchased from an outside company.

Thus the process for implementing procurement was triggered following a make/buy decision by one of the divisions of Prolific Projects. More recently this has begun to change in most of the case studies.

Change to the Procurement Decision Making Processes

As outlined in the theory section, procurement processes are set in motion after an organisation decides that it will not, or cannot, deliver the asset internally (the make/buy decision). There are signs that this fundamental logic is being reassessed within Delta:

Yeah our traditional thinking is very much, can we do it ourselves? No, how are we going to do it? As opposed to, how should we do this, to get the best outcomes for the business and the project ... So there is probably a level of commercial maturity that we are getting but we are just not there yet ... [Interview 25]

In other words the assessment has gone beyond a simple make/buy decision and other factors are being considered in relation to procurement. Part of the thinking here is reflected in Beta, where the make/buy decision is being critiqued at the level of whether the organisation needed a set of new assets, or whether better utilisation of the existing set of assets can be achieved:

say we've got a Beta contract, we need you know 15 Asset 1s and 400 Asset 2s and you know they went out and got purchased, rather than no one was really asking the questions like well do we really need 15, what does it look like, can we get by

with 12, are there any others around the place, or can we make current operation work better and free up some asset that way [Interview 29]

Part of this involves a structural shift where the divisions no longer purchase independently, but are now looking to collaborate in purchases:

I guess the good news in terms of critical assets procurement is that the two groups have now developed a mechanism for sharing information at the high level, so if Beta is buying some new critical assets, then they might have something that they can cascade out of their business, so that that can go into Gamma's plan, if in fact they need it, so there is this overall concept of a Plan [Interview 10]

So the organisation as a whole is in the beginning stages of forming a master plan for procurement:

as an asset intensive business, there are some significant applications for either being over capitalised having too many assets or the wrong sort of assets, and likewise there are some significant implications of being undercapitalised, having the wrong resources or not enough resources. So the biggest and first question to get right is the strategic alliance piece of what level of asset, what types of assets, positioned where in the supply chain make the most sense strategically [Interview 28]

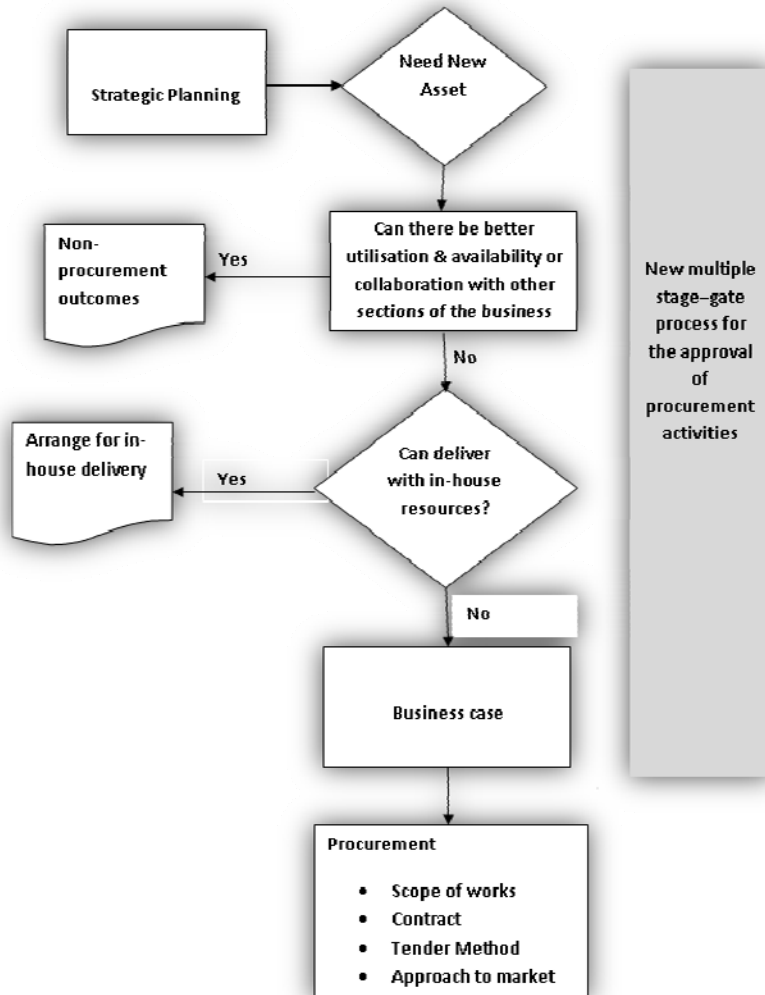
This is reflected in a shift in the assessment of procurement tenders away from technical to a more commercial focus in procurement:

Most times engineering are providing engineering support and the analysis to support the buying process, but not doing the buying process so there is a strong push to have a commercial process that is driving the procurement with engineering playing that technical supporting role, and not leading that process [Interview 15]

Thus while the overall pattern of procurement didn't change, an increased rigour has been put in place about whether an asset should be purchased in the first place. There is a move away from a simple make / buy decision to a larger strategic procurement process where the overall needs of the organisation are assessed, and there is collaboration developing between divisions in purchasing. Procurement is being considered alongside broader utilisation and availability considerations, and procurement decision making is moving away from purely technical considerations to a more commercial set of considerations.

The revised process could best be summarised in Figure 39 below:

Figure 39 – Revised procurement process



Comparison of Figure 38 and Figure 39 shows that there has been the introduction of a set of additional stages before moving to a procurement outcome.

Thus while Scope of Works → Contract → Tender → Approach to Market does not change, this process has become part of a larger strategic asset management process within the organisation.

Having considered the overall adaptation of the

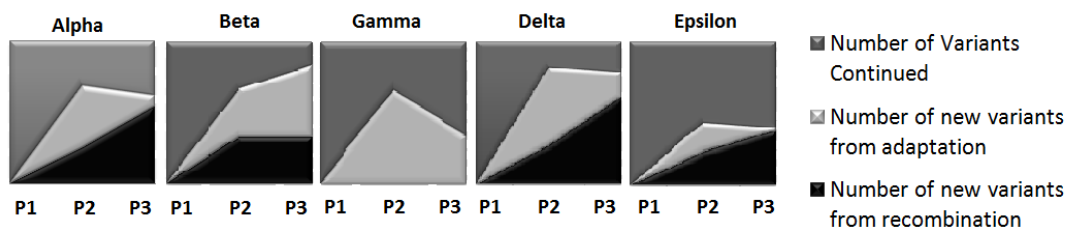
routines, individual variants of a routine shall be considered in the section that follows.

Adaptation of variants of a routine

In the case studies, differentiation was made between a variant of a routine which was the result of a recombination of existing sub-routines, as opposed to a new variant which is the result of adaptation (the introduction of a new process). However, as shown above in the stability and variety sections, the answer to this dilemma is to examine adaptation at multiple levels of analysis.

Each variant of the routine implemented was set out in the first few pages of each case study. As each variety is clearly identified, it's occurrence for the first time can be noted. This is then cross referenced by the first time each sub-routine is used, using the contingency tables in each case study specifying the occurrence of each of the sub-routines in each time period. If the new routine consists of sub-routines which had already been implemented then this was judged as a recombination of the existing repertoire. In other words the variant of the routine itself was new, but the sub-routines from which it was comprised, were not new. If, however, a new sub-routine was introduced in a given time period for the first time, and this was included in a new variant of the routine, then this was judged to be a new variant of a routine caused by adaptation. In other words the variant of the routine was new, if it had not been implemented before and at least one of the sub-routines of which it was comprised was also new. The results of this from each of the case studies (Alpha - Table 39, Beta - Table 49, Gamma - Table 58, Delta Table 67, Epsilon - Table 79) is summarised in Figure 40 below:

Figure 40 – Source of Variance in Routines in each time period – Each Case Study



Again, given the different volume of activity between each of the cases, the extent of variation is reported as a proportion of the total variants in use.

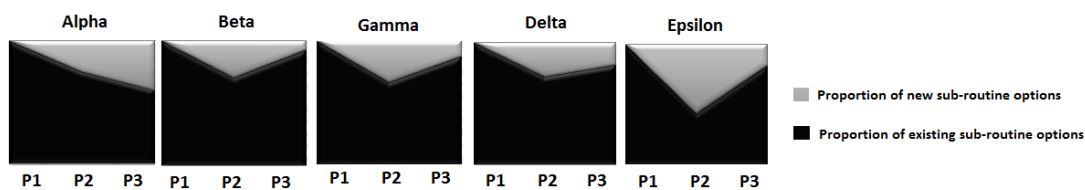
Thus each case study has a set of routine variants in each time period, which were the same as the previous time period (they were retained from one time period to the next). There was also a set of routine variants which were new due to adaptation – they included new sub-routine options which had not been used before. Interestingly in four out of five cases (Alpha, Gamma, Delta, and Epsilon) the number of routine variants which were the result of adaptation, decreased as a proportion of all variants in Period 3. In four out of five time periods there is also a set of routine variants which are due to recombination. While these variants of the routine are new, it is not because of the introduction of a new sub-routine option, but rather due to a re-combination of existing sub-routine options.

In terms of the type of variety, there was adaptation of routine variants in each case study. However there was also stability in every case study, and recombination in four out of five case studies.

Adaptation in sub-routine options

At the sub-routine option level, each case study also demonstrated the introduction of a number of new sub-routine options in each time period. Figure 41 reports the percentage of new sub-routines introduced in each case study, based on the information reported in each case study (Alpha - Table 40, Beta - Table 50, Gamma - Table 59, Delta - Table 68, Epsilon - Table 80). In each and every case, and in each and every time period, using the first period as a base line, new sub-routine options were introduced²⁴.

Figure 41 – Adaptation in Sub-Routine Options in each time period – Each Case Study



In summary, at the routine variant level and also at the sub-routine option level, there is adaptation in each case study and in each time period.

Having considered the first three types of variety, the fourth theoretical type – dynamic variety is considered next.

5.1.4 DYNAMIC (HIGH VARIETY AND HIGH ADAPTATION)

The last type of variety postulated from the literature is that of dynamic variety.

In the literature review, dynamic variety was argued to be where there was both adaptation (the introduction of new sub-routine options and variants of the routine) as well as variety (in the routine variants and sub-routine options) (see Section 2.3.4). Previous sections have already shown that there is diversity in the number of varieties of organisational routines in use in each of the case studies, as well as sub-routine options. Additionally, evidence has been presented of adaptation in the variants and sub-routine options.

Specifically, each of the case studies reported the results of Principal Component Analysis, which found between two and three components in each of the data sets. In each case there were a small number of sub-routine variants which explained a small amount of variance. This component was

²⁴ Recombination is not reported here as it is not relevant at the sub-routine option level

typically comprised by the variant of the routine which was used most often, and typically was the variant which demonstrated stability. Thus the PCA identified the most highly used and stable routine variant. However, the other component, which according to the PCA explained most of the variance in each of the cases, involved a larger set of sub-routine options. Thus statistical tests show that in each case, there is both stability and variance in the way sub-routine options are associated with each other. The tables and graphs above, have also shown that there is also adaptation and the introduction of variety.

In answer to the research question then, what type of variety exists in procurement routines – well it depends on the level of analysis. The set of findings from this section are summarised in Table 85 below:

Table 85 – Summary of Findings – Types of variety in organisational routines (by level of analysis)

	Pattern of action	Variants of Routine	Sub-Routine Options
Stability	The same overarching pattern of action is present in each case and time period	While no case used a single variant to the exclusion of all others, specific individual variants of the routine exhibited stability	Specific Individual sub-routine variants exhibit stability. In some cases a specific option (RFO/Tender) became the only one used.
Diverse	No evidence for diversity in the overarching pattern	There are 114 variants of organisational routines in use demonstrating diversity. Variety was found in each case and each time period	There are 25 variants of sub-routines: <ul style="list-style-type: none"> • scope of works (6) • contracts (12) • tender methods (3) • approach to market (4)
Adaptive	No evidence for adaptation. However, there are changes in the wider organisational processes around procurement	A number of new variants of the routine were created through the introduction of new sub-routines to the repertoire of options (adaptation)	New sub-routines are adapted and introduced into the repertoire of options.
Dynamic	No evidence for dynamic variety in the pattern of action	There is evidence of both diversity and adaptation in the variants of routines	There is evidence of both variety and adaptation in sub-routine options

5.1.5 FINDING 1

Finding 1:

There is evidence of stability, diversity, adaptation and dynamic change in organisational routines

Thus the analysis of the implementation of sub-routines over time in each of the cases has demonstrated more than one type of variety in organisational routines. While different depending

on the level of analysis, there is evidence of Type I – Stable, Type II – Diverse, Type III – Adaptive, Type IV – Dynamic variety. This holds across cases and time, although stability in Beta at the variant level is unusual.

A discussion about what this means theoretically will be undertaken in the Discussion chapter.

5.2 RESEARCH QUESTION 2: HOW DOES SELECTION CREATE VARIETY IN ORGANISATIONAL ROUTINES?

Prior to examining the particular dynamic by which selection creates variety in organisational routines, it is important to firstly examine what was selected in each of the case studies.

As outlined in the methods section, each routine is seen to be comprised of a number of sub-routines (following Pentland 1995, 2003b; Pentland and Feldman 2005; Pentland, Haerem and Hillson. 2010). For procurement the main types of sub-routine relate to the scope of works being requested, the contract which is established to undertake the scope of works, the tender method and the approach to market. While this pattern of action was the same in each case and time period, there were a number of different options that each of these could be done.

For each procurement event, a single scope of works was defined, a contract selected, tender method implemented, and approach to market undertaken. Thus, the specific variant of the routine depended on which set of sub-routine options were selected. Thus selection operates at a sub-routine level in choosing from the repertoire of sub-routines. Three main ways that selection affects variety can be identified through the case studies: increased variety through differences between the cases in the specific options selected; increased variety through recombination of sub-routine options into new variants of the routine; and reduction in variety through the repeated selection of the same variety of routine. Each of these is examined in turn below.

5.2.1 ENDOGENOUS VARIETY BETWEEN CASES

Moreover, while Chi squares in each case showed that there are significant correlations between various sub-routine options, different cases tended to select different sub-routine options.

In order to explore this further, a set of chi squares was undertaken to determine if there were differences in the proportion of times, various sub-routine options were selected by each of the case studies. Tables were created in SPSS with the Cases forming the columns of each table, and the set of sub-routine options (such as tendering) forming the rows. The test for independence (Chi Square) hypothesises that the distribution of Scope of Works across case studies is unrelated – that the proportions are the same across columns. If the Chi Square test produces a statistically significant

result, this indicates that the hypothesis is incorrect and that the columns and rows are in fact related. Firstly scope of works is tested.

Comparison of Scope of Works Between Cases

The Chi Square results were: [χ^2 (20, N=794) =187.734, p =.000]. Therefore the cases and scope of Works are not independent of each other, and there is a relationship between specific scope of works and specific cases. In order to test to see which rows and columns are responsible for this relationship, a Z-test were then used to determine if the correlation between each of the columns is in equal proportions across all of the rows. (PAWS ND, 141-142). In other words does a case study utilise some of the scope of works to a higher proportion compared to the other case studies. The results for this test are set out in Table 86 below:

Table 86 – Comparison of the proportion of Scope of Works used by each of the Cases

	Alpha	Beta	Gamma	Delta	Epsilon
	(A)	(B)	(C)	(D)	(E)
Design, deliver and Test (1)		A D E			
Provide Services (2)	D E				
Construction (3)				A C E	
Supply, deliver and commission (4)		. ^a			
Supply and Install (5)					
Supply deliver and load (6)		. ^a	A D		A D

Note:

Results are based on two-sided tests with significance level 0.05. For each significant pair, the key of the category with the smaller column proportion appears under the category with the larger column proportion.

a. This category is not used in comparisons because its column proportion is equal to zero or one.

b. Tests are adjusted for all pair wise comparisons within a row of each innermost sub table using the Bonferroni correction.

What Table 86 demonstrates is that each case reported a proportionally higher use of one specific scope of works compared to other case studies. For example Alpha used ‘Provide services’ scope of works more than Delta and Epsilon. Beta used ‘Design Deliver and Test’ proportionally more than Alpha, Delta and Epsilon. Gamma and Epsilon used ‘Supply deliver and load’ proportionally more than Alpha or Delta, and Delta used ‘Construction’ proportionally more than Alpha, Gamma or Epsilon.

Thus each case used a different scope of works proportionally more than other cases. There was variety in the extent to which different cases selected each scope of works, with each case preferring one over others. A similar result can be found for contracts.

Comparison of the Contracts Selected by cases

A test for independence (Chi Square) was undertaken to assess the hypothesis that the proportions of contract use was the same across all case studies. Chi Square results were: [$\chi^2(52, N=762) = 427.776, p=.000$]. Therefore the cases and tender method are not independent of each other. In order to test to see which rows and columns are responsible for this relationship, a columns proportion test was undertaken. Pair wise tests of the equality of column proportions (Z-tests) were used to examine the proportion of contracts used across cases (see Table 87 below).

