A Design Research approach to developing a Process Reference Model for leadership of integrated teams in virtual environments

A thesis submitted to Griffith University for the Degree of Doctor of Philosophy

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This thesis is dedicated to my second self, 
and best earthly companion

Angela

And the third and fourth members 
of our Nation-of-Four

John and Nicola
Abstract

Purpose: the aim of this thesis is to determine the qualities and characteristics of effective leaders of integrated teams operating in virtual environments.

Research paradigm and methodology: The study was conducted using the Design Research paradigm in which a series of six review cycles were conducted using a combination of qualitative and quantitative data collection methods.

Findings: The study establishes:

1. the qualities and characteristics of effective leaders of integrated teams operating in virtual environments can be identified,
2. that these characteristics of leadership can be expressed in a Process Reference Model (PRM) or Reference Model of Organisational Behavior,
3. that Design Research can effectively be used to develop a PRM, and
4. that Behavior Engineering is an effective formal method for validating PRMs.

Research limitations: The project uses Design Research to determine leadership factors. These are then synthesised into a Process Reference Model, yet there is little or no theory base for applying Design Research in this way. The usefulness of this approach should be confirmed by follow-up research.

Practical implications: Project managers in the Software Engineering sector specifically, and more generally in other sectors using virtual teams to perform projects will benefit from using this Process Reference Model to better coordinate their teams to achieve objectives.

Originality & value: The project is original and valuable in it’s:

1. application of Design Research to develop a Process Reference Model,
2. formulation of leadership qualities into a PRM,
3. application of Behavior Engineering to the validation of a PRM, and
4. development of a practical and academically rigorous approach to PRM-development.

Keywords: Leadership, Process Reference Model, Design Research, Behavior Engineering.
Statement of Originality

This work has not previously been submitted for a degree or diploma in any university. 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 in the thesis itself.

Signed: _______________________________ Date: ______________

Acknowledgments

Special thanks are due to my partner Angela for her unwavering support and encouragement. In addition to this, her domain knowledge and technical advice in the model-based based process improvement domain has also been invaluable. Also to John and Nicola for listening patiently as we drove the long drive between Redland Bay and Brisbane on school days.

Special thanks to my supervisors Terry Rout and Peter Bernus for their excellent and timely advice and mentoring. Terry and Peter have not only provided support throughout the PhD research, but also friendship and advice about life in general.

Thanks also to Bruce Rowlands for his research methodology and scholarly writing advice and encouragement.

I also gratefully acknowledge Griffith University for allowing me to find my vocation and do a PhD, all rolled into one. My interest in leadership began as a child in the 1960’s on hearing the speeches of John F. Kennedy and Martin Luther King, and wondering at the power of rhetoric to inspire and motivate millions.

With all of the above to help, the five year task was accomplished.
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## Glossary of terms

The following terms are used in the thesis, occasioning the need to define.

<table>
<thead>
<tr>
<th>Term</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abduction</td>
<td>In logical reasoning, abduction, or inference to the best explanation, is a method of reasoning in which one chooses the hypothesis that would, if true, best explain the evidence.</td>
</tr>
<tr>
<td>ASL</td>
<td>Application Services Library. A standard for processes within the Application Management discipline.</td>
</tr>
<tr>
<td>Behavior Engineering</td>
<td>An integrated discipline that supports the systems and software engineering of large-scale, dependable software-intensive systems (Dromey, 2002).</td>
</tr>
<tr>
<td>CMMI&lt;sup&gt;®&lt;/sup&gt;</td>
<td>Capability Maturity Model Integration&lt;sup&gt;®&lt;/sup&gt; is a framework describing the key elements of an effective product development and maintenance process. CMMI&lt;sup&gt;®&lt;/sup&gt; covers practices for planning, engineering and managing product development and maintenance (Chrissis et al, 2003)</td>
</tr>
<tr>
<td>Co-Located Team</td>
<td>A generic category of team distinct from virtual teams in which members are located in the same physical location, as opposed to ‘virtual’ teams. Both categories of team will use information/communication technology (ICT), with virtual teams relying more heavily or solely on ICT.</td>
</tr>
<tr>
<td>Concurrent Engineering</td>
<td>A systematic approach to integrated and concurrent development of a product and its related processes. Concurrent engineering emphasizes response to customer expectations and embodies team values of cooperation, trust, and sharing-decision making proceeds with large intervals of parallel work by all life-cycle perspectives, synchronized by comparatively brief exchanges to produce consensus (Garcia, 1997).</td>
</tr>
<tr>
<td>Design Research</td>
<td>A reiterative research approach in which multiple contextually situated socio-technologically constructed alternative world-states are considered (Vaishnavi and Kuechler, 2004/5).</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>DSDM</td>
<td>Dynamic Systems Development Method.</td>
</tr>
<tr>
<td>ESI</td>
<td>European Software Institute in Bilbao, Spain.</td>
</tr>
<tr>
<td>GERAM</td>
<td>Generalised Enterprise Reference Architecture and Methodology (Rout and Bernus, 1999).</td>
</tr>
<tr>
<td>Goal</td>
<td>Identified from the vision (see below); a projected state of affairs which a person or a system plans or intends to achieve or bring about.</td>
</tr>
<tr>
<td>INCOSE</td>
<td>International Council on Systems Engineering</td>
</tr>
<tr>
<td>IPM</td>
<td>Integrated Project Management (a CMMI® Process Area) (Chrissis et al, 2002).</td>
</tr>
<tr>
<td>IPPD</td>
<td>IPPD is systematic approach to product development that achieves a timely collaboration of relevant stakeholders throughout the product lifecycle to better satisfy customer needs (Chrissis et al, 2002).</td>
</tr>
<tr>
<td>IPRC</td>
<td>International Process Research Consortium; an SEI-sponsored advisory body tasked with identifying the research agenda for the process research community (Forrester, 2006)</td>
</tr>
<tr>
<td>ISO/IEC 12207</td>
<td><em>International Standard for Information Technology-Software Life Cycle Processes.</em> Describes the method of selecting, implementing and monitoring the life cycle for software by defining a common framework for software lifecycle processes</td>
</tr>
<tr>
<td>ISO/IEC 15504</td>
<td><em>International Standard for Information Technology: Process Assessment</em> (also known as SPICE or Software Process Improvement and Capability dEtermination)</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Integrated Team</td>
<td>A group of people with complementary skills who are committed to delivering specified work products in timely collaboration. Integrated team members provide skills and advocacy for all phases of the work products’ life and are collectively responsible for delivering work products as specified.</td>
</tr>
<tr>
<td>ISPL</td>
<td>Information Services Procurement Library, a best practice library for the management of Information Technology related acquisition processes (Franckson, 1999).</td>
</tr>
<tr>
<td>ITIL</td>
<td>Information Technology Infrastructure Library (ITIL) is a widely accepted approach to IT service management in the world. ITIL provides a cohesive set of best practice, drawn from the public and private sectors internationally. Evolved since the 1980’s into ISO/IEC 20000 (from an earlier version of British Standard 15000).</td>
</tr>
<tr>
<td>Leadership</td>
<td>Generically, the activity of leading or the ability to lead. No commonly agreed definition of leadership has been reached across disciplines. Developing a working definition of leadership is an objective of this project. Former US President Eisenhower defined it as the art of getting someone else to do something you want done because he wants to do it. (1988).</td>
</tr>
<tr>
<td>Model Based Process Improvement</td>
<td>An approach within the software engineering discipline that uses a model to guide the improvement of an organisation’s processes … growing out of the quality management work of Deming, Crosby and Juran and … aimed at increasing the capability of work processes.’ (Clouse et al, 2003)</td>
</tr>
<tr>
<td>People CMM</td>
<td>People Capability Maturity Model (People CMM, PCMM, P-CMM) is a maturity framework that focuses on continuously improving the management and development of the human assets of an organization (Curtis et al, 2001).</td>
</tr>
<tr>
<td>Process</td>
<td>Process in the software development sense is the coherent set of policies, organizational structures, technologies, procedures, and artefacts that are needed to conceive, develop, deploy, and maintain a software product (Fuggetta 2000).</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Process Model</td>
<td>An abstract representation of a process architecture, design or definition (Feiler &amp; Humphrey, 1992).</td>
</tr>
<tr>
<td>Process Reference Model (PRM)</td>
<td>A model comprising definitions of processes in a life cycle described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes. (ISO/IEC 15504-1:2004)</td>
</tr>
<tr>
<td>Reference Model of Organisational Behavior (RMOB)</td>
<td>Reference Model of Organisational Behavior is a new kind of reference model that is defined more broadly than a Process Reference Model, describing process outcomes in terms of organisational behavior. This is a new term.</td>
</tr>
<tr>
<td>SEI</td>
<td>Software Engineering Institute, Carnegie-Mellon University, Pittsburgh, U.S.A.</td>
</tr>
<tr>
<td>Software process</td>
<td>The coherent set of policies, organizational structures, technologies, procedures, and artefacts that are needed to conceive, develop, deploy, and maintain a software product (Fuggetta, 2000).</td>
</tr>
<tr>
<td>Software process research</td>
<td>Discipline arising in the 1980’s (i.e. the <em>International Software Process Workshop</em>) to strategise on the increasing complexity and criticality of software development (Fuggetta, 2000).</td>
</tr>
<tr>
<td>SQI</td>
<td>Software Quality Institute, Griffith University, Australia.</td>
</tr>
<tr>
<td>TQM</td>
<td>Total Quality Management. A widely practiced business management strategy that embeds awareness of quality in organizational processes.</td>
</tr>
<tr>
<td>Virtual Team</td>
<td>Group of geographically and/or organizationally dispersed co-workers that are assembled using a combination of telecommunications and information technologies to accomplish and organizational task (Townsend et al, 1998).</td>
</tr>
<tr>
<td>Vision</td>
<td>The ability to clearly perceive a worthy goal in terms of organisational success, and which has the quality of making people want to be part of the effort to make it real (Bennis and Beiderman, 1997)</td>
</tr>
<tr>
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</tbody>
</table>