Table 87 – Comparison of the proportion of Contracts Used by each of the Cases

	Alpha	Beta	Gamma	Delta	Epsilon
Contracts	(A)	(B)	(C)	(D)	(E)
Alliance	.a	E	.a	E	
Construction Management		.a	.a	.a	
Consultancy		.a	.a		
Design and Construct		.a	.a		
Engineering and Civil Works		A	.a	A E	A
Service Contract	D E	.a	D		
Supply Contract	D E	.a	.a		
Maintenance services		.a	.a		
Major Supply and Install		A D E	A D E		D
Minor Supply and Install					
Minor Works				A	A
Services Panel	.a	.a	.a		.a
Repairs contract		.a		.a	.a
Other	.a	.a	.a	.a	

Note:

Results are based on two-sided tests with significance level 0.05. For each significant pair, the key of the category with the smaller column proportion appears under the category with the larger column proportion.

- a. This category is not used in comparisons because its column proportion is equal to zero or one.
- b. Tests are adjusted for all pair wise comparisons within a row of each innermost sub table using the Bonferroni correction.

Beta and Gamma utilised Major Supply and Install contract to a much greater proportion than any of the other case studies, and Beta and Delta used Alliances in a far greater proportion than Epsilon. Alpha used Service contracts and supply contracts in a greater proportion than both Delta and Epsilon. And Delta and Epsilon used Minor Works Contracts in a greater proportion than Alpha.

Thus there were clear differences between the cases in the proportion to which different contracts were used. Each of the cases reported a higher proportional usage of a particular contract, compared to other cases. Thus there was a statistical difference in the extent to which cases used specific forms of contract. Moreover, each case had a statistically higher proportional usage of specific forms of contract compared to other cases. A similar story can be seen for Tendering sub-routines.

Comparison of the Tendering Method Selected by each case study

A test for independence (Chi Square) was undertaken to test the hypothesis that the proportion of Tender methods was the same across case studies. Chi Square results were: [χ^2 (8, N=792) =52.871, $p=.000$]. As this result is significant, the cases and tender method are not independent of each other, and there is a relationship between some of the Tender methods and cases. In order to test to see which rows and columns are responsible for this relationship, a columns proportion test was undertaken. Pair wise tests of the equality of column proportions (Z-tests) were used to examine the proportions of tender methods used between case studies (see Table 88 below)

Table 88 – Comparison of the proportion of tendering used by each of the Cases

	Alpha	Beta	Gamma	Delta	Epsilon
	(A)	(B)	(C)	(D)	(E)
Registration -> RFO/Tender			^a	A E	
RFI/EOI -> Tender		^a		^a	
RFO/Tender	D				D

Note:

Results are based on two-sided tests with significance level 0.05. For each significant pair, the key of the category with the smaller column proportion appears under the category with the larger column proportion.

- a. This category is not used in comparisons because its column proportion is equal to zero or one.**
- b. Tests are adjusted for all pair wise comparisons within a row of each innermost sub table using the Bonferroni correction.**

Alpha and Epsilon used RFO/Tender in a greater proportion than Delta, while Delta used Registration → Tender to a greater extent than either Alpha or Epsilon. Thus there was a statistical difference in the extent to which cases used specific forms of tender, although this is less obvious than other sets of sub-routine options reviewed. Remember for both Beta and Gamma RFO/Tender became a constant in Time Periods Two and Three (see section 4.6.1). Finally, analysis of the proportional use of the approach to market also yielded some significant results.

Comparison of the Approach to Market - Selected by each Case Study

A test for independence (Chi Square) was undertaken to test the hypothesis that the distribution of Approach to Market across case studies is unrelated. Chi Square results were: [χ^2 (12, N=794) =73.660, $p=.000$]. Therefore the cases and tender method are not independent of each other, and there is a relationship between approach to market and specific cases. In order to test to see which rows and columns are responsible for this relationship, a columns proportion test was undertaken.

Pair wise tests of the equality of column proportions (Z-tests) were used to examine the proportional usage of Approach to Market across case studies (see Table 89 below)

Table 89 – Comparison of the proportion of Approach to Market used by each of the Cases

	Alpha	Beta	Gamma	Delta	Epsilon
	(A)	(B)	(C)	(D)	(E)
Closed			. ^a		A D
Pre-Qualification	. ^a	. ^a	. ^a	E	
Sole Tender					
Open Tender	D E				

Note:

Results are based on two-sided tests with significance level 0.05. For each significant pair, the key of the category with the smaller column proportion appears under the category with the larger column proportion.

- a. This category is not used in comparisons because its column proportion is equal to zero or one.*
- b. Tests are adjusted for all pair wise comparisons within a row of each innermost sub table using the Bonferroni correction.*

Alpha used open tender proportionally more often than Delta or Epsilon. Delta used pre-qualification proportionally more than Epsilon, and Epsilon used Closed Tender proportionally more often than Alpha or Delta. Three of the cases reported a higher proportional usage of a particular approach to market, compared to other cases. Thus there was a statistical difference in the extent to which cases used specific forms of approach to market, at least for the cases with a larger number of procurement events undertaken.

Thus each of the z-tests above, show that there is a statistically significant difference in the selection of specific subroutines by each of the cases. Thus while there is variety, there is a statistically significant difference in the extent to which the different sub-routines were used, although this was more market for scope of works and contracts, than tendering and approach to market.

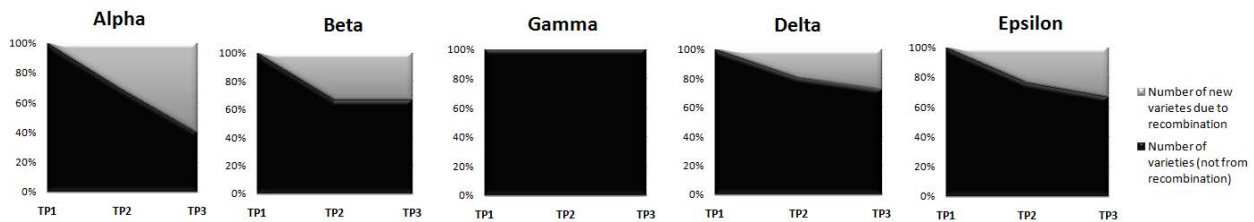
In terms of the research question, each of the cases increased variety by selecting a set of subroutine options proportionally different to other cases. No one case implemented all of the variants of the routine found within Prolific Projects. In other words there are endogenous differences between the cases in terms of what subroutines are selected. So there are differences **between** cases in the selection of sub-routine options which increases the variety of sub-routine options overall.

5.2.2 SELECTION AND THE CREATION OF VARIETY THROUGH RECOMBINATION

By selecting different sub-routine options different variants of the routine are created. As was noted in each of the cases, selection creates variety through recombination of sub-routine options into new variants of the routine. Note that this is different to adaptation, as no new sub-routine option is being introduced into the variant of the routine. Instead existing options are simply combined in new ways.

In each of the cases, the number of variants in each time period was identified, along with the number of routines which had been recombined into a new variant of the routine (Alpha - Table 38; Beta - Table 47; Gamma - Table 57; Delta - Table 66; Epsilon - Table 76). The proportion of new variants of the routine, as a percentage of all routine variants for each of the cases is set out in Figure 42 below.

Figure 42 – New routine varieties through recombination, as a percentage of all routine variants



Again each of the cases used recombination to a different extent. Gamma didn't use recombination at all, while for Alpha, nearly 60% of all routine variants in the final time period are through recombination. Thus in answer to the research question, selection creates variety within a case, through the recombination of sub-routine options into novel variants of the routine.

5.2.3 SELECTION AND REDUCTION IN VARIETY THROUGH STABILITY

It has been established in the previous two sections that selection increases variety, as each case selects different sub-routine options, and recombines these options, both of which creates new varieties of the routine. However, selection can also reduce variety, by repeatedly selecting the same variant of the routine to a greater extent than other variants of the routine (see Section 5.1.1).

In most of the cases the selection of specific variants of a routine (Figure 36) and in sub-routine options (Figure 37) follows a Pareto curve. Thus some routine variants and sub-routine options are selected far more often than others. As companies tend to only have a limited number of procurement events in which to make a selection between options, using one variant to a greater extent than others decreases the overall opportunity for variety.

5.2.4 FINDING 2

In summary, selection can either increase or decrease variety.

Finding 2:

Repeated selection of the same variant, or sub-routine option, will reduce variety. Selecting different sub-routine options to other cases will increase variety between cases; and recombination of existing options will increase the heterogeneity of variants within a case.

Having investigated selection, and how it creates variety, the next section considers adaptation.

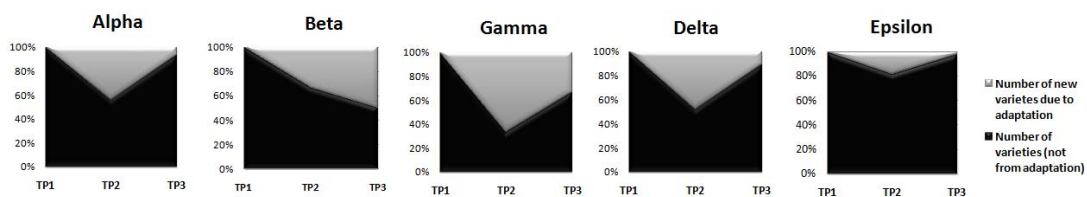
5.3 RESEARCH QUESTION 3: HOW DOES ADAPTATION CREATE VARIETY IN ORGANISATIONAL ROUTINES?

As adaptation involved the introduction of a new sub-routine option into the repertoire, the relationship between adaptation and variety is fairly easy to determine. Figure 41 has already outlined the number of new sub-routine options which were introduced in each case and each time period.

5.3.1 ADAPTATION INCREASES VARIETY WITHIN CASES THROUGH INCREASING THE REPERTOIRE OF SUB-ROUTINE OPTIONS

Whenever a new sub-routine option is introduced into an organisation, such as a new form of contract, then whenever this new contract is used in the routine, a new variant is automatically created, as no previous variant would have included that contract. Figure 43 provides an overview of the number of new variants of the routine in each of the cases, created through adaptation (based on the Tables in each of the case studies: Alpha - Table 39; Beta - Table 49; Gamma - Table 58; Delta - Table 67; Epsilon - Table 79).

Figure 43 – Number of New Variants of the Routine, due to introduction of a new sub-routine into the repertoire



As this figure shows the number of new sub-routines, as a proportion of the total number of sub-routines in use, followed a similar pattern for four out of the five cases (Alpha, Gamma, Delta and Epsilon). In the majority of cases the proportion of new subroutines was much higher in the second time period (P2 - 2005 to 2006) compared to the final time period. Beta increased the number of new sub-routines in use in the third period. Thus in Period 2, there was a fair deal of experimentation of new sub-routine options, while in Period 3, fewer adaptations were made overall.

Within each of the cases, adaptation creates variety through the introduction of new sub-routine options which increases the overall repertoire of sub-routines which can be selected for implementation.

5.3.2 ADAPTATION INCREASES VARIETY BETWEEN CASES, THROUGH THE ADOPTION OF NEW SUB-ROUTINE PROCESSES

As the database had the specific date in which a particular variant was implemented, it is possible to examine how adaptation of sub-routine options was implemented through the various cases of Prolific Projects. The scope of works will not be included here as they are an artefact of data reduction and apparent diffusion may simply be due to the clustering process rather than anything else. Figure 44 provides the order in which each adaptation in Tendering was implemented in each of the cases.

Figure 44 – Diffusion of Tendering Methods Across Case Studies

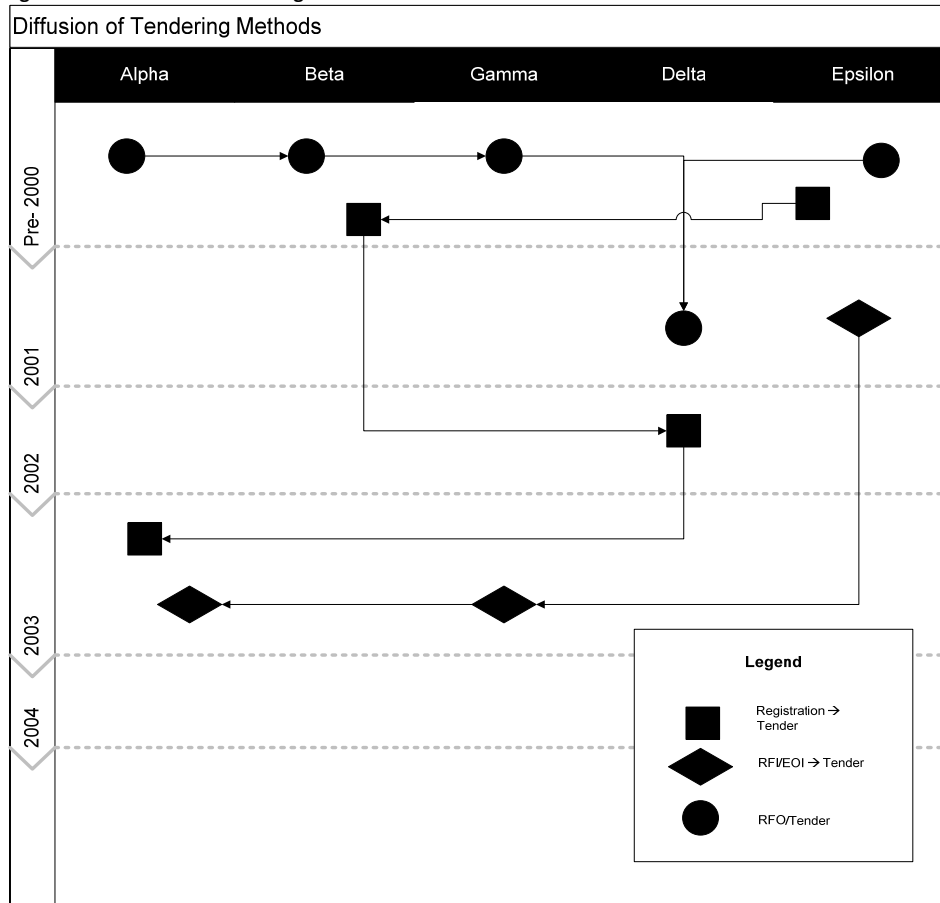
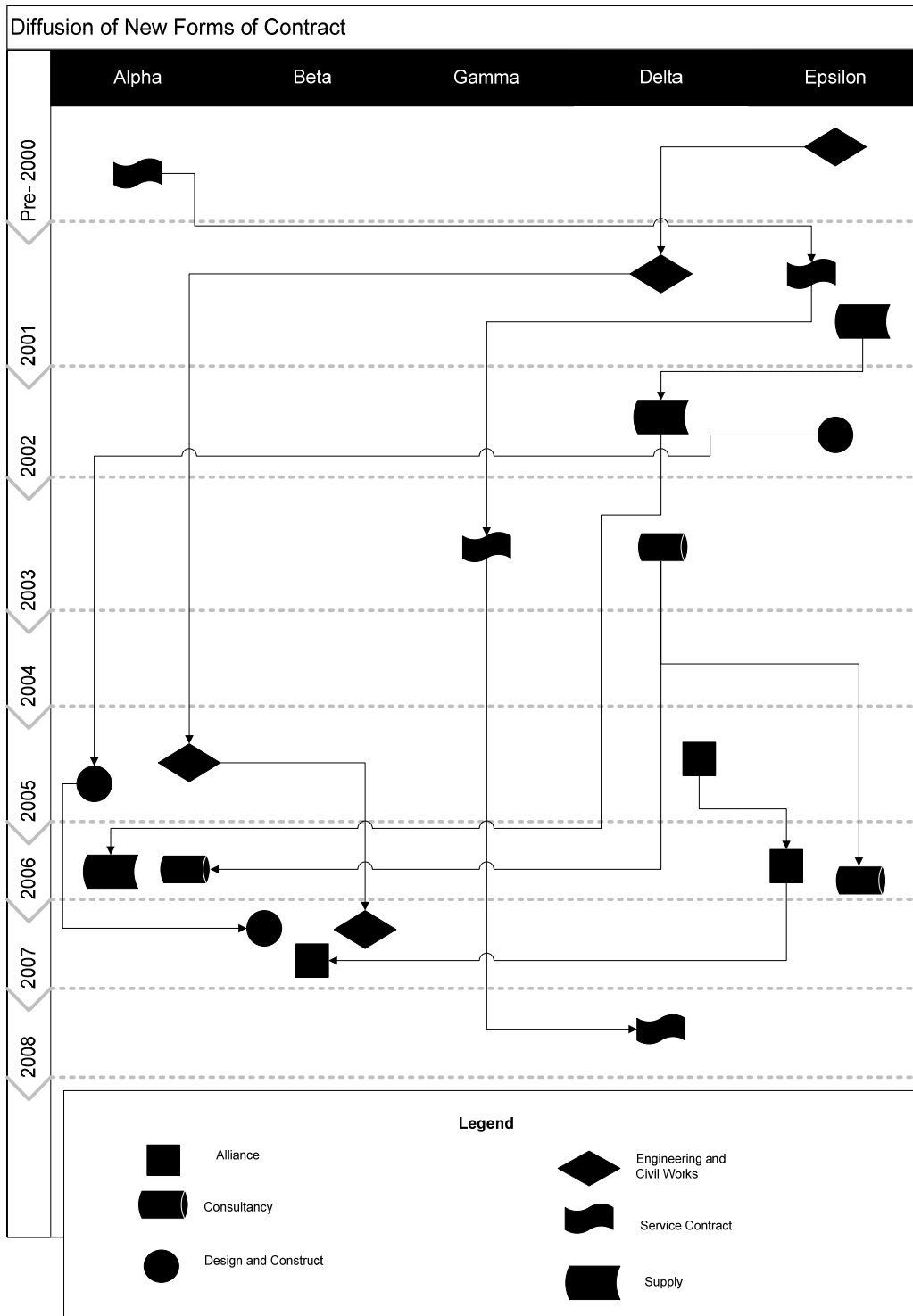


Figure 45 provides the order in which new forms of contract were implemented in each case study. Some contract have not been included in Figure 45 (below), if they were only implemented in a single case study, or were implemented in multiple case studies in the same year, without spreading wider.