Table 1: Glossary of Terms
Academic publications from thesis

The following peer-reviewed publications have been derived from the thesis. Australian academics will recognize the system of categorisation used in Australia to assess research quality by the Federal Government.

2009

Category E1A - Conference Publications (Full Written Paper - Refereed)


Category B1 - Book Chapters


2008

Category B1 - Book Chapters


Category E1A - Conference Publications (Full Written Paper - Refereed)


Category E1A - Conference Publications (Full Written Paper - Refereed)


Category E3 - Conference Publications (Extract Paper)

2007

Category E3 - Conference Publications (Extract Paper)


2006

Category E1A - Conference Publications (Full Written Paper - Refereed)


Category E3 – Conference Publications (Extract Paper)


Other publications/events

**Newspaper article** in the *Australian Financial Review* on 21st November 2008 (Australia’s highest rated newspaper), on the topic of virtual team leadership.

**Public lecture** hosted by the Australian Computer Society in September 2008 on the topic of virtual team leadership. Lecture slides at: http://www.cit.gu.edu.au/~davidt/

**Industry training course** for project managers of virtual teams (1st Oct 2009). This first presentation was well attended and received positive feedback by the attendees. Further courses are planned. Course information may be seen at: http://www.cit.gu.edu.au/~davidt/leadership/Leadership_Course_fact_sheet_Oct09.pdf
Human Research Ethics

Australian Research Higher Degree projects are required to provide evidence of Human Research Ethics Committee clearance (a Federally mandated process).

Protocol No. ICT/15/06/HREC. Ethical Approval herewith granted:

ETHICAL CLEARANCE CERTIFICATE

This certificate generated on 29-10-2007.

This certificate confirms that protocol 'Effective leadership factors for integrated teams operating in virtual environments' (GU Protocol Number ICT/15/06/HREC) has ethical clearance from the Griffith University Human Research Ethics Committee (HREC) and has been issued with authorisation to be commenced.

The ethical clearance for this protocol runs from 29-06-2007 to 01-02-2008.
(An extension was later sought and granted until 30 June 2009 to cover the complete period of data collection.)

The named members of the research team for this protocol are:
Mr David Tuffley
APro Terence Rout

The research team has been sent correspondence that lists the standard conditions of ethical clearance that apply to Griffith University protocols.

The HREC is established in accordance with the National Statement on Ethical Conduct on Research Involving Humans. The operation of this Committee is outlined in the HREC Standard Operating Procedure, which is available from www.gu.edu.au/or/ethics.

Please do not hesitate to contact me if you have any further queries about this matter.

Dr Gary Allen
Manager, Research Ethics
Office for Research
Bray Centre, Nathan Campus
Griffith University
Phone: 3735 5585
Facsimile: 3735 7994
Email: g.allen@griffith.edu.au
1. Introduction

1.1. Overview of topic

Leadership as a concept has been well-researched over many decades; however there is relatively little empirical research in the area of leadership of integrated teams in virtual environments. This thesis aims to address this gap in the literature.

Social influence. The Oxford English Dictionary defines leadership as the ability to influence others within a given context. A leader motivates others to achieve a goal. This quotation from Eisenhower sums up the process:

Leadership is the art of getting someone else to do something you want done because he wants to do it. Dwight D. Eisenhower (1988).

Of the hundreds of quotes about leadership, this well-known quote from Eisenhower seems to exhibit best, though perhaps does not explain, the enduring enigma that is leadership. A manager may use authority to achieve compliance, but a leader finds a way to make the person want to do it. But how do we understand the distinction?

No commonly accepted definition of leadership. While leadership has been observed and studied for countless generations, little consensus exists as to what true leadership is. Indeed, on-going controversy exists between psychologists, sociologists, historians, political scientists and management researchers on this point (Yukl, 1994). Despite all of this time and effort, a universally accepted definition of leadership is yet to be developed.

Bennis and Nanus (1985) observe that even after thousands of empirical studies on leadership over the previous 75 years, no clear and unequivocal understanding has emerged as to how we can distinguish leaders from non-leaders.

Nature or nurture? The thinking on leadership is somewhat polarised into two opposing views. Conventional wisdom maintains that leadership is an innate ability that natural leaders are born with, and which cannot be learned. A different school of thought, typified by Peter Drucker (1996) and Warren G. Bennis (1994), maintains that
leadership can indeed be learned; that in effect, leaders are made rather than born. This is an underlying assumption of this project, and a view supported by the philosopher Plato who maintained in *The Republic* that the art of ruling (leadership) can be based on scientific principles and can therefore be learned (Takala, 1998). The leader (ruler) uses the dialectic method to rationally analyse situations to determine appropriate courses of action informed by wisdom and understanding.

Leadership studies have been performed across the centuries in a wide variety of cultural contexts. Considering this wealth of material, it is hard to not come to the conclusion that leadership is a fundamental activity of the human species. It might be more accurate to say that there is an almost universal tendency for people from a wide variety of cultural backgrounds and historical periods to cooperate in groups to achieve outcomes difficult or impossible for individuals to achieve alone, and for their efforts to be coordinated by a leader. Highly effective team-work and leadership might arguably be cited as a defining characteristic of the human species.

**Virtual leadership in today’s world.** In the world of technology development, the business of managing complex projects across a variety of disciplines and geographical locations has never been more difficult, given the rising complexity of a global economic environment and the multi-national corporate entities that now inhabit this brave new world. There would appear to be a clear need to find improved ways of managing this often difficult process now and into the future.

This thesis describes a **Design Research project** that seeks to identify the underlying leadership factors that can be derived from the literature and formulate these into a **Process Reference Model (PRM)** that can be used by project managers across a wide variety of sectors to better manage their virtual teams. It will be seen that certain leadership factors do emerge as being in-common across time and across cultures. **Design Research (DR)** will be seen as a useful method for developing a **PRM**, though DR does not appear to have been used before in this way.
1.2. Project description

The fundamental research question is what are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments? The research question is expanded upon in Chapter 2.

The research project aims to identify the qualities and characteristics of effective leaders and formulate these into a Process Reference Model (PRM) for leadership of integrated teams in virtual environments. PRMs are used in software engineering to formally express a set of behaviors that if performed over time will bring about desirable outcomes. This PRM aims to subsequently assist geographically dispersed integrated project teams who are collaborating in virtual environments to function more efficiently.

The project expands on the limited amount of research performed in the area of the leadership of integrated (multi-disciplinary) teams operating in virtual (not co-located) environments. This area of research is likely to become more thoroughly explored in the future as more researchers respond to the clear need for a better understanding of team leadership in a globalised project environment.