Figure 45 – Diffusion of New forms of Contract across Case Studies

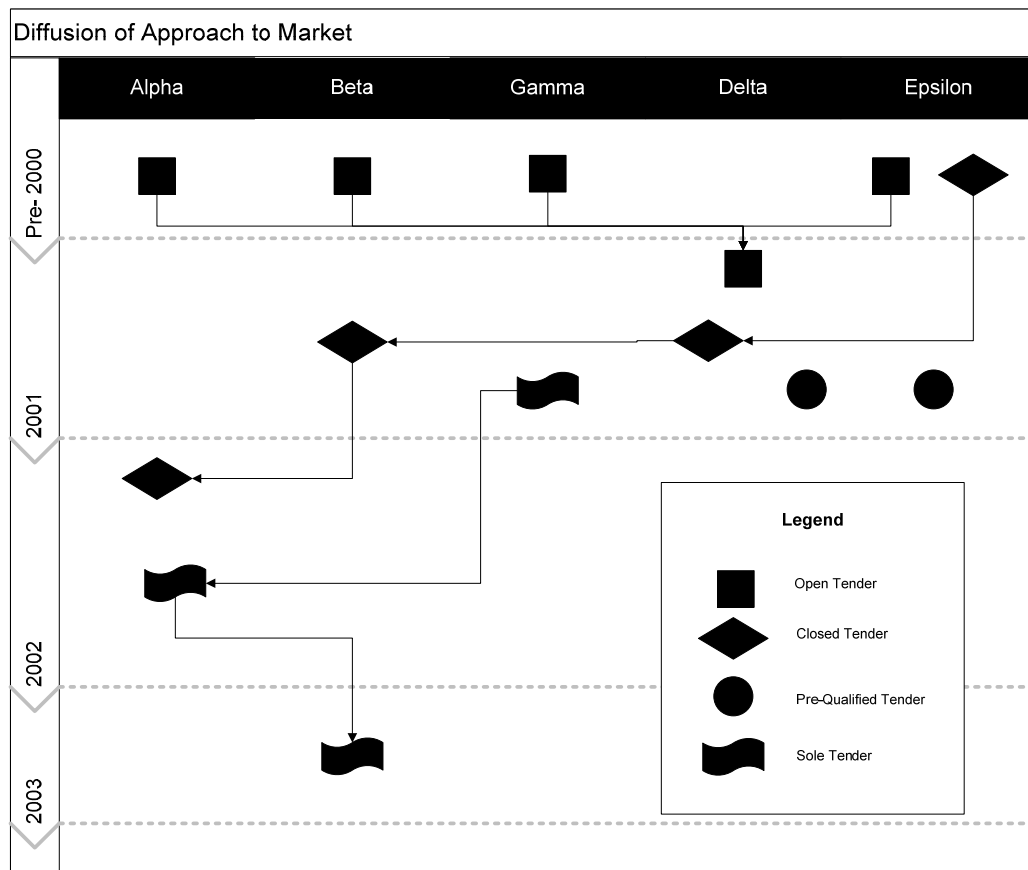


A note of explanation with the diagrams, each symbol represents the first use only of a particular contract by a case study. To see if the sub-routine is used in later years it will be necessary to examine the detailed data in the case studies. Nevertheless, Figure 45 above shows how new forms of contracts implemented throughout the organisation.

Thus in each and every case the contract was introduced in a particular division and then was later utilised by another division at a later date. Thus while the case studies note the reason for the introduction of the sub-routines, the cross case analysis is able to show that this does not stop with the original case, but is also imitated by other divisions.

As with the contracts similar patterns of the introduction of a form of approach to market in one case which is then diffused through the organisation can be seen in Figure 46 below.

Figure 46 – Diffusion of Approach to Market across Case Studies



Thus, with the exception of the Pre-Qualified tender, the Approach to Market was implemented in each of the case studies, as is demonstrated in Figure 46. As with the contracts and approach to market, the introduction of a new form of tendering in one case is then utilised through the organisation.

Thus, once a new sub-routine is introduced in one case study the adaptation is implemented in other organisational units. This provides quite strong evidence of organisational learning.

While there was no evidence of this from interviews, I was able to observe the process of transfer of knowledge while embedded inside the Epsilon case, when coding the database. Epsilon had maintained a specialist contract management section which handled most of the tendering and contracting on behalf of other organisational units in Prolific Projects. At least part of the reason for the diffusion of innovation rests with this centralised contract section.

While responsibility for tendering and contracting lies back in the other sections, often new staff are involved ... Sometimes this lack of expertise means that people ask for advice of contract section staff on the procurement or tendering process. Each day, in addition to calls requesting updates on various tenders / contracts which were in process, there were also phone calls asking to clarify processes, discuss tender and contract options, clarify delegated authority levels, etc.
[Observation 28]

Thus, there are new sub-routines which are adapted and introduced in each of the case studies. Over time, these adaptations were implemented in other organisational units. While they were not necessarily implemented in every case, each sub-routine option did at least diffuse into multiple other organisational units (with the exception of pre-qualification) processes.

5.3.3 FINDING 3:

Thus within a case study, adaptation increases variety by increasing the repertoire of sub-routine options available for selection. New sub-routine options, when selected, create new variants of the routine. Moreover, between cases there is evidence of organisational learning as nearly every adaptation was implemented across all the cases studies.

Finding 3:

Adaptation increases variety by increasing the repertoire of sub-routine options available for selection.

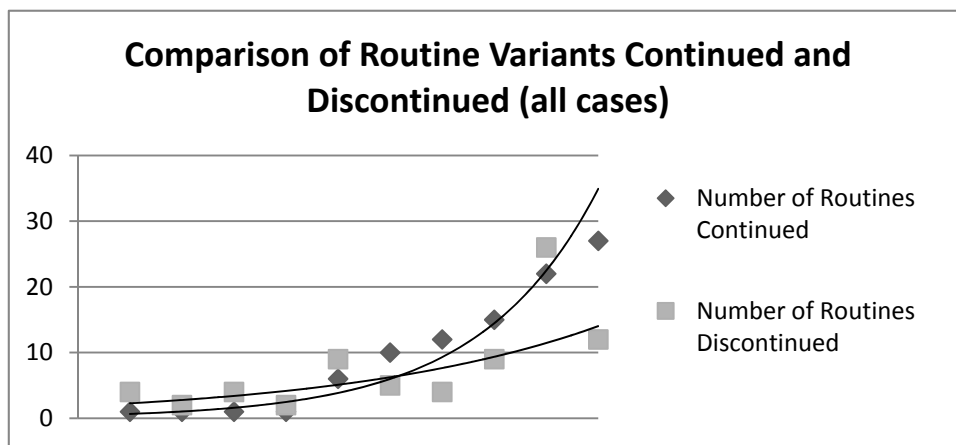
Having considered selection and adaptation, the last research question considers how retention affects variety in organisational routines.

5.4 RESEARCH QUESTION 4: HOW DOES RETENTION AFFECT VARIETY IN ORGANISATIONAL ROUTINES?

As has been noted above, selection affects variety by creating variants from the repertoire of sub-routine options. Adaptation increases variety by adding new sub-routines options to this repertoire.

Retention works differently however. Retention is concerned with the retention of sub-routines and variants in organisational memory – as some variants and options are kept, and a few are not utilised again. In each of the cases, examination was made of the number of variants of the routine which were continued in use, and those which were no longer in use within the case and time period (Alpha - Table 41; Beta - Table 51; Gamma - Table 60; Delta - Table 70; Epsilon - Table 81). These findings are collated in Figure 47 below. Rather than report on a case by case basis, the number of routine variants continued and discontinued are plotted as a parallel series. The number of routine variants continued and discontinued in each case and time period are plotted together, while the trend line follows each individual series

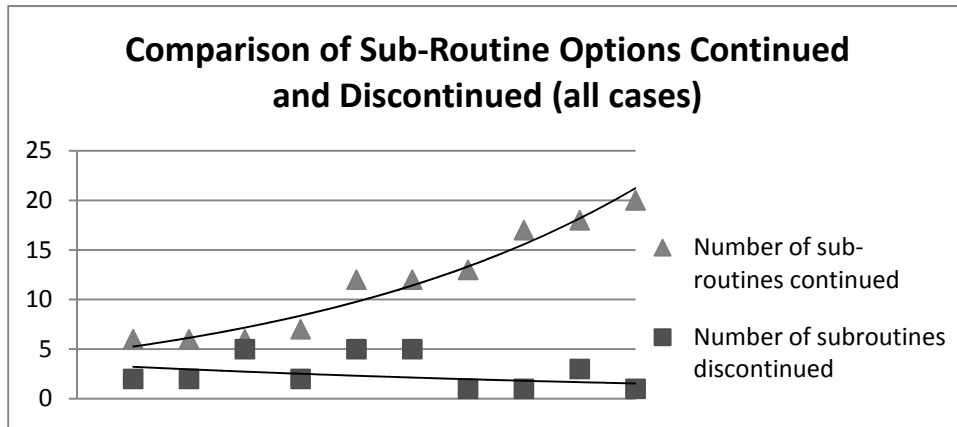
Figure 47 - Number of Routine Variants Continued and Discontinued (all cases)



As Figure 47 sets out, there is a large divergence in the number of routines discontinued from one year, although the trend line is not very steep. The trend line for number of routines retained, though follows an exponential curve. Nevertheless there appears to be a positive correlation between the number of routines retained and the number of routines discontinued. In other words, the more routines were retained, the high the number of routines which were discontinued. Consider in contrast the retention of sub-routines.

As with the previous graph Figure 48 sets out the number of sub-routine options which were continued and discontinued in each of the cases and time periods (reporting data from: Alpha - Table 42; Beta - Table 52; Gamma - Table 61; Delta - Table 71; Epsilon - Table 82). Again these are plotted in parallel series in order to show the number continued and discontinued.

Figure 48 – Number of Sub-routine options continued and discontinued (all cases)



The graph indicates a negative relationship between the number of sub-routine options retained and the number of sub-routine options discontinued. In other words the more sub-routine options were retained in a given case and time period, the less were discontinued. Reasons, as outlined in the case studies, for continuing a sub-routine related primarily to the perceived effectiveness of the option in achieving a particular outcome.

There was also evidence in the case studies of a limited number of routine variants and sub-routine options which were used in Time Period 1, not used in Time Period 2, and then used again in Time Period 3 (see Table 42, Table 60, and Table 71 for examples). This provides support for retention, as the absence, or non-use, of a particular variant or sub-routine option, does not mean that it has been 'forgotten'. In the interviews, only Alliances were strongly identified as potentially not being continued in use.

The literature already acknowledges retention as part of organisational memory, and that decisions are made about whether routines are to be retained in organisational memory, or not retained (Teece and Pisano 1994). In terms of retention in relation to variety through, retention affects variety by determining the number of sub-routine options which are continued or discontinued. While adaptation may introduce a new sub-routine option, retention involves choices about whether or not to keep using that option. Retention then affects variety through determining the composition and size of the repertoire of sub-routine options available for selection.

5.4.1 FINDING 4

Retention can increase variety, by retaining a large number of sub-routine options in organisational memory so that they can be selected and recombined into an increasing variety of options. However, retention can decrease variety through the forgetting, or discontinuing the use of a particular sub-routine option, thereby decreasing the overall number of options available for selection. Thus retention also involves choice – not about which variant or sub-routine option to use, but whether the option is suitable for continued use. Retention is also therefore evaluative. While the charts above indicate the non-use of specific sub-routine options, there is evidence from the interviews of only one sub-routine option (Alliances) which may or may or may not be used again.

Finding 4:

Retention affects variety through the selective retention of the total repertoire of sub-routine options

Having examined variety, and how selection, adaptation and retention affect variety individually, it is important to consider how these dynamics affect each other.

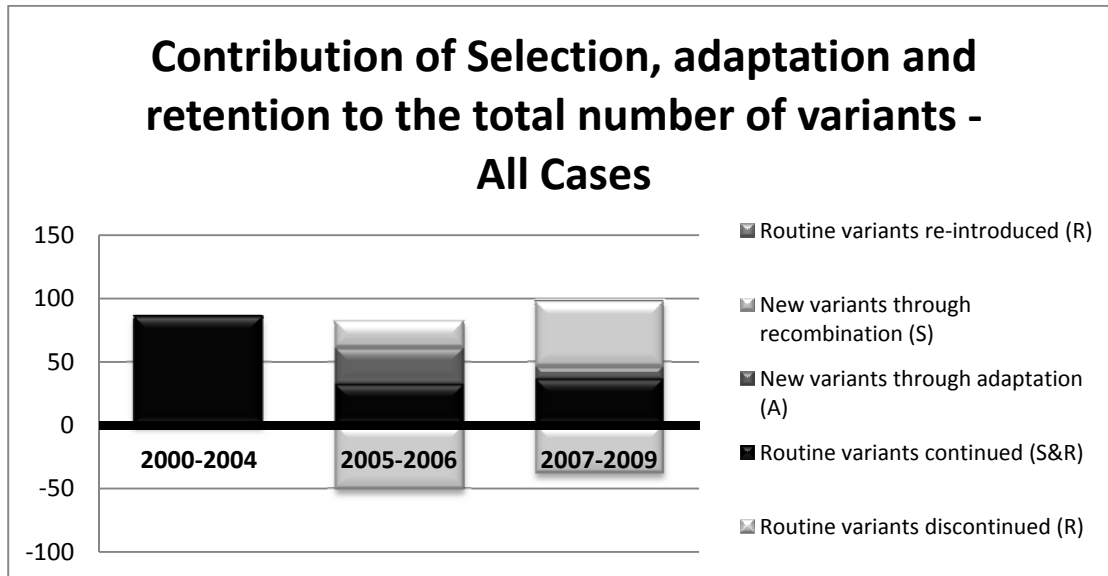
5.5 SELECTION-ADAPTATION-RETENTION AND VARIETY

In the previous sections of this chapter, each of the research questions has considered questions in relation to variety: what sort is there and how do the various dynamics affect variety. By way of recapitulation, selection has been seen to reduce variety through the repeated selection of the same variant or the same sub-routine option to a greater extent than others. Each case also tended to use different combinations of sub-routine options to purchase, which also created variety between cases. Within cases, recombination of sub-routine options created new varieties of the routine. Adaptation increased variety through the introduction of new sub-routine options into the repertoire. These adaptations also spread throughout each of the cases over time. And finally retention increases variety through choices about which sub-routines to keep on using and which to no longer use. Consequently, there is a complex interaction between selection, adaptation and retention in terms of how each of these affects variety.

While each of the cases reported the continued selection of existing variants of the routine, the recombination of sub-routine options into new variants; the creation of new variants through adaptation (and the introduction of new sub-routine options) as well as variants of the routine which

were not continued from one time period to the next. Figure 49 below reports the total number of each of these for all cases and all time periods.