A comprehensive review of the general leadership literature as well as the literature concerned with the leadership of virtual teams and integrated teams in the software engineering domain is provided. Also reviewed is the literature on leadership in the management and social psychology domains. The material is synthesised into a Process Reference Model for leadership using the prescribed method in ISO/IEC 15504: 2003 Information Technology -- Process Assessment and ISO/IEC TR 24774:2007 Software and systems engineering -- Life cycle management -- Guidelines for process description provides.

The PRM is then validated in a series of Design Research iterations (Vaishnavi and Kuechler, 2004/5) in which the existence of objective evidence will be determined to support the purpose and outcomes of the various processes within the PRM.
1.3. Broad thesis

A basic assumption of this project is that the factors and behaviors supporting effective leadership can be described in a process model. An argument in favour of this assumption is developed in subsequent sections, a summary of which is presented now.

Repenning and Sterman (1997) observe a broad movement among ‘managers, consultants and scholars’ to recognize the value of understanding an organization’s activities in terms of processes rather than functions. While this tends to confirm the effectiveness of defined processes to solve the various challenges facing organizations, it considers also the limitations, namely the significantly high failure rate of process improvement exercises. In recognition of this, Börjesson (2006) discusses four practical indicators that help PI initiatives to stay on track and make progress. Niazi (2006) examines the relationship between various approaches to SPI and evaluates their merits. Herbsleb and Goldenson (1995) identify several factors that distinguish more successful PI efforts from less successful ones. Essentially, they found that the results of appraisals were accurate and useful in guiding their future PI efforts, but that resistance to change often prevented such efforts getting underway. Overcoming this inertia is a key challenge in successful PI initiatives.

Given this recognition of the efficacy of process, there is no observable reason (Repenning and Sterman, 1997) to suggest that process modelling could not be applied to leadership. Indeed, Total Quality Management (TQM) emphasises the importance of leadership (along with human resource issues and strategic planning) to achieving success with TQM.

Humphrey (2002) demonstrated the importance of leadership in the software development domain, including the importance of having managers learn leadership skills in Winning with Software. Humphrey notes that as Director of programming with IBM he supervised 4,000 software professionals across many locations. His first step in transforming this extended team from one which had never delivered anything on time to one that did not miss a single commitment was to send 1,000 managers on a one week training course to establish effective practices (Humphrey, 2002).

A commitment to defined process in the software development domain, as typified by Humphrey (2002) is reflected more broadly by W. Edwards Deming who is famously
quoting as saying ‘If you can’t describe what you are doing as a process, you don’t know what you’re doing.’ (2000).

The Model-based Process Improvement (MBPI) domain has generated a wide variety of process models over the past several decades (Sheard, 2001). This represents an elaboration on the commitment to defining processes discussed by Humphrey (2002). One weakness of process modelling is that as an abstract representation of reality, and not reality itself, they run the perpetual risk of being less than completely accurate. Inherent flaws notwithstanding, they are arguably still worth developing and using, as drily observed in this well-known quote attributed to George Box that all models are wrong, some are useful (Box, 1996).

Therefore if we accept the assertion that leadership is a form of behavior that can also be learned rather than only be inherited, then it is logical to assert that such behavior can be described in terms of processes, as suggested by Deming (2000). If leadership behavior is describable in process terms, as a sequence of actions, then it should also be possible to formulate these leadership processes into a Process Reference Model (PRM) that conforms to the requirements of ISO/IEC 24774:2007 and ISO/IEC 15504-2:2003. Using a PRM in this way creates the means by which leadership behavior can be consistently performed, while also creating an organisational environment in which the practice of leadership is optimised.

Using PRMs in this way creates a new category of PRM that might best be described as a Reference Model of Organisational Behavior (RMOB), distinguished from a PRM by having its Outcomes expressed in terms of organisational behavior.

Factors facilitating software development. There are a range of factors facilitating software development, one of which is the existence of effective teams; another is the existence of defined processes to support the activities of the development team. The confluence of these two factors leads to the possibility of a process reference model for leadership comprising generic and specific leadership skills, as seen below:
The logic is as follows:

**Teams need leaders.** Software in the modern context is developed by teams rather than individuals, particularly true in relation to complex systems (Humphrey, 2000). Yet effective teams do not normally occur by accident; it is the actions of an effective leader that results in an effective team (Drucker, 1996). While not all activities performed by the team are done by the leader, it is ultimately the leader’s responsibility to see to it that all of these activities are performed. Hence the leader is pivotal to project success (Bennis, 1994). This arguably remains true in the case of self-organising, self-directed teams, where a co-ordinating influence is still required, even if this resides in more than one person.