Figure 49 – Contribution of selection, adaptation and retention to the total number of variants



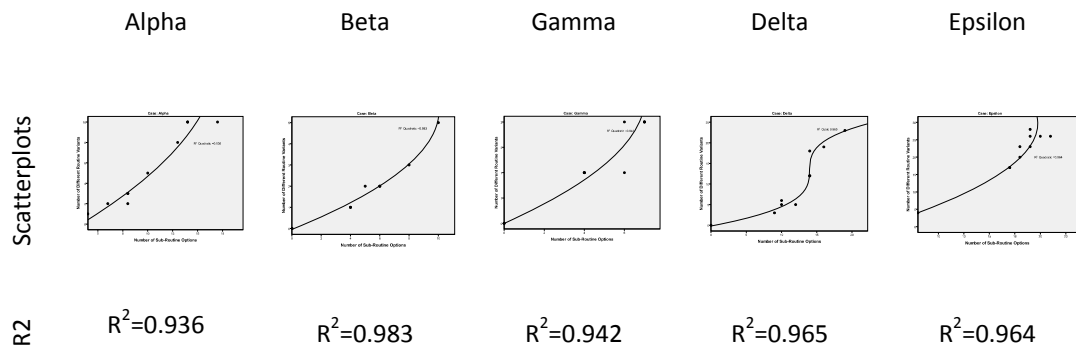
As Figure 49 indicates, discontinuation reduces the overall number of variants in use, while continuation maintains the same number of routines from one period to the next. Adaptation increases the number of routines, as does recombination. In Time Period Three (2007 to 2009), the majority of new routine variants were through adaptation. However, in Time Period 3, the majority of new variants was through recombination. Thus selection, adaptation and retention all affect variety, and they do so in a way that affects the operation of the other dynamics. For example, adaptation involves the introduction of a new sub-routine option. This is chosen (selection) in association with other existing sub-routine options kept alive (retained) in organisational memory. Having implemented the routine, an evaluation process happens concerning whether there was merit in the continued use of the sub-routine option. Certainly, selection-adaptation-retention affects variety in concert, not in isolation. This will be considered further in the discussion chapter.

Having reviewed all of the findings to date, it would seem that there is a relationship between the total number of sub-routine options available and the number of variants of the routine implemented.

Relationship between Variety of Routines and the Repertoire of Sub-routine Options

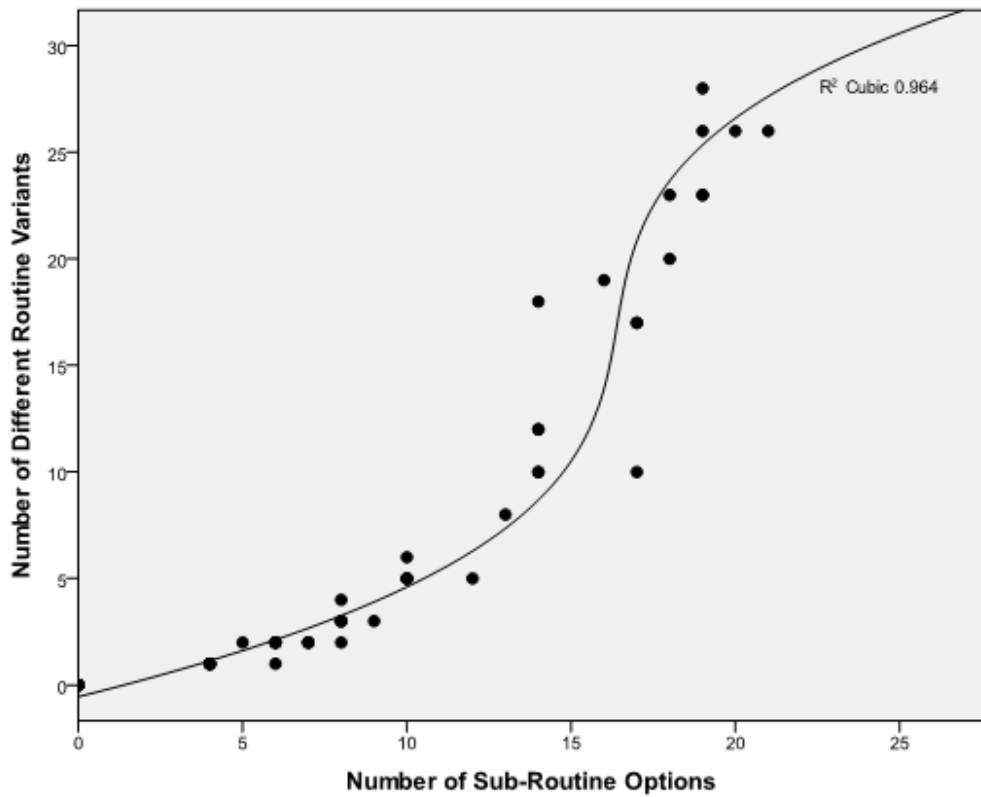
The final way identified in the case studies as causes of variety are due to the combination of sub-routines to form different sub-routines. Throughout each of the cases, there appeared to be a relationship between the number of sub-routine options available for selection (whether via adaptation or retention). These relationships are summarised in Figure 50 below.

Figure 50 - Relationship between the number of sub-routines options (the repertoire) and the number of routines



The R² is very high across all of the cases, with the number of sub-routines predicting the number of routines over 94% of the time in each case. In other words the number of sub-routines options available for selection is strongly related to the number of routines variants which are selected, and this relationship is highly unlikely to have occurred by chance. In order to verify this, all the data was combined from each case study in order to examine the relationship between the number of sub-routine options and the number of varieties of the routine implemented (see Figure 51 below).

Figure 51 – Relationship between the number of sub-routines and routines (all cases – all years combined data)



What Figure 51 shows is the R^2 for the cubic fit line (0.964) is very high, indicating that there is a very strong relationship between the number of sub-routine options and the number of routine variants. However this relationship is not linear, as the R^2 cubic is a much higher relationship than the linear R^2 (0.846).

At the left hand side of the graph, there is an almost linear relationship between the relatively few sub-routines options and the number of routine variants selected from these. Once there are more than 14 sub-routine options available, the number of routines variants increases exponentially, so that a very small increase in the number of sub-routines results in an exponential increase in the number of routine variants, before reducing to a less dramatic curve at around 27 routine variants.

This provides a strong piece of evidence that increasing the repertoire of sub-routine options increases the number of variants of a routine.

Thus, the selection-adaptation-retention dynamics act in concert to affect the number of sub-routine options available for selection. The more sub-routine options are available, the greater the number of variants of the routine.

5.5.1 FINDING 5:

While individually selection, adaptation and retention affect variety in organisational routines, there is a dynamic interaction between each one of them. Each one affects the number of sub-routine options available for selection, and the greater the number of options, the greater the number of variants. This leads to the final finding:

Finding 5:

There is a dynamic interaction between selection, adaptation and retention. Individually and in concert each has an effect on variety.

5.6 SUMMARY

Selection adaptation and retention affects variety in organisational routines in the following ways:

- Multiple forms of variety have been found, with stable adaptive, diverse and dynamic variety found
- Adaptation increases the repertoire of sub-routine options available for selection (resulting in an increase in the number of routine variants)
- Retention determines the number of sub-routine options which are kept from one time period to the next (resulting in either an increase or a decrease in the number of available sub-routine options).

- Selection chooses a set of sub-routines from the available repertoire of sub-routine options. Selection creates variety either through the recombination of existing routines, within cases. Between cases, sub-routine options were chosen in different proportions between the cases. Selection can also reduce variety through the repetitive selection of the same sub-routine option or variant.

Selection, adaptation and retention all contribute to variety in a dynamic way

5.7 CONCLUSION

This chapter has advanced a series of findings from the cross case analysis. Through each of the cases, routines have been analysed as multi-level phenomena. This approach enabled the demonstration of multiple forms of variety, with stable, diverse, adaptive and dynamic types of variety noted. And finally, how selection, adaptation and retention creates variety, both individually and in concert, in organisational routines has been explored.

The next chapter explores the theoretical implications of these findings further.

CHAPTER SIX

6) DISCUSSION

The overall aim of the thesis has been to explore the dynamic processes which create variety in organisational routines. Each of the case studies and the cross case analysis provided a number of findings, each of which has theoretical implications. The discussion of these findings in this chapter is structured in accordance with the questions posed in order to facilitate a coherent theoretical advancement of our understanding of routines, particularly how the dynamic processes of selection-adaptation-retention create variety in organisations.

Structurally, the chapter has three main sections. The first section considers the variety found in each of the cases. While some authors have suggested that routines are stable, or varied, or adapt over time, all of the different types of variety have been found to exist in the same routine, although this varied depending on the level of analysis.

The second section considers selection, adaptation and retention in turn in order to see how each contributes, individually, to variety in organisational routines. Diagrams are used to facilitate the theoretical discussion in this section.

The final section considers selection, adaptation and retention not as individual phenomena but as interrelated dynamics which affect each other, as well as the overall variety in a routine. A model of how selection-adaptation-retention dynamics affect variety in an organisational routine is advanced.

6.1 FINDING 1: ON THE DIFFERENT TYPES OF VARIETY IN ORGANISATIONAL ROUTINES

As has been noted throughout the thesis there are different types of variety in organisational routines. A typology of the various types of variety (see Figure 2) has been used as an analytical lens throughout each of the case studies, and cross case analysis. The types of variety are: Type I – Stable where routines are stable and don't change over time; Type II – Diverse, where routines exhibit concurrent variety, or heterogeneity; Type III – Adaptive, where routines adapt and change over

time; and Type IV – Dynamic, where routines both adapt and are diverse at the same time. Additionally, as routines are multi-level constructs, these different types of variety need to be considered in relation to a specific level of analysis: the overall pattern of the routine, the individual variant of the routine, or the sub-routine options. Each of the types of variety is considered in turn, in relation to the different levels of analysis below.

6.1.1 TYPE I – STABLE – ORGANISATIONAL ROUTINES

Traditionally, routines have been seen to be stable in organisations (Cyert and March 1963; Nelson and Winter 1982), and such stability is seen to contribute to inertia in terms of change. In the current study, there is evidence for Type I – Stable, of organisational routines and this is discussed in relation to each of the levels of analysis. Firstly, the pattern of action is considered.

Stability at the pattern of action level

In the literature review, organisational routines were defined as:

‘Recurrent interaction patterns’ involving multiple actors working to achieve a particular outcome (Becker 2004, 645, 2005a, 818).

As a recurrent pattern of activity (Becker 2004), a routine needs to demonstrate a fairly stable pattern of action that continually repeats. If a pattern of action only occurred once, then it could hardly be seen to constitute a routine. Thus for a particular phenomena to be considered a routine, it would need to demonstrate stability at the pattern of action level.

For this study the overall pattern of action involved a process of determining the **scope of works** → identifying the right form of **contract** → choosing the **tender method** → and deciding the **approach to market**. At the highest level, the overall pattern of action holds over time. The use of a database to record all aspects of the procurement process, and the need to progress through the database in order, certainly helped to achieve this outcome. In other words the database helped to enact the performance of the routine, as the structure of the ostensive element was part of the coding: each element was needed.

This level of analysis provides considerable support for the understanding of stability in organisational routines. A number of authors argue that routines provide stability for organisations, and can in-fact inhibit innovation (Howard-Grenville 2005; Nelson and Winter 1982).

That the overall pattern of action can be stable is already understood in the literature (Pentland and Feldman 2005). Thus empirical studies of routines need to demonstrate, in order to meet the criteria of actually being a routine, that there is a pattern of action which is used recurrently.

Stability at the variant level

While each of the cases demonstrated heterogeneity in the variants of organisational routines, each of the cases also selected a specific variant of the routine at a higher rate than others. This was shown primarily through raw counts of variants implemented in each of the case studies, and has been displayed in the Pareto shaped graphs. In other words a particular variant of the routine was more dominant in utilisation than other variants of the routine.

Thinking this through practically, it is likely that certain variants of a routine are more 'routine' to an organisation than others. In other words, a certain variant of the routine may be closest to a standard operating procedure (Egidi 1996; Nelson 1994), or as an established or preferred way of operating. If a routine is indeed the successful solution to a particular problem (Teece and Pisano 1994), and there is a dominant variant of the routine which is maintained over time; then this implies that this variant successfully resolves a particular problem for that organisation. Thus a dominant variant of a routine is the standard operational response to the standard problem facing the organisation.

In the case of this study, the most common form of procurement for each division related to key responsibility for that division within the organisation. For Alpha the dominant variant (#33) revolved around procurement of services; for Beta and Gamma the dominant variant (#5) was for the procurement of machinery; for Delta (#45) and Epsilon (#67) the dominant variant was for construction. The dominant variant of the routine is thus the standard organisational response to the main procurement activities of the organisational division.

This level of analysis provides less support for the understanding of stability in organisational routines, while also some support for the notion of heterogeneity of routines. While some authors argue that routines are stable and do not change, (Howard-Grenville 2005; Nelson and Winter 1982), while others have found heterogeneity (Pentland, Haerem and Hillison 2007; Pentland, Haerem and Hillison 2009; Pentland 1992; Pentland 1995) the cases have shown that there can in fact be both stability and heterogeneity. Put another way, amidst the heterogeneity, there can be stability in organisational routines. This understanding of stability amidst heterogeneity is not elsewhere noted in the literature, and shall be discussed in more detail below.

Stability at the option level

Each of the cases also had particular sub-routine options which were stable over time. PCA showed statistical associations (components) between a small number of sub-routine options in each case.

While statistically correlated, they explained little of the variance in the data. In other words a set of sub-routine options was used more often, than other variants. As the dominant variant of the routine was typically comprised of the dominant sub-routine options, this makes sense.

Additionally, for some cases, a particular sub-routine option became a constant in each and every variant in the last two time periods. This is particularly the case for RFO/Tender in Alpha - Table 35, Beta - Table 44, and Gamma - Table 54. Once a particular routine activity demonstrates that it can achieve particular outcomes for an organisation, then this will tend to be continued inside an organisation (Nelson 1994; Nelson and Winter 1982).

Elements of the routine and the level of analysis

As has been acknowledged throughout the thesis, there is a difference between the ostensive and performative elements of a routine. The ostensive is the conceptualisation of what the routine is (Becker 2004), or the 'in principle' (Latour 1986) understanding. This includes the pattern of action Pentland (2011) which is the main stages of the routine necessary for its implementation. For an organisation there is a general in principal understanding about how a routine operates, and there may be a deal of agreement concerning the pattern of action in the organisation. This was certainly the case in each of the case studies, with the same pattern evident in each. In contrast, the performative is the actual implementation of the routine (Becker 2004) or the 'in practice' (Latour 1986) aspect. There can be considerable variety even within an organisation in the in practice level of the routine, as has been demonstrated in the case studies, with no two cases implementing exactly the same set of variants. Thus there is stability the 'in principal' level and variety in the 'in practice' level. However, each of the cases also had a specific variant of the routine which was also stable over time. While the ostensive aspect of the routine has been associated with stability in the literature (Pentland and Feldman 2005), the notion that a particular variant of the routine could also demonstrate stability over time appears to be novel.

Stability and heterogeneity

Thus at both the variant and sub-routine option level there is stability amidst heterogeneity. As noted with the variant level of analysis, this has hitherto not been acknowledged in the empirical studies. Theoretically this is interesting, as this finding makes simplistic notions of stability and heterogeneity no longer plausible. The way current debates are framed, stability (Howard-Grenville 2005), or heterogeneity (Pentland, Haerem and Hillison 2007), are seen as debates about the nature of routines themselves. Instead, the finding that a single routine exhibits stability amidst heterogeneity, suggests that stability and heterogeneity are properties which a routine exhibits. This

gives further credibility to the typology of variety advanced in Chapter Two, as a framework for examining variety in organisational routines.

Additionally, the original conceptualisation of organisational routines (Nelson 1994; Nelson and Winter 1982), equated routines with a standard operating procedure. If routines only exist in terms of heterogeneity, it is difficult to argue that they equate to a standard operating procedure. However, if some variants of the routine are chosen more frequently than others, as is the case with procurement, then the most frequent variant of the routine corresponds to a standard operating procedure, while the other variants deal with the less frequent transactions required by the division under examination. This means that organisations can reduce complexity in decision making by having a single variant of a routine which operates sufficiently well to be considered a standard operating procedure (Egidi 1996; Hodgson and Knudsen 2004), while also coping with complexity in their external environment by having sufficient heterogeneity to cope with non-standard situations (Becker 2005b; Boisot and Child 1999).

6.1.2 TYPE II – ADAPTIVE – IN ORGANISATIONAL ROUTINES

While routines have been associated with stability, Feldman (2000, 2003) demonstrated that routines can in fact change over time. That routines can change has been repeatedly supported in the cases, and is discussed according to each of the levels of analysis below.

Adaptation at the pattern of action level

As the overarching pattern of action has been seen to be stable over time, it is perhaps not surprising that there was no evidence of change in all of the cases at the overall pattern of action level. There was evidence at the other levels however. In terms of stability, this finding supports notions that routines are stable over time (Nelson 1994; Nelson and Winter 1982). Thus rather than suggesting routines change, or are heterogeneous, it is possible that different routines have different properties – some are stable, some change, and some are heterogeneous.

Adaptation at the variant level

In most of the cases there is evidence that new variants of the routine were created through adaptive processes, not just through recombination of existing routines. As adaptation involves the generation of new ways of operating (Winter 1975, 102), adaptation involves more than simple recombination (Feldman 2000, 613). Due to the longitudinal nature of the data, there is considerable evidence that routines indeed change and adapt over time. However, adaptation is understood here as the introduction of new sub-routine options. However the demonstration of this adaptation involved a change in the performative options in use over time, and the introduction of new options into the repertoire of choices, as evidence of adaptation.

Adaptation at the option level

While studies demonstrating adaptation are not new (c.f. Feldman 2000, 2003), the multilevel longitudinal approach to examining change in organisational change has been able to demonstrate a) when a new option entered into the repertoire of sub-routine options; b) how this was combined into new variants of the routine, and c) how this adaptation was imitated by other cases within Prolific Projects. Moreover the interviews have been able to elaborate on why such adaptation took place. That for most of the cases, adaptation involved the introduction of a new contract also links this to the artefact nature of routines, as contracts are artefacts.

While many authors have argued that routines are stable (Nelson 1994; Nelson and Winter 1982), it is possible that this may be due to a level of analysis. In other words, examination at the pattern of action level would indicate that the routines are stable. However, finer grained analysis at the variant level shows that there is indeed adaptation underway. This suggests that when undertaking empirical examination of routines, the unit of analysis would need to be acknowledged, as this is likely to have a bearing on whether routines are perceived as being stable or adaptive.

In terms of the routines literature, this findings supports other authors who have argued that routines do in fact change over time (Feldman 2000, 2003). Methodologically, both Feldman and Pentland (2000, 2003) and this study, employed a longitudinal analysis. This also has implications methodologically for the study of routines, as a cross-sectional analysis is unlikely to demonstrate change over time.

6.1.3 TYPE III – DIVERSE – IN ORGANISATIONAL ROUTINES

That there could be diversity in organisational routines has also been noted in the literature (c.f. Pentland, Haerem and Hillison 2009; Pentland 1992; Pentland 2003a, 2003b). This thesis continues to support this, although the multi-level analysis has added some clarity in terms of how a routine can both be stable and heterogeneous at the same time.

Diversity at the pattern of action level

As has already been discussed, the overall pattern of action does not change or vary over time. This is important in terms of the definition of a routine as a 'repetitive pattern of action' (Becker 2004), as the pattern of action needs to be the same repeatedly, in order for an organisational activity to be considered 'routine'.

Diversity at the variant level

As noted above, variety in the variants of the organisational routines has already been well demonstrated, particularly in the various works of Pentland. However, given that routines should be examined in the specific, not in the abstract (Pentland 2011), demonstrating variety in the specific routine of procurement, only goes to strengthen the evidence that routines exhibit variety in a number of different contexts. In addition to the database which recorded the individual performances, I was able to see the project files which contained all of the correspondence, the tendering document and the contractual information. Again these artefacts underscored the heterogeneity of variants in the procurement process.

Diversity at the option level

As variants of the routine are comprised of sub-routine options, then if there is diversity in the number of variants of the routine, then there will be diversity in the number of sub-routine options. While this has been demonstrated in other studies, the multi-case study approach has shown that different cases used different sub-routine options, and therefore different variants of the routine.

At both the variant and sub-routine option level, there is a heterogeneity of variants. This supports other researchers who have also found variety in organisational routines (Pentland, Haerem and Hillison 2009; Pentland 1992; Pentland 1995). However, as noted in section 6.1.2, amidst this variety there is also stability at both the variant as well as the option level. This complicates notions of heterogeneity, as simplistic understanding of routines as being stable, heterogeneous or adaptive no longer hold. As discussed in the next section, all can co-exist at the same time.

6.1.4 TYPE IV – DYNAMIC – IN ORGANISATIONAL ROUTINES

As has been discussed already, the notion that there is variation and adaptation in organisational routines is not new. However, this thesis has demonstrated that routines can exhibit both variety and adaptation. In other words, routines can exhibit not just change over time (adaptation) or variety (diversity at a single time), but can also exhibit dynamic variety – both variety and change over time.

For example, Feldman's (2000) examination of budgeting routines involves analysis of a single routine which changes over time. In most organisations, budgeting is something which occurs once a year, so while change over time can be readily studied, there would seem to be little likelihood that there is concurrent variety (more than one variant in use at the same time) in budgeting routines. Likewise in the analysis of call centre routines (Pentland 2003b) there would be evidence of concurrent variety (variants) of organisational routines (Pentland and Feldman 2005) but as the data

is cross sectional, there is little chance of observing change over time. Consequently, the demonstration of diversity and variety requires a longitudinal, multi-level analysis.

In summary, all four types of variety have been demonstrated as existing in a specific example of organisational routines. There are thus methodological implications from this study for the examination of stability, variety and adaptation in organisational routines.

The main theoretical implications concerning dynamic variety, relates to notions of organisational capability.

6.1.5 THEORETICAL IMPLICATIONS ARISING FROM DYNAMIC VARIETY

That routines might be essential to organisational capability is one which has been long posited in the academic literature (e.g. Teece, Pisano and Shuen 1997), and leading authors have recently called for this relationship to be more extensively explored empirically (Pentland 2011; Vergne and Durand 2011). The findings of this thesis enable this to be extended in two ways.

Firstly, in the case studies, certain sub-routine options would not be selected in specific cases, as specific expertise was needed for their successful completion (see Section 4.5.2 and Section 4.7.2). Put simply, while routines provide capability for organisations, internal capability is also required in order to select certain routines. This speaks against simplistic notions of routines as capabilities of the firm, and suggests a more complex relationship.

A routine, which some authors claim is an organisational capability (Teece, Pisano and Shuen 1997), which happens to lack the resources needed to implement it, is at best potential capability not an enacted capability. Thus it is worth identifying what could be considered a potential capability - which is stored in the organisational memory, or the ostensive element of the routine, which cannot be enacted due to a lack of human resources in the firm. The shift from the ostensive to the performative, or from the potential to the enacted capability, is thus not just a question of decision making, or memory but also of resources. This non-linear relationship between routines and organisational capability warrants further study in later research.

The second relationship where these findings extend our understanding is in relations to dynamic capabilities (Teece and Pisano 1994; Teece, Pisano and Shuen 1997). Routines are held to be foundational to organisational capabilities (Winter 2000), and have been viewed through a similar theoretical framework based on Campbell (Zollo and Winter 2002). However, the view in much of this literature sees routines as static and relatively unchanging. If routines are not just stable, but can

change (Feldman 2000, 2003), and exhibit heterogeneity (Pentland 2003b), or even exhibit dynamic change (as has been found with procurement routines) this suggests some amendments to this theoretical understanding. If routines change, exhibit heterogeneity and yet can also be stable at the same time, then this suggests organisations can respond to their external environment in different ways. Stability can reduce transaction costs (Williamson 1985), as routine ways of operating, can enable the reduction in complexity related to decision making (Egidi 1996; Hodgson and Knudsen 2004). However, heterogeneity in routines enables firms to respond to complex tasks, (Becker 2005b) or to respond to complexity in the external environment (Boisot and Child 1999).

As noted in the findings, routines are not just stable, or heterogeneous or capable of change – all of these properties can co-exist. Thus it makes perfect sense for an organisation to have a stable variant of a routine – a preferred standard operating procedure. However, whenever a slightly different task resents itself, or when changes in the external environment demand it, alternative variants can be chosen, or new ones developed either through recombination or through adaptation. Like individuals, organisations could well have their preferences based on experience which show there is a variant which provides responses which are adequate (Winter 2000). However, organisations are pragmatic enough to respond to change in the internal or external environment in order to choose a variant which best needs a particular situation.

6.1.6 METHODOLOGICAL ISSUES CONCERNING THE ANALYSIS OF STABILITY, ADAPTATION AND VARIETY IN ORGANISATIONAL ROUTINES

The study has established that all four types of variety exist in a specific example of an organisational routine, although there are differences depending on the level of analysis. Thus the level of analysis may make a difference in terms of determining variety in organisational routines. For example, viewing procurement routines at the top level would result in a view that there is little change over time, or adaptation, as the overall pattern is stable over time. Even at the variant level, the cases showed that there were a number of dominant variants of a routine (typically around the procurement of a particular type of asset), and at the options level specific sub-routines (such as RFO/Tender) which became constants in certain case studies.

Consequently, if a researcher were to use this data set, but only examine the overall pattern of procurement, or the purchasing of a specific asset (say Asset 1), or if they were to focus just on the tender method in either Alpha, Beta or Gama cases between 2005 and 2009, they would logically conclude that there was stability over time. This is because in each of these instances there is no adaptation or variety.

Thus the determination of whether variety exists in organisational routines is likely to be due to the level of analysis involved, as well as whether cross sectional or longitudinal analysis has been

undertaken. Even in this data set, it is only because a longitudinal, multi-level multi-case analysis using multiple methods has been undertaken, that such fine grained analysis has been possible.

In order to structure further discussion of the methodological issues involved, please consider Table 90 below.

Table 90 – Evaluation of methodological issues in relation to variation in organisational routines

	Qualitative	Quantitative	Cross Sectional	Longitudinal
Stable	✓ (ostensive)	✓ (performative)	✗	✓
Adaptive	✓ (ostensive)	✓ (performative)	✗	✓
Diverse	✓ (ostensive)	✓ (performative)	✓	✓
Dynamic	✓ (ostensive)	✓ (performative)	✗	✓

Consider the work of Feldman (2000, 2003; 2004). In each of Feldman’s studies there is evidence of adaptation over time, as the methodology is a qualitative longitudinal analysis. Howard-Grenville (2005) also undertook longitudinal qualitative analysis and found stability over time. Consequently, in order to see adaptation or stability, then longitudinal analysis is essential.

In comparison, consider the work of Pentland (2009; 1992, 1999a; 2003a, 2003b) who used predominantly quantitative measures, particularly computer records. With cross sectional data, the demonstration of variety is possible, particularly if quantitative data is available, such as with data bases, but the ability to demonstrate that a routine is stable, adaptive or dynamic would not appear possible. Conversely, while variety can be demonstrated through qualitative research, it is easier to demonstrate variety when quantitative data is available

In this respect data access for this thesis has been very fortuitous, particularly in being given access to 10 years of records of the procurement process, which have been able to demonstrate change over time, together with qualitative interviews which can provide explanation about why such change has occurred. Having access to the database, which as an artefact recorded the performance of the routines over time, enabled the checking of interview data for accuracy, and the longitudinal analysis. Additionally, the longitudinal, multi-level, multi-case analysis using multiple sources of data has been able to demonstrate stability, adaptation, variety and dynamics all at the same time.

In conclusion, it is possible that some of the discussion in the literature about adaptation, stability, and variety in organisational change is due to either methodological or level of analysis issues. It is not my intention to advocate that every research design follow the one set out in this thesis.

However it is my contention that methodological and level of analysis issues should be considered and where appropriate acknowledged in terms of the possible limitations that the method, or level

of analysis may cause in the analysis of adaptation, variety, stability and dynamic change in organisational routines.

Having considered various types of variety, and the related level of analysis issues, the specific roles that selection, adaptation and retention play in organisational routines can now be considered.

6.2 INDIVIDUAL CONTRIBUTION OF SELECTION, ADAPTATION AND RETENTION TO VARIETY IN ORGANISATIONAL ROUTINES

Throughout the thesis, the role of selection, adaptation and retention in relation to variety in organisational routines has been examined. Each of these is examined in turn.

6.2.1 SELECTION AND VARIETY IN ORGANISATIONAL ROUTINES

As is outlined in the theory chapter, selection was held to be a process of choosing between alternatives, and Campbell (1965) indeed argued that selection is a deliberate process of choice between various alternatives. Pentland and Feldman (2005) term these alternatives a ‘repertoire’. Consequently, “selection assumes variation” (Van de Ven 1992, 180), and “variations provide adequate raw materials for selective systems to operate on” (Campbell 1965, 28). Thus in order for there to be selection there needs to be variety. This is because in order to exercise choice between alternatives, requires firstly that there are a number of alternatives to choose from.

As with the previous section, how selection operates at each of the various levels of analysis will be considered.

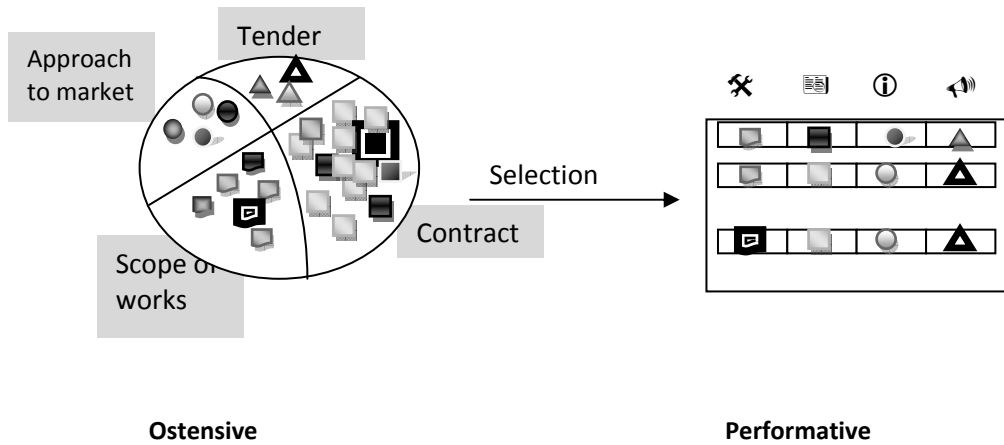
Selection and variety at the pattern level

In each case, there was a pattern of sub-routines: approach to Market → Contract → Tender → Approach to Market, and there was no variety evident here across the cases. Instead variety was demonstrated at the variant level.

Selection and variety at the variant level and at the option level

As noted in Section 6.1.1, within each of the sub-routines, there were a set of options available for selection. Specific variants were created through the selection of a combination of options, one from each sub-routine. This finding supports the contention of other authors, such as Pentland and Feldman (2005), who specifically argue routines are created by organisations out of a repertoire of possibilities. This is perhaps best illustrated by way of a diagram (see Figure 52 below):

Figure 52 – The process of selection, and how it creates variety in organisational routines



The overall pattern for action is depicted by the circle on the left hand side of Figure 52. The circle is in quarters as there are four sub-routines which make up the overall pattern of action, and all four are needed in order to complete the routine (Scope of works, Contract, Tender, Approach to Market). Within each sub-routine, there are a set of options available. For example, within Tender, these were RFO/Tender, Registration → Tender and EOI/RFI → Tender, represented by triangles. One of these options, such as RFO/Tender is selected, along with a single option from every other quadrant. All four options together make up a particular variant of the routine represented by the line of boxes on the right hand side of Figure 52. The diagram thus embeds the multilevel view of routines, as it depicts the overall pattern (the circle with quadrants), the options (the symbols within each quadrant), and the variants which are selected from these options (the particular combinations of symbols on the right hand side of the diagram).

By elaborating on the multilevel nature of routines, this diagram also enables the resolution of a particular theoretical conundrum: that while selection requires variety to operate (Van de Ven 1992, 180), it also creates varieties through recombination (Aldrich et al. 2008). The answer, without resorting to some recursive argument, is that there is an overall pattern of action which tends not to change. However, within each sub-routine that makes up the overall pattern, there are a set of options available for selection (the left hand side of Figure 52). Thus there is choice for selection to operate on. However, the selection of a particular combination of options from each quadrant of the circle creates a particular variety of the routine. Moreover the recombination of these options in different ways, creates diverse variants of routines (the right hand side of Figure 52).

While much of this understanding comes from observations and analysis of the database, it is also reflected in the interviews. In Section 4.5.2, for example, the interviews made clear that decisions were made about how to approach the market, how to tender, which contract to use, and what it was that was being contracted. In the words of an interviewee

“All those combinations, you need to choose one of each of those and then come up with the final thing” [Interview 13]

Figure 52 also allows for the different elements of a routine: the ostensive and the performative. While not shown in this figure, the individual performances were recorded in the database, which of course provided evidence of the artefact element of the routine.

Thus, through recombination of the options available in the repertoire, selection creates numbers of different varieties of the routine. However, as noted in Section 6.1.1, repeated selection of the same variant of the routine can also create stability at the variant level. While Figure 52 shows the creation of multiple variants of the routine, the same mechanism would also create stable variants. The key difference is that instead of choosing multiple variants from the repertoire, only a single variant is chosen.

Selection and the ostensive and the performative elements of the routine.

Consider the issue of the ostensive element of the routine in terms of what is actually selected. When decisions are being made about which tender option to pursue, or which contract to use, interviewees were asked to reflect back on specific instances, and explain why they chose a particular option. In each case, selection was made before implementation. While this seems an obvious point, it becomes evident that selection occurs from the ostensive element of the routine. In other words, when making a selection from a range of options, these options are from the ostensive understanding of the routine. Having selected a particular combination of subroutine options from the ostensive element of the routine, this is then implemented, and recorded in the database (the artefact).