**Projects need defined processes.** Software development is also facilitated by defined process (Humphrey, 2002). Without clearly defined and understood processes, a development team cannot hope to bring about a successful project outcome (i.e. one that is on-time, within budget and with a minimum of defects) (Deming, 2000).
There is literature in the model-based process improvement discipline that details how to describe a process (Rout, 2003; Van Loon, 2004, ISO/IEC 15504-2:2003). Further, as noted by Punter, Trendowicz, Kaiser (2003) there is a widespread assumption that the quality of the product is dependent on the quality of the process (Punter, Trendowicz, Kaiser, 2003). This assumption derives from earlier, seminal work by Deming (2000) and Juran (1974) that places the efficacy of process at the centre of product quality.

*Therefore, this project asserts that successful project outcomes can be achieved through the definition and subsequent application of a leadership process reference model.*
1.4. Rationale for research

Organisations in industrialised economies have increasingly established international consortia and networks of subsidiaries and affiliates with which to pursue a global agenda, taking advantage of economies of scale and effort, as well as leveraging reduced labour overheads in developing regions coupled with increasingly efficient logistical support (Herbsleb and Moitra, 2001). This trend has inevitably led to the advent of distributed work environments and the consequent formation of multi-disciplinary virtual teams (teams that operate across different time zones and physical space).

Greater reliance on virtual teams in today's world plus the on-going challenges of coordinating teams calls for a way to help project managers of virtual teams do their jobs more effectively.

The significance of virtual teams in a development environment characterised by nationally or globally dispersed multi-disciplinary teams should not be underestimated. Technology development by virtual teams to capitalise on market opportunities represents significant challenges in the management of such teams (Herbsleb and Moitra, 2001).

Some of these challenges can be categorised under the heading 'effective leadership'. Effective leadership is therefore recognised as a key capability of technology development organisations.

Model-based process improvement (MBPI) and in particular such process models as the Capability Maturity Model Integration (CMMI) and ISO/IEC 15504 (also known as SPICE) may provide the conceptual basis for investigating leadership functions of integrated virtual teams. While CMMI and SPICE are not specifically leadership-oriented models, the CMMI does nonetheless include an addition for integrated teams that has proved effective in the past for organisations wishing to operate integrated (synonymous with 'complex') teams, sometimes in a virtual environment. This addition is known as Integrated Product and Process Development (IPPD) whose roots can be traced back to the late 19th century in the tradition known as Concurrent Engineering (discussed further in the Literature Review).
While MBPI has not (to the knowledge of the author) been used to study leadership, there is arguably a sound basis for assuming that it can be used in this way. As seen in the diagram below, there are two broad justifying reasons; first that Leadership can be taught and learned by those who would practice it (Drucker 1996, Bennis 1994, Humphrey 2002). Second, that the defining of processes is necessary for organisational effectiveness (Repenning et al 1997), and that if you cannot describe what you are doing as a process, then you don't know what you are doing (Deming 2000).

Figure 2: MBPI enables leadership processes to be defined

Link these two concepts together and we have the need to Define Leadership Processes, as seen in the diagram. Furthermore, MBPI provides a suitable framework around which the definition of leadership processes can occur. The resulting PRM is also consistent with other PRMs, having used the common reference of ISO/IEC 15504-5:2006.

The resulting PRM might also benefit from being verified by means of a formal method in addition to the peer/expert review method commonly used in PRM development. Dromey’s (2007) Behavior Engineering, a formal method developed for use in the software engineering domain to verify software requirements, might prove useful.

Leadership has been well-researched over many decades; yet there is relatively little empirical research in the area of leadership of integrated teams in virtual environments. The CMMI-IPPD discusses integrated teams in detail, but does not explicitly focus on leadership functions, though such functions may be implied by the need for someone to perform certain activities in to bring about successful outcomes. There is only one reference to ‘leadership’ in CMMI outside the IPPD addition.