In terms of the relationship between selection and path-dependence and satisficing, there is support for satisficing, but less support for path-dependence. There is little evidence of path-dependence, apart from the dominant variant of the routine in each case, or the overall pattern of the routine. The sheer heterogeneity and adaptation which has been observed, does not support a path-dependant view. Instead the more complex relationship outlined in Section 6.1.5 between dominant variants as ‘standard operating procedures’ and the complexity absorption response provided by heterogeneity problematises simplistic notions of path-dependence. It is possible that this is due to the considerable innovation and review pressure that the organisation was under when undertaken the study. I strongly suspect that if the study had happened 8 years earlier, the picture would have

predominantly been of a stable operating system, and very little change particularly in the ostensive element of the routine.

In terms of satisficing, there is considerable evidence that often procurement had to be ‘good enough’ rather than optimal, however unpalatable that may have been for the organisation. For example, open tendering is the preferred method of tendering, and this became the sole approach for the Alpha case study. However for the Beta case study, lack of external suppliers led to increased use of closed tendering and sole invitee. The clear preference in the organisation was to use open tendering to drive prices down, but the lack of competition in the external environment led to a pragmatic decision to use alternative methods.

Consequently the initial concept of change advanced in the theory chapter, does not adequately capture this understanding of selection, as it fails to take into account the multiple levels of analysis, nor the ostensive and performative elements of the routine.

Having considered selection in relation to variety, the next section considers adaptation.

6.2.2 ADAPTATION AND VARIETY IN ORGANISATIONAL ROUTINES

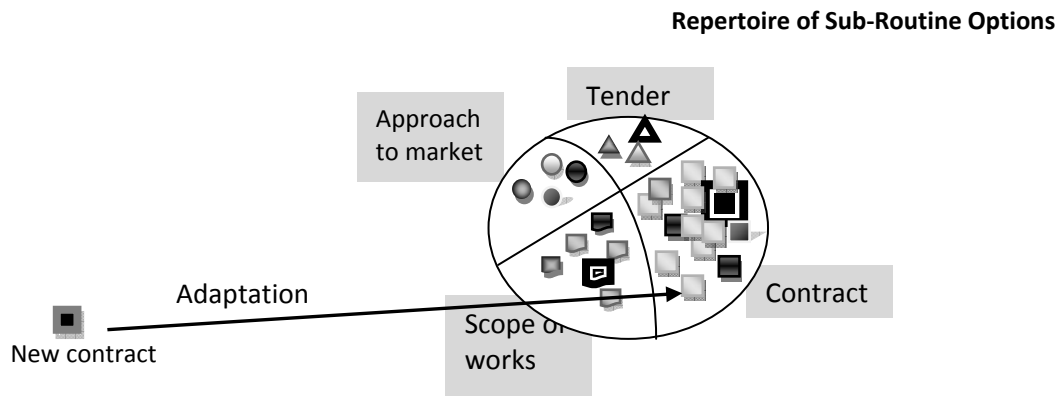
A fundamental understanding of evolutionary economic theory, is that variation is driven either by recombination or by mutation (Aldrich et al. 2008) (which I have termed throughout the thesis as adaptation). As already noted, selection creates variety by the recombination of the repertoire of sub-routine options into multiple combinations. This has been addressed throughout the thesis as a function of selection. In contrast, adaptation involves the generation of new ways of operating (Winter 1975, 102). As Feldman (2000, 613) argues “change is more than choosing among a repertoire of responses”.

In other words adaptation is different from recombination, even if both result in a new variant of a routine. This is because adaptation *increases* the repertoire of options available for selection. Gersick and Hackman (1990, 85) argue that if an organisation realises its routines are insufficient for its needs, they might establish a more “generous repertoire of alternatives”. While their discussion is focused on individual versus group sources of innovation, the notion that adaptation increases the repertoire of alternatives on which selection can act is supported through this thesis.

While much of the literature has focused on adaptation at the level of the routine, adaptation can also occur at the sub-routine level (Nelson and Winter 1982, 130 -131). In fact little support has been found for the notion of adaptation at the entire variant level. Instead adaptation has revolved

around the introduction of new sub-routine options. Thus the cases support the understanding that adaptation increases the repertoire of sub-routine options available for selection. Again, this is easier to demonstrate via a diagram (see Figure 53 below).

Figure 53 – How Adaptation increases variety in the repertoire of sub-routines



Ostensive

As outlined in each of the cases, adaptation involved the introduction of a new option (such as a new form of contract) into the repertoire of sub-routines.

The routines literature has already outlined how organisations seek to steadily improve their routines over time, through learning from experience (March 2008a, 2008b).

Figure 53 shows this adaptation by adding a new sub-routine to the repertoire of sub-routines, and therefore provides a new option available for selection²⁵. Examples for this in the cases include the introduction of Alliances contract (Section 4.8.3 in the Delta Case Study) or Construction Management (Section 4.5.3 in the Alpha Case Study).

While the routines literature is replete with examples of learning from experience (c.f. Feldman 2000), both of the examples cited in the previous paragraph, happened *before* performance. In other words, when making a choice about which contract to use, none of the existing repertoire of contracts were considerable able to address the needs of the organisation for a particular situation. Consequently new options were introduced.

²⁵ If a previous option was not performing adequately then this would presumably be ‘forgotten’, and the new and improved option would be the one carried forward by the organisation

The suggestion from Gersick and Hackman (1990) that organisations could look at their existing routines, and create new options if the current set was insufficient, thus finds empirical support from the case studies. Thus adaptation involves not just a retrospective learning from experience, but also a determination that the current set of options is insufficient and new ones are needed.

Thus adaptation increases the overall number of sub-routines available for selection. As selection involves choosing from the repertoire of sub-routines, increasing the number of options in the repertoire increases the potential number of variants which can be created.

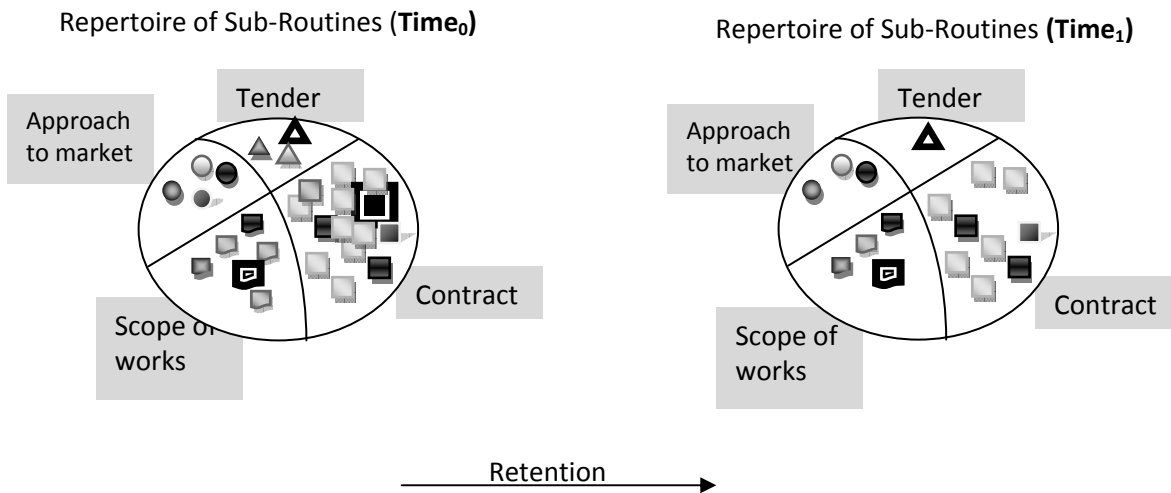
Consequently the initial understanding of change advanced in the theory chapter does not adequately capture this understanding of adaptation occurring before selection, as the model assumes adaptation occurs only after the selected variant has been performed. This has been shown in the exponential relationship between the number of sub-routine options and the number of variants of the routine in the cross case analysis (see Figure 51). The more options there are, the more variants there are.

6.2.3 RETENTION AND VARIETY IN ORGANISATIONAL ROUTINES

There is a consensus in the organisational routines literature that there retention involves organisational memory (Miner, Ciuchta and Gong 2008). In each of the cases evidence was found that there was retention of sub-routine options in use over time. However, there was also evidence of the discontinuation of sub-routines over time. Additionally there was evidence of sub-routines being implemented in time Period One (2000 to 2004), then not being used in Period Two (2005 to 2006) and then being used again in Period Three (2007 to 2009) (see Section 5.4). Thus the sub-routine option was retained in organisational memory and used again. This provides evidence of retention forming part of organisational memory.

However, as the Pareto curves showed, a number of variants of the routine were only implemented once or twice. Campbell (1965, 1974) predicted that there would need to be a large number of trial and error attempts to identify routines which worked or didn't work. In other words that amidst the variety there is likely to be a large number of routines which were only implemented once or twice (Romanelli 1999). Thus the long tail on the Pareto curves is not information which should be ignored, but in fact is important evidence of combinations of sub-routine options which have been trialled but may not be used again. However, there is stronger evidence that retention operates primarily at the sub-routine level. Again this is easier to explain using a visual representation (see Figure 54 below).

Figure 54 – How retention affects variety in organisational routines



Ostensive (Time₀)

Ostensive (Time₁)

Figure 54 portrays the process of keeping, and not keeping, sub-routine options available for selection. On the left hand side, is the repertoire of sub-routine options available at Time Period 0 (T_0). On the right hand side, is a representation of the repertoire of sub-routine options available for selection in Time Period 1 (T_1).

As can be seen by comparing T_0 with T_1 , a number of options have not been retained. Take for example the Tender options. In T_0 there are three options, while in T_1 there is only one option available. This of course, reflects the actual scenario in Alpha, where in Time Period 2 (2005 to 2006) and Time Period 3 (2007 to 2009) only RFO/Tender was used.

As retention involves organisational memory, routines cannot just be remembered, they can also be forgotten (Argote 1999; Hedberg 1981). Having implemented a routine, organisations tend to follow some process of evaluation. Where a particular option has not performed adequately, this can be forgotten or discarded, and therefore is no longer available for use in the repertoire of options. Alternatively there could be legislative or policy changes which affect the ability to implement a particular option, regardless of its perceived performance.

As suggested in the literature review, without removing specific sub routine options from the repertoire, and assuming there is the regular introduction of new sub-routine options into the repertoire over time, there would be a steady increase in the number of options over time. Likewise,

as Denrell and March (2008) note, certain options could be retained in the repertoire, even if they were not performing well, due to the considerable 'buy in' from organisational members. It is also important to distinguish between 'forgetting' and 'not-using' (Argote 1999) as a number of cases provided evidence of the use of various options after an absence of a couple of years. In these cases, the option had continued to be available to the organisation, but presumably the suitable opportunity for its use had not presented itself.

Thus while previous studies have acknowledged the performative, ostensive and artefacts in routines, there is a theoretical contribution made here about the relationship between the dynamics of selection, adaptation and retention and how these relate to the elements of the routines: ostensive, performative and artefacts.

The other aspect to consider is in relation to the ostensive and the performative. In terms of retention, it is the performative which is retained. This can be logically deduced. Having completed a particular procurement project, an organisation determines to keep using a particular form of contract. In the language of this section, the contract option is retained. However this retention occurs in the ostensive. While the implemented contract will be copied, archived, and possibly used as a template for future contracts, the performance is finished. What is retained is an understanding about the contract, that it worked, and in what situations it would be appropriate to use again. Thus retention, as part of organisational memory, occurs in the ostensive element of the routine.

Having considered selection, adaptation and retention as individual phenomena, how they act in combination will be considered next.

6.2.4 COMBINED CONTRIBUTION OF SELECTION-ADAPTATION-RETENTION TO VARIETY IN ORGANISATIONAL ROUTINES

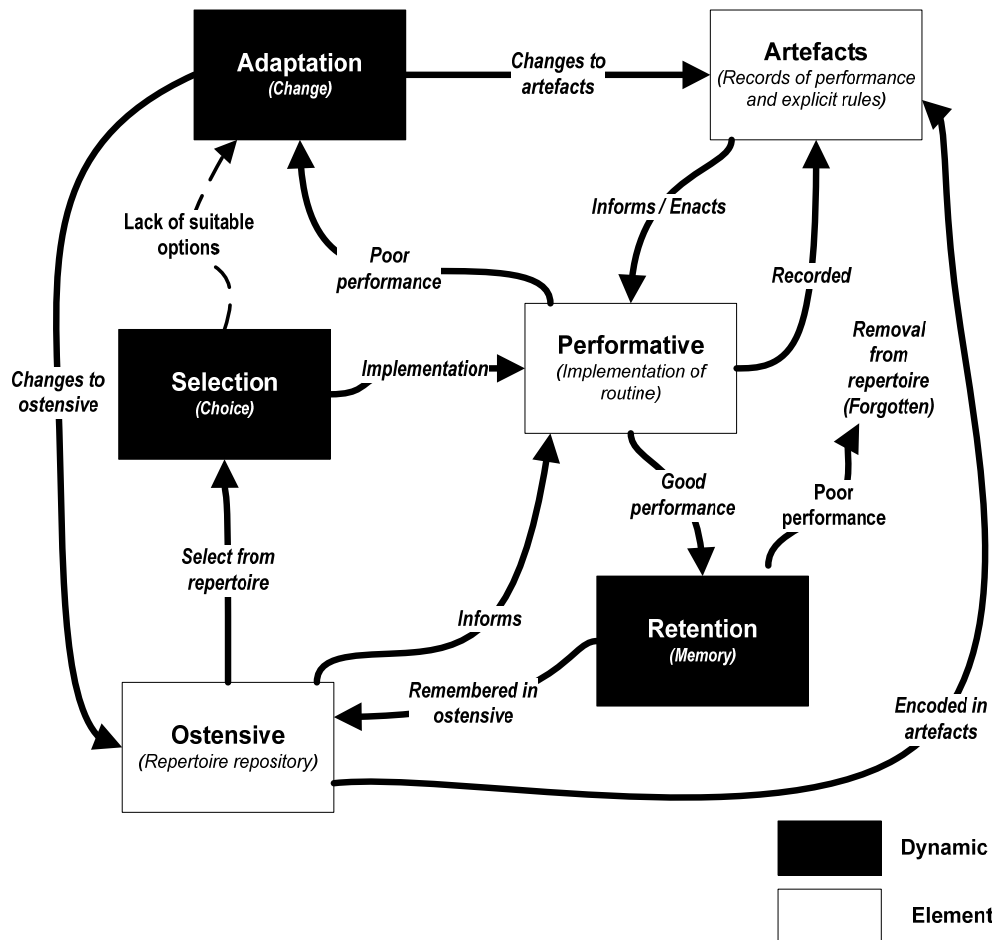
As noted in the sections above, routines are multilevel phenomena which consist of a pattern of action. There are a number of choices for each sub-routine, which is termed the repertoire of action. Variants are unique combinations of sub-routine options. As has been shown, while there is considerable variety in organisational routines, there is also stability at both the pattern of action level and also at the variant level.

As discussed in the sections above, the initial theoretical review outlined how selection, adaptation and retention might affect variety from the existing theoretical literature. However, this did not take into account sufficiently the ostensive, performative and artefacts – the various elements of the routine. Additionally while including selection, adaptation and retention, this did not adequately

address how these dynamics of a routine might affect variety, based on the evidence in the case studies. Moreover, the model does not adequately address how the dynamics and the elements of routines interact.

Drawing the discussion together, it is possible to advance a representation of how variety is created through the selection-adaptation-retention dynamic in organisational routines, which also takes into account the elements of the routine (see Figure 55 below).

Figure 55 – Selection, adaptation and retention dynamics in relation to the elements of organisational routines



This diagram depicts the interaction between the elements of a routine (the ostensive, performative and artefact) with the dynamics of a routine (selection, adaptation and retention) which has been outlined in the pages earlier. As can be seen there is a complex and dynamic interaction between each of these. The following discussion will focus on the dynamics of routines, but elaborate how these interact with the elements of the routine and the other dynamics.

Selection

As set out in Figure 54, selection chooses from the repertoire of options a particular variant of the routine. This variant is chosen from the ostensive element of the routine – the repertoire of possible

‘in principle’ actions. Selection creates variety in the performative element of the routine (not the ostensive) by combining various options together. This understanding is quite close to that set out in theory section, as selection occurs from the ostensive element of the routine.

Adaptation

Adaptation has typically been noted to follow the performance of the routine, with poor performing routines adapted in order to improve their performance. However, as noted in the cases and summarised in Figure 54, it was also possible that adaptation follows selection, as there was not an appropriate option of the routine to select. In both these cases, adaptation increased the ostensive options which can be selected for implementation. Note this is different however from the that advanced in the theory section, as adaptation does not always automatically follow from implementation in the performative. In other words, adaptation is not always retrospective, but can also be prospective.

Retention

Following implementation, an evaluation of the performance of the routine is undertaken. As noted earlier, poor performance leads to adaptation in order to improve the functioning of the routine. Two other options are possible however. As Figure 54 details, good, or at least acceptable, performance can lead to the retention of the routine in organisational memory (the ostensive element of the routine). Poor performance, can lead to a decision not to implement or even to ‘forget’ the routine. While the notion of forgetting is not new, how this relates to selection and adaptation, together with the ostensive and performative and artefacts, does extend our understanding of the dynamics of routines.

Ostensive, performative and artefacts

Considerable evidence has been found to support the notion that routines have an ostensive and performative element. Particularly once the discussion moves to what is being selected, adapted and retained, this multilevel phenomena becomes quite clear. In particular, the importance of three elements, three dynamics of the routine, and how they interact, have been shown throughout the thesis, and are summarised in Figure 54.

There is a clear theoretical understanding of a particular set of options which can be selected (the ostensive repertoire). These options, when combined, create specific variants of the routine. Additionally, while artefacts certainly record the performance, and also encode elements of the ostensive (Pentland and Feldman 2005, 2008), artefacts also *enable* the performance of routines. It

is very difficult to imaging procurement without tender documents and contracts. The database too, while recording the routine as implemented, also enabled the routine, as the sequencing of the database followed the overall pattern of the routine. The contracts, in addition to encoding the ostensive element, also where involved in the implementation as the contract specifies the relationship between Premium Projects and whichever organisation was performing the contract.

As summarised in Figure 54, this thesis has extended our knowledge of the complex interrelated dynamics of selection which create variety in organisational routines, and how these relate to the elements of the routines themselves. Selection makes choices from the repertoire of options available in the ostensive element of the routine. Adaptation introduces new options into the repertoire, either revising existing options, or introducing something completely new prior to implementation. Following the performance of the routine, retention involves a decision about whether to keep an option in organisational memory, or whether to forget the option, and ensure that it is not used in future. All of these dynamics interact with the various elements of a routine.

Evolutionary approach to change in organisational routines

A number of authors have argued for a literal *natural selection* approach to change in organisational routines (Felin and Foss 2011; Freudenburg 1986; Hodgson 2001; Hodgson and Knudsen 2006; Knudsen 2002; Knudsen 2008). An alternative approach was proposed in the literature review which posited that evolution should be viewed as analogy to change in organisations (Morgan 1997), and a theoretical understanding of changed derived from the work of Campbell (1965, 1974). The model advanced in the previous section, developed from the case study findings, is a clear contribution to theory which advances out understanding of the inter-relationship between the elements and the dynamics of the routine. This contribution also has wider implications for theory.

One of the key challenges to the notion of *natural selection* is the role of agency in organisations. Put simply organisations are not at the mercy of their environment (Morgan 1997), but can in fact influence that external environment, or at least exercise choice in how to respond to that environment. As noted in the literature review, Knudsen (2002) argued that the knowledge, experience, and interaction between staff influence the choices made in relation to organisational routines. As intentional change in systems is the result of human intelligence and agency (Witt 2008), agents may identify a better solution, make a mistake, or be forced to change due to regulatory changes (Romanelli 1999). This research found that choices were certainly made by individuals individually and in concert, and that and adaptation of new sub-routines options was often instigated through the introduction of new people into the organisation (see for example Section 4.5.2). Agents are therefore key to selection, adaptation and retention in organisational routines.

6.3 CONCLUSION

Routines have been defined as “recurrent interaction patterns, involving multiple actors working to achieve a particular outcome” (Becker 2004, 645) for an organisation. While there are many worthy research topics in relation to organisational routines, this thesis aimed to explore the causes of variety in organisational routines. This is because the existence and cause of variety is one of the key questions currently facing social research (Aldrich et al. 2008), and the dynamics which cause stability or change in organisational routines is a topical and important empirical research topic.

6.3.1 METHODOLOGICAL AND THEORETICAL CONTRIBUTIONS OF THE THESIS

Initially, a framework for analysing variety in the context of organisational routines needed to be developed. To this end a typology of variety in organisational routines was advanced in the theory chapter (Figure 4). Routines have been found to exhibit four types of variety by researchers: Type I – where the routine is stable over time; Type II – where a routine changes over time; Type III – where a routine exists in a diversity of forms; and Type IV – where the routine is both diverse and also adapts over time. This typology proved very fruitful as an analytical device for examining different types of variety in organisational routines. Having developed a way of determining different types of variety, the causes of different types of variety can be examined.

Campbell (1965) argued that evolutionary understandings of selection, adaptation and retention were applicable in organisational contexts. Indeed Campbell’s theories are the primary theoretical foundation for evolutionary change in organisational theory (Romanelli 1999). A detailed exposition of how selection, adaptation and retention, individually and in concert, might affect variety was examined in the theory chapter. Based on this review, a set of research questions were developed, and a theoretical understanding developed concerning how selection, adaptation and retention might create variety in organisational routines.

Methodologically, a longitudinal, multi-level, multi-case analysis was been undertaken, using multiple data sources, in order to investigate selection-adaptation-retention dynamics and how these affected variety in routines. The context for this study was a large multi-division engineering asset intensive organisation, and the routine examined was procurement.

Four types of Variety Co-exit

The research provided a number of methodological and theoretical contributions. Firstly, while other research has tended to find only one or at the most two forms of variety, the multi-level longitudinal analysis showed that all four types of variety existed across all the cases. To the best of my knowledge this finding is novel. Moreover, this variety became even more exaggerated when a multi-level analysis was deployed. This showed that at the top level of the pattern of a routine, there was stability; at the variant level, heterogeneity, adaptation and stability; and at the option level, adaptation, heterogeneity and stability. This has strong implications for research design into routines and the consequent conclusions drawn about the different types of variety in organisational routines. Specifically, certain types of research design are better suited to examining different types of variety than others. In order to explore the richness of routines, a multilevel, longitudinal design seems imperative.

Multiple Forms of Variety Complicates Our Understanding of Routines

Secondly, if a single routine can be both stable, varied and adaptive at the same time, this complicates other research to date. Essentially those who argued that routines were adaptive were right, as were those who argued that routines are heterogeneous or stable. The existence of dynamic variety suggests that stability and heterogeneity are properties on a continuum, rather than a specific state.

Amidst variety there can be stability

Thirdly, the notion of stability amidst variety is novel. This suggests that organisations can indeed develop standard operating procedures, while also developing heterogeneity in the variants in order to cope with internal or external complexity.

Capability is needed to enact Routines

Fourthly, while routines are held to be essential to organisational capability, organisational capability is also required in order to enact a routine. Thus this suggests that there are potential capabilities as opposed to enacted capabilities within a firm.

Path dependence and satisficing in routines

Fifthly, there is little evidence of path dependence due to the large amount of variety observed, although this is likely to be due to the stage that the research was undertaken, or possibly the routine being examined. There is support for satisficing in decision making however, as better options were available for an organisation, however these could not be implemented due to the external environment.

Metaphorical approach to evolutionary change has been validated

Sixthly, a theoretical approach which drew on evolutionary metaphors, rather than a literal *natural selection* view, has been advanced and tested. This proved robust in its explanatory power for understanding how variety is created in organisational routines.

Specifically, selection has been shown to affect variety in two different ways: recombination of sub-routine options increases variety, while recurrent selection of the same variant reduces variety. Adaptation increases variety through the introduction of new sub-routine options, and increasing the options increases number of variants of the routine. Retention increases, or decreases variety by making choices about how many sub-routine options to keep in organisational memory. Moreover selection, adaptation and retention are seen to occur primarily in the ostensive aspect of the routine, although once selected from the ostensive, the routine variant is performed.

A dynamic model of how variety is created has been advanced

Seventhly, this led to the development of dynamic model has been advanced that captures the dynamic process of the creation of variety, and also which takes into account the multifaceted nature of organisational routines (Figure 54). This model shows the inter-relationship between the dynamics of a routine (selection, adaptation and retention) and the elements of a routine (ostensive, performative and artefact). This is a novel contribution which has drawn together these two threads of the routines literature and empirically demonstrated their relationships.

Thus the thesis makes a series of methodological and theoretical contributions which improves the understanding of organisational routines. Methodologically, the strength of the longitudinal multi-level, multi case analysis resulted in a clear understanding of variety in organisational routines. The multi case analysis also enabled a better understanding of the dynamics of organisational routines, particularly how they are selected, adapted and retained. Moreover a dynamic model of how these dynamics create stability, variety and change in organisational routines has been advanced which clarifies how routines can be stable, diverse, adaptive and dynamic, and thus achieves the original research aim.

Taken together, this amounts to a solid advancement of our understanding of organisational routines. While grounded in the existing literature, the findings confirm, extend and clarify previous empirical studies of organisational routines as well as show the relationship between the dynamics and elements of organisational routines for the first time.

6.4 DELIMITATIONS AND FUTURE RESEARCH

Within each research project there is a practical limit to what can be considered and examined. Given the complexity inherent in the existing study, there are a number of important research areas which were worthy of examination, but could not be undertaken due to the scope of the main research questions. In particular the issues of agency and organisational capability are worth mentioning.

Agency is an important aspect of organisational life. However, so is the external environment. Considerable work has been undertaken in the evolutionary economic literature on the impact that the environment has on organisational routines, which has had different levels of support in this thesis. However, the relationship between agency and environment (Furneaux 2011), or agency and structure (Mestan, Scutella and Allen Consulting Group 2007; Productivity Commission 2010) warrants further examination. Questions arising from this perspective include: Just how free are individuals to choose? What is the role of hierarchy, as opposed to front line, in decision making?

In terms of capability, there is an opportunity to further explore the relationship between routines and capabilities. The capabilities perspective tends to view routines as a 'black box', focussing instead on how routines enable the achievement of organisational goals (Johnson and Onwuegbuzie 2004). Theoretical questions which arise from this literature, and the findings of this thesis would include the following: When are routines constrained by lack of capability, and when are capabilities restricted by routines? Additionally, while the focus of the capabilities perspective on routines has not been on the dynamic process, but on outcomes, (Johnson and Onwuegbuzie 2004), a question still exists as to whether selection, adaptation and retention impacts organisational capability, as some have suggested (Zollo and Winter 2002)?

In terms of organisational learning, there is much yet to be understood in terms of the ostensive element of the routine. For instance, how is tacit knowledge encoded in the routine? How does notions of the performative and the ostensive elements of a routine, be reconciled with a the social construction of knowledge (Berger and Luckman 1996).

Finally, the methodological approach has born considerable fruit in the findings. Applying the same methodology (longitudinal multilevel analysis) to alternative research contexts would be fruitful. For example, the analysis of multiple routines in a single organisation, or the same routine in different organisations would be a logical extension of existing work.

APPENDICES

7) APPENDICES

7.1 APPENDIX A – SEMI STRUCTURED RESEARCH QUESTIONS

Semi-Structured Interview Questions Protocol
Good morning / afternoon – how are you? (Introduce self, sign consent form)
Can you please tell me a bit about yourself and your role in the organisation generally
Overview of procurement process - RQ 1 variety
Tell me about a typical recent procurement project in which you were involved? Can you talk me through the various stages of the process?
In any project there are a number of important factors, drivers which need to be considered. Can you outline the factors / drivers / rules / objectives which informed that specific procurement process?
Can you tell me about another incident, different to the first one? What process was followed for this procurement project? What were the factors / drivers / rules / objectives which informed this second specific procurement process?
Documents which inform decision making (looking for ostensive, and artefacts)
Are there any policy documents, regulations, rules of thumb, manuals which inform your procurement decisions? (artefacts) What records do you keep of the project?
Factors which influence decision making - RQ 1 variety
In these examples you have given, there seem to be a range of options, in both the process and also the drivers or factors which influence each project. Can you discuss the variations possible in a procurement process? Can you discuss the various factors which need to be considered in a procurement process? Variability in the type of asset or service being purchased makes sense. How did the different procurement arrangements come about? Is there any part of the process, or other factors, which affect the outcome of procurement more than the others?
RQ 2 - Selection
Thinking again about one of the procurement project you just described. Why did you select these options and not others? What factors influence these choices? Can you think of a time when these is an exception to these factors?
RQ 3 - Adaptation
Tell me about a recent procurement event, when an innovation was attempted What was the main reason for attempting this innovation? Where did the idea for the change come from? How does this change relate to other changes in the organisation?
RQ4 - Retention
Thinking back through the options available in procurement, are there some options used more than others? Why are these used more than others? Has the use of these options changed over time? What would need to happen for you to not use that arrangement again?
Is there someone else who is experienced in the procurement area in your division that I might talk to?
Thank you for your time

7.2 APPENDIX B - PROCESS FOR VERIFICATION OF TRANSCRIPTION ACCURACY

As the transcription work was undertaken by a professional transcriber, a random check of the quality of audio transcription to text was undertaken by myself, in order to ensure the accuracy of the transcriptions. 20% of the length of each audio file was checked. The starting point for each check was randomised. The process is detailed below:

Firstly, 20% of the total length of the audio file was calculated.

Let χ = the total length of the audio file. Let γ = the length of the random segment to be checked $\therefore \gamma = \chi * 20\%$

The starting point of the sample was then calculated randomly.

The starting point had to be calculated from a set of random numbers, the range of which was the total length of the interview less 20% (i.e. between 1 and 80% of the length of the file) which allows for the randomised starting point of checking to be anywhere up to 80% of the length of the audio file.

\therefore Starting point for the range of the random sample is between 1 and $\chi * 80\%$.

The random starting point for checking date was determined by generating a randomised integer calculated by a random number generator on www.random.org, which was asked for a random number between 1 and $\chi * 80\%$.

Example:

For example, if the file was 50 minutes long, and the sample was 10 minutes (50 minutes * 20% = 10 minutes) then the randomised starting point could be anywhere between 1 and 40 minutes. A randomised number (integer) would be requested within the range of 1 and 40. If 1 to 40 was entered into the randomiser and 33 was the result, then data checking would commence at the first second of the 33rd minute, and continue for 10 minutes.

The audio file would be set to start at the 33rd minute mark, with the corresponding part of the text identified. The tape would then be played and any differences between the audio file and the transcription were noted by using tracked changes in the transcription text. “Umms” “ahhs” and other trivial vocalisations (e.g. err, you know, etc.) which the transcriber was not required to record were not noted as errata. Repetitions were also not counted e.g. “I mean um, I mean” where the transcription is provided as “I mean ..” or where the interviewee corrected their own grammar e.g. “a order – an order”, or corrected themselves (e.g. ‘we didn’t sorry did’ – when the transcript reported ‘we did’) as this did not materially change the meaning or affect coding.

The total number of changes made was calculated in order to give the percentage difference between the audio and the transcribed text (error rate). The number of words changes, divided by the total number of words in the sample, gave the error rate (words different / words in sample * 100 = percentage error). The average error, across 30 interviews (189,591 words), was 3% which was considered not statistically significant.

Details of the results of data checking are below.