The CMMI-IPPD is arguably a useful tool when examining leadership in a virtual team.
1.5. Significance & contribution of thesis

As discussed in earlier in this chapter, with an increasing portion of the estimated US$600 billion (Cusamano, 2004) global software industry being performed by virtual teams, and with the mechanics and dynamics of virtual team operations being a relatively new area of study, there is a clear need for research into ways of improving the coordination of integrated teams operating in virtual environments. Yet as Cusamano (2004) asserts, it is the business itself (and the processes therein), not the technology that determines the success or failure of the organisations that produce the software.

Model-based process improvement initiatives such as the Capability Maturity Model Integration (CMMI) offer significant opportunities to organisations wishing to become more effective in this fiercely competitive global industry.

This thesis makes contributions in the following ways:

- Improved practical understanding of leadership useful for project managers across a wide variety of domains
- Process Reference Model (PRM) for leadership of complex virtual teams that is presented in a way that is likely to be understood by software engineering professionals already familiar with the concept and use of PRMs
- Answers the question; is it possible to have PRM for leadership?
- Improved method for PRM development using a Design Research approach

In addition to the preceding contributions, the thesis demonstrates significant alignment with the International Process Research Consortium (IPRC) research agenda. The thesis is aligned in at least 12 ways as discussed in the Literature Review Chapter with the broader process research framework, as outlined in Forrester (SEI, 2006). It therefore has the potential to make a significant contribution to the IPRC research agenda.
1.6. Contents of Thesis

The broad architecture of the thesis is as follows:

![Thesis Architecture Diagram]

Figure 3: Thesis architecture

The content of each chapter is outlined below:
Research question & objectives (Chapter 2)

Defines the following elements of the research project

1. Relevance of the research question
2. Importance of the research question
3. Conceptual overview
4. Research domain & approach

Literature review (Chapter 3)

Examines and discusses in terms of the research objectives a range of literature relevant to the problem; namely:

1. Leadership
2. Process and process models in software engineering
3. Teams (co-located and virtual)
4. Characteristics of successful teams
5. Applying Behavior Engineering to process modelling

Research approach (Chapter 4)

Surveys a range of approaches, and then describes in detail the design research approach that is considered most appropriate for this project. This approach will be discussed in relation to a critical review of other possible approaches. This is followed by detailed discussion of the research strategy, and the underlying rationale that informs this strategy.

1. Design research: constraints & limitations
2. Design research: relevance & rigour
3. Critical review of other research approaches
4. Design research: the proposed approach
5. Software engineering reference discipline
6. Empirical research in software engineering
7. Design research: ontology & epistemology
8. Design research: broad strategy
9. Design research: outputs
10. Design research: PRM development
11. Design research: guidelines for performing
12. Design research: data collection method
13. Design research: review & verification techniques

**Process Reference Model (Chapter 5)**

1. PRM architecture & content; a rationale & approach
2. Generic leadership personality factors
3. Integrated team leadership management factors
4. Leadership challenges in virtual environments (Bell & Kozlowski)

**Research event (Chapter 6)**

The research project chapter is a detailed description of the data gathering interviews, and other review activities:

1. Selection of research participants
2. The participants
3. Design of field experiment instruments
4. Stage review protocols
5. Aggregation of data
6. Justification of data collection method
7. Limitations of field interviews
8. Ethical considerations related to interviews
Data analysis (Chapter 7)

The data analysis chapter gives results and analysis of the relevant data collected during the data collection stage.

1. Measurement framework
2. Data analysis approach: summary
3. Stage 1: first data gathering & review (V0.1 to V0.2 PRM)
4. Stage 2: second data gathering & review (V0.2 PRM)
5. Stage 3: ISO/IEC 15504-2 and ISO/IEC 24774 review (V0.2 to V0.32 PRM)
6. Stage 4: Behavior Tree notation review (V0.32 to V0.4 PRM)
7. Stage 5: Expert Panel review (V0.4 to V0.5 PRM)
8. Stage 6: Composition Tree review (V0.5b to V0.6 PRM)
9. Version 1.0 PRM
10. Conclusions

Findings (Chapter 8)

The findings discuss the how the data can be interpreted in relation to the research objectives. Specifically the findings will examine the:

1. Qualities of effective leaders
2. Leadership PRM
3. Is it a PRM or a RMOB?
4. Is Design Research good for PRM development?
5. Behavior & Composition tree notation
6. IPRC research questions

Conclusions (Chapter 9)

This chapter indicates the contribution made by the thesis to the body of research knowledge, the significance of the findings in relation to the research question, the limitations and strengths or the project, and possible directions for future research:
1. Significance of the findings in relation to the research question
2. Contribution of the thesis
3. Main findings
4. Limitations of the research
5. Opportunities for future research
6. Concluding remarks

References

In APA style.

Appendices

The appendices contain:

- A draft Process Assessment Model, and
- A compilation of the full data set from all six reviews
- Version 1.0 Process Reference Model

The total amount of data is around 100,000 words, equal to the maximum allowable size of the thesis. For this reason, a representative subset of the data is given in the data analysis chapter allowing the thesis to be of an allowable size and length.
2. Research question & objectives

The evolution and rationale for the research question is detailed in the previous chapter. In summary, with so much virtual team-work happening in the world and so little research on the leadership of virtual teams, a need exists for an empirical study to be done in this area.

**Research question:** What are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments?

Deriving from the research question is a series of related research objectives, as follows:

**Research objectives:**

1. To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments.

2. Based on the identified qualities and characteristics, to develop a Process Reference Model (PRM) for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007 *Software and systems engineering -- Life cycle management -- Guidelines for process description*.

3. To determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior.

4. To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior and/or Process Reference Models in the software engineering domain.

5. To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.
2.1. Relevance of the research question

The research question (what are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments?) arises from a repeatedly recognised and often discussed issue in the practitioner and academic literature of the importance of effective team functioning in technology development. By extension, this issue is also important in the emerging field of integrated teaming in virtual environments. Little work has been done to date concerning integrated teams in virtual environments. This project aims to contribute to this specialised domain.

Integrated teaming is an area that has not yet been thoroughly researched, as discussed in the literature review. This thesis goes some way towards adding to the literature. While the topic of virtual environments has been studied somewhat, the combination of integrated teaming in a virtual environment has not. The Integrated Product and Process Development (IPPD) addition to the CMMI for example discusses the topic in some detail, though it does not prescribe whether it shall occur in a co-located or virtual environment.

This thesis asserts that the issue of integrated teaming in virtual environments is both relevant now and will be of growing importance in the future, given the trend towards technology development being performed by integrated teams in geographically distributed environments. Perhaps these teams work for a single multi-national organisation, or perhaps they are comprised of consortia members.

2.2. Importance of the research question

With the rise of globalisation, software development, indeed technology development generally, is becoming a global business. Increasingly, software and systems are being developed by multidisciplinary teams located in geographically dispersed areas. It is now not uncommon for project teams to span several continents and time zones. Such projects might also contain diverse cultural elements.

This project is done in the context of software engineering, however it has become apparent that the resulting PRM is generic enough be applicable to a broad range of
virtual projects across diverse sectors. There is nothing in the PRM that ties it specifically to software engineering.

Given the challenges of managing a project in which the team members are not in the same physical location as each other, *there is a pressing need to examine the process of virtual team operations with a view to identifying those factors that can optimise the functioning of the team*, particularly in view of the high price of technology development and the sometimes critical nature of the technology product that is the outcome of the project. Issues such as cross-sites, co-located, support, problem solving, collaboration, coordination, awareness, and dependencies have been investigated and point to the need for further work (Herbsleb et al, 2001)

The results of this research have relevance in the field of model based process improvement in particular, and for technology project managers in general. Organisations wishing to implement models such as the CMMI in relation to integrated multi disciplinary teams will find the results of this project useful. Organisations in general that operate virtual teams will find the principles outlined in the research to be of some use.

Model based process improvement efforts can be strengthened by work done to better understand how IPPD can be implemented effectively. IPPD has been something of a ‘grey area’ in the domain of empirical software engineering in the sense that it is recognised as an important topic area, but one which involves significant ambiguity due to the complexities of managing people in challenging and often pressurised environments.

### 2.3. Conceptual overview

The conceptual overview diagram below illustrates the evolution of the research question (*what are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments?*).

The basic topic of team functioning is examined first, which leads to the identification of what characteristics are likely to create a successful team. Arising from this work on successful teams, leadership thereof is of critical importance