Audio File	Length (rounded to the nearest minute)	20% of length (rounded to the nearest minute)	Range to conduct tests within (total Length – 20%)	Randomised Result	Number of words in file	Number of word changes	Percentage of word changes	Words spoken per minute	Any material difference
Interview 1	75 minutes	15 minutes	1 to 60	47th minute (47 to 62)	9,281 1,971 in sample	23	1.16%	123.75	No
Interview 2	35 minutes	7 minutes	1 to 28	9 th minute (9 to 16)	4,995 1,051 in sample	39	3.7%	142.71	No
Interview 3	79 minutes	16 minutes	1 to 63	(4 to 20)	9,267 1,899 in sample	37	1.9%	117.30	No

Audio File	Length (rounded to the nearest minute)	20% of length (rounded to the nearest minute)	Range to conduct tests within (total Length - 20%)	Randomised Result	Number of words in file	Number of word changes	Percentage of word changes	Words spoken per minute	Any material difference
Interview 4	52 minutes	10 minutes	1 to 42	10 th minute (10 to 20)	5,366 1,173 In sample	42	3.6%	103.19	No
Interview 5 (part 1)	62 minutes (1 st of 2 audios)	12 Minutes	1 to 50	50 th minute (50 to 62)	See below				
Interview 5 (part 2)	24 minutes (2 nd of 2 audios)	5 Minutes	1 to 19	4 th Minute (4 to 9)	12,004 1,739+695=2434 in sample	40	1.16%	139.58	No
Interview 6	50 minutes	10 Minutes	1 to 40	5 th Minute (5 to 15)	6,627 1,384 In sample	30	2.16%	132.54	No
Interview 7	48 minutes	10 Minutes	1 to 38	30 th minute (30 to 40)	5,924 1,367 In sample	71	5.2% (strong accent)		No
Interview 8 (part 1)	48 minutes	10 Minutes	1 to 38	32 nd Minute (32 to 42)	See below				No
Interview 8 (part 2)	9 minutes	2 Minutes	1 to 7	5 th minute (5 to 7)	8,409 1,424 + 357=1,781 In sample	46	3.23%	147.52	No
Interview 11	79 minutes	16 Minutes	1 to 63	23 rd minute (23 to 39)	9,808 1,266 In sample	67	5.29%	124.15	No
Interview 12 (Part 1)	50 minutes	10 Minutes	1 to 40	31 st minute (31 to 41)	See below				
Interview 12 (Part 2)	33 minutes	7 minutes	1 to 26	17 th minute (17 to 24)	8,921 1002+806=1,808	83	4.59%	107.48	No

Audio File	Length (rounded to the nearest minute)	20% of length (rounded to the nearest minute)	Range to conduct tests within (total Length – 20%)	Randomised Result	Number of words in file	Number of word changes	Percentage of word changes	Words spoken per minute	Any material difference
					In sample				
Interview 13	46 minutes	9 minutes	1 to 37	4 th minute (4 to 13)	6,275 1,247 in sample	50	4.09%	136.41	No
Interview 14	54 minutes	11 minutes	1 to 43	20 th minute (20 to 31)	6,122 1,201 in sample	73	6.07%	94.85	No
Interview 15	58 minutes	12 minutes	1 to 46	34 th minute (34 to 46)	7,481 1,609 in sample	42	2.61%	128.98	No
Interview 16	59 minutes	12 minutes	1 to 47	28 th minute (28 to 40)	7,688 1,663 in sample	10	0.6%	130.31	No
Interview 17	52 minutes	10 minutes	1 to 42	22 nd minute (22 to 32)	6,399 1,296 in sample	54	4.17%	123.06	No
Interview 18 (Part 1)	49 minutes	10 minutes	1 to 39	34 th minute (34 to 44)					
Interview 18 (Part 2)	5 minutes	1 minute	1 to 4	2 nd minute (2 to 3)	6,265 1,263 + 140 = 1,403 in sample	47	3.35%	127.86	No
Interview 19	51 minutes	10 minutes	1 to 41	7 th minute (7 to 17)	6,291 1,234 in sample	41	3.32%	123.35	No
Interview 20	No audio								
Interview 21	62 minutes	12 minutes	1 to 50	21 st minute (21 to 33)	8,495 1,649 in sample	92	5.57%	137.02	No
Interview 22	43 minutes	9 minutes	1 to 34	30 th minute (30 to 39)	5,398 1,201 in sample	54	4.50%	125.53	No
Interview	51 minutes	10 minutes	1 to 41	30 th minute	5,998	37	3.09%	117.61	No

Audio File	Length (rounded to the nearest minute)	20% of length (rounded to the nearest minute)	Range to conduct tests within (total Length - 20%)	Randomised Result	Number of words in file	Number of word changes	Percentage of word changes	Words spoken per minute	Any material difference
23				(30 to 40)	1,197 in sample				
Interview 24	54 minutes	11 minutes	1 to 43	35 th minute (35 to 46)	8,791 1,941 in sample	72	3.71%	162.80	No
Interview 25	35 minutes	7 minutes	1 to 28	28 th minute (28 to 35)	4,849 953 in sample	25	2.62%	138.54	No
Interview 26	52 minutes	10 minutes	1 to 42	38 th minute (38 to 48)	5,948 1,144 in sample	34	2.97%	114.38	No
Interview 27	54 minutes	11 minutes	1 to 43	28 th minute (28 to 39)	7,684 1,689 in sample	15	0.89%	142.30	No
Interview 28	53 minutes	11 minutes	1 to 42	22 nd minute (22 to 33)	6,825 1,300 in sample	40	3.08%	128.77	No
Interview 29	63 minutes	13 minutes	1 to 50	24 th minute (24 to 37)	8,316 1,902 in sample	23	1.21%	132.00	No
Interview 30	45 minutes	9 minutes	1 to 36	10 th minute (10 to 19)	6,791 1,319 in sample	9	0.68%	150.91	No
Average						44.3	3%	128.96	

7.3 APPENDIX C – ROUTINES IN USE – BY YEAR AND BY CASE

Variant #	Scope of Works	Contract	Tender	Approach	2000 to 2004					2005 to 2006					2007 TO 2009					Total	%	
					Alpha	Beta	Gamma	Delta	Epsilon	Alpha	Beta	Gamma	Delta	Epsilon	Alpha	Beta	Gamma	Delta	Epsilon			
1	Design	Supply	RFO/Tender	Open Tender											1					1	0	
2	Deliver	Major Supply and Install	Registration -> RFO/Tender	Closed		1														1	0	
3	And Test		RFI/EOI -> Tender	Open Tender	1															1	0	
4			RFO/Tender	Closed		1			1					1	1				2	6	1	
5				Sole Tender	1	2	2		3					2						2	12	2
6				Open Tender	2	1			4		1			3					5	3	19	3
7	Provide	Consultancy	RFO/Tender	Closed																2	2	0
8	Services			Sole Tender									1							1	2	0
9				Open Tender				1												1	2	0
10		Engineering and Civil Works	Registration -> RFO/Tender	Closed																	1	1
11				Sole Tender														1		1	1	0
12				Open Tender				1	1											2	2	0
13			RFO/Tender	Sole Tender					1					2		1		1	2	7	7	1
14				Open Tender				1	4									1		6	6	1
15		Service Contract	Registration -> RFO/Tender	Open Tender																2	2	0
16			RFI/EOI -> Tender	Open Tender					2												2	0
17			RFO/Tender	Closed					2					1	1					4	4	1
18				Sole Tender	2				1					2						5	5	1
19				Open Tender	5		2		2	17				1	11			3	1	42	42	6
20		Maintenance services	Registration -> RFO/Tender	Closed					1											1	1	0
21			RFO/Tender	Closed															1	1	1	0
22				Open Tender						1											1	0
23		Major Supply and Install	RFO/Tender	Closed					1												1	0
24				Open Tender									1								1	0
25		Minor Works	RFO/Tender	Closed				1	1												2	0
26				Sole Tender															1		1	0
27				Open Tender															2	1	3	0
28	Construction	Alliance	Registration -> RFO/Tender	Open Tender										5						3	8	1
29			RFO/Tender	Sole Tender																1	1	0
30				Open Tender												2			7	9	9	1
31		Construction Management	RFO/Tender	Closed										1	1					1	3	0
32		Consultancy	RFI/EOI -> Tender	Sole Tender																1	1	0
33			RFO/Tender	Closed						1				2						1	4	1
34				Open Tender				1		1											2	0
35		Design and Construct	Registration -> RFO/Tender	Closed																2	2	0
36			RFO/Tender	Closed																1	1	0
37				Sole Tender					1												1	0
38				Open Tender						1										2	3	0
39		Engineering and Civil Works	Registration -> RFO/Tender	Closed				1	3					4	2						10	1
40				Pre-										1						1	2	1

Variant #	Scope of Works	Contract	Tender	Approach	2000 to 2004					2005 to 2006					2007 TO 2009					Total	%		
					Alpha	Beta	Gamma	Delta	Epsilon	Alpha	Beta	Gamma	Delta	Epsilon	Alpha	Beta	Gamma	Delta	Epsilon				
41				Qualification																			
				Sole Tender									1						4			5	0
42				Open Tender				3	12				7						2	1		25	3
43			RFI/EOI -> Tender	Closed																	1	1	0
44			RFO/Tender	Closed					3				1	1	1				4	1		11	1
45				Pre- Qualification				6	14				12	2					12			46	6
46				Sole Tender					1				2						7	1		11	1
47				Open Tender				1	7	1			6	3			2		10	3		33	4
48		Service Contract	RFO/Tender	Sole Tender							1											3	0
49				Open Tender										3	1						2	6	1
50		Supply	RFI/EOI -> Tender	Open Tender						1												1	0
51			RFO/Tender	Sole Tender									1			1						2	0
52				Open Tender				1	2	6						6				1		16	2
53		Maintenance services	RFO/Tender	Open Tender	1				1	1					1						1	5	1
54		Major Supply and Install	RFI/EOI -> Tender	Sole Tender						1												1	0
55				Open Tender											1							1	0
56			RFO/Tender	Closed					1						2						1	4	1
57				Sole Tender								1					1				3	5	1
58				Open Tender	1	1			3	1					1						2	9	1
59		Minor Supply and Install	RFO/Tender	Sole Tender																2		2	0
60				Open Tender	3						1				1							5	1
61		Minor Works	Registration -> RFO/Tender	Closed											1						1	2	0
62				Sole Tender																	1	1	0
63				Open Tender																	2	2	0
64			RFI/EOI -> Tender	Open Tender											1						1	2	0
65			RFO/Tender	Closed				1	13				5	14						1	4	38	5
66				Sole Tender					4			1	3	1	1					4	3	17	2
67				Open Tender				1	20	2				22	1	1				10	29	86	0
68		Services Panel	RFO/Tender	Closed																1		1	0
69		Repairs contract	RFO/Tender	Sole Tender																	1	1	0
70		Other	RFI/EOI -> Tender	Open Tender						1												1	0
71			RFO/Tender	Closed						1												1	0
72				Sole Tender																	1	1	0
73				Open Tender					4													4	1
74	Supply,	Engineering and Civil Works	Registration -> RFO/Tender	Sole Tender																	1	1	0
75	Deliver		RFO/Tender	Open Tender											1							1	0
76	And	Major Supply and Install	RFI/EOI -> Tender	Open Tender						1												3	0
77	Commission		RFO/Tender	Sole Tender	3				2												1	6	1
78				Open Tender					3					4							5	12	2
79		Minor Supply and Install	RFO/Tender	Open Tender										1	1							2	0
80	Supply &	Engineering and Civil Works	Registration -> RFO/Tender	Sole Tender											1							1	0

Variant #	Scope of Works	Contract	Tender	Approach	2000 to 2004					2005 to 2006					2007 TO 2009					Total	%			
					Alpha	Beta	Gamma	Delta	Epsilon	Alpha	Beta	Gamma	Delta	Epsilon	Alpha	Beta	Gamma	Delta	Epsilon					
81	Install			Open Tender									1	1					2	0				
82				RFI/EOI -> Tender	Open Tender						1										1	0		
83				RFO/Tender	Closed						1										1	0		
84						Open Tender					6				6					3	1	16	2	
85				Supply	RFO/Tender	Sole Tender														1		1	0	
86						Open Tender					1											1	11	
87				Major Supply and Install	Registration -> RFO/Tender	Open Tender															1	1	0	
88						RFO/Tender	Closed	1			1						1				1	4	1	
89						Sole Tender												1			1	1	3	0
90						Open Tender			1	3	3					3		2	1	1	1	1	16	2
91				Minor Supply and Install	RFO/Tender	Closed											1	2				3	0	
92						Open Tender								1	1		1					3	0	
93				Minor Works	Registration -> RFO/Tender	Open Tender				1											1	2	0	
94						RFI/EOI -> Tender	Open Tender															1	1	0
95			RFO/Tender	Closed				2	8					1	2			3	3	19	3			
96			Sole Tender					2						1	9			2	2	16	2			
97			Open Tender					1	1				6	1	1			5	4	19	3			
98	Repairs contract	RFO/Tender	Open Tender	2															2	0				
99	Supply &	Engineering and Civil Works	Registration -> RFO/Tender	Open Tender										1					1	0				
100	load			RFO/Tender														1	2	0				
101				Sole Tender												1				1	0			
102				Open Tender						26						15				10	51	7		
103				Service Contract	Registration -> RFO/Tender	Open Tender	1														1	0		
104			RFO/Tender	Closed						1									1	0				
105	Supply	Registration -> RFO/Tender	Closed					1											1	0				
106			RFO/Tender	Closed						1									1	0				
107			Open Tender															1	1	0				
108	Major Supply and Install	RFI/EOI -> Tender	Closed					2											2	0				
109			RFO/Tender	Closed					11					1					12	2				
110			Sole Tender															1	1	0				
111			Open Tender			1						1				1		4	7	1				
112	Minor Supply and Install	RFO/Tender	Closed											1				3	4	1				
113			Sole Tender															1	1	0				
114			Open Tender							2				3				1	3	9	1			

Types of contract	Used for	Timing	Complexity	Risks addressed	Contestability	Costs / Remuneration method	Disadvantages	Value stated in interviews	Value in database	Correlation between interview data and database
	operational during upgrades) Procurement on behalf of the client								Median 6,700,00	
Consultancy	Harder to specify the outcomes for this in advance - but needs to occur	Quick to implement Flexible	Can deal with complex issues	May not be able to determine outcomes beforehand	Depends on service – but generally available	Hourly rate May be hard dollar	Can be costly – not sure of value beforehand Unless outcome is clearly specified outcome may be less than expected.	\$15k to \$15m	Range 6,650 – 3,395,478 Mode 6,650 Mean 585,254 Median 262,900	↕ Mean ↓ Mode ↕ Median
Design and Construct	Design and construct type arrangements (straight forward asset 4 upgrades)	Quicker brief	Refurbishments which are not too difficult	Site, cost, design	Large number of firms can provide this type of service	Hard dollar contracts Guaranteed Maximum Price	Lose some control on the design and the final quality of the product	\$100k to 1m	Range 254,970 - 7,335,058 Mode 254,970 Mean 1,387,300 Median 402,600	↑ Mean ↕ Mode ↕ Median
Engineering and Civil Works	Engineering and civil works	Slower – due to design process (often traditional method)	Ranges from simple to complex	Site cost design	Many suppliers	Hard dollar Bill of Quantities	Costs can blow out due to claims by contractor (Increased costs may also be due to variations to scope of work made by client)	Up to \$100million (or higher)	Range 115,800 - 33,086,293 Mode 606,000 Mean 2,853,590 Median 1,476,054	↕ Mean ↕ Mode ↕ Median

Types of contract	Used for	Timing	Complexity	Risks addressed	Contestability	Costs / Remuneration method	Disadvantages	Value stated in interviews	Value in database	Correlation between interview data and database
Maintenance services	Providing maintenance of assets and other simple – easily specified services Maintaining plant and equipment	Quick to establish 6mth to three years	Simple Services provided	Ensuring equipment runs Operational risk	Lots of suppliers Will often go back to original supplier for certain parts	Rates Guaranteed work and optional work	Some of the quality not maintained Sole suppliers create risks due to dependence on specific parts	\$10,000 to 250,000 (can be higher)	Range 137,009-1,000,000 Mode 137,009 Mean 482,898 Median 361,166	↕ Mean ↕ Mode ↕ Median
Minor supply and installation contract	Short term minor supply and installation contract works type purchasing	Three months	Simple – ‘off the shelf items’	Site risks Cost risks	Lots of suppliers, but tend to buy out of a catalogue	Fixed price	May be repetitive (going to market again and again for the same thing)	\$5,000 to \$50,000	Range 455-1,401,200 Mode 455 Mean 197,947 Median 98,600	↑ Mean ↓ Mode ↑ Median
Minor works	For small types of building services (e.g. electrical)	Six months	Not complex	Site and cost risks	Lots of providers	Fixed price		\$100k to 250K	Range 396 - 3,647,978 Mode 100,000 Mean 328,932 Median 126,355	↑ Mean ↕ Mode ↕ Median
Services Panel	e.g. earthmoving - established in a ‘mother contract’ – orders fall of	Medium (five years) Quick to implement order	Simple work with an array of suppliers	Availability of supply	Pre-approval of suppliers – orders under contract	Rates		? (depends on the amount of work)	Range Mode Mean	N/A

Types of contract	Used for	Timing	Complexity	Risks addressed	Contestability	Costs / Remuneration method	Disadvantages	Value stated in interviews	Value in database	Correlation between interview data and database
	this							Median		
Supply contract	More robust contract dealing with a site specific difficulties and complex specifications	Up to three years	Site, product, complexity Elements of design	Sites, product, design risks	Tender for supply	Fixed price Rates		\$250,000 to \$100M	Range 30,000-2,450,000 Mode 30,000 Mean 545,917 Median 400,000	↕ Mean ↓ Mode ↕ Median
Major supply and install	Major equipment purchases and upgrades	Long term (5 years plus)	Very complex	Product, design, operational risks	Few suppliers	Hard dollar	Cost and time over runs Need to adapt for specific purposes	\$250K and up	Range 30,892-200,000,000 Mode 263,210 Mean 11,942,296 Median 1,230,445	↕ Mean ↕ Mode ↕ Median
Repairs	Equipment components	Short term	Medium	Operational risks	Fewer suppliers	Rates	Specifications of work Over or under delivery	Up to \$100,000	Range 28,000-449,250 Mode 28,000 Mean 198,417 Median 118,000	↑ Mean ↕ Mode ↕ Median
Services contract	Wide variety	Less than 3 years	Varies	Operational risks	Lots of suppliers	Rates	Difficult to administer Personalities Internal stakeholders	Up to \$1M	Range 510-4,483,000 Mode 25,000 Mean 1,080,732 Median 352,811	↕ Mean ↕ Mode ↕ Median

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8) REFERENCE LIST

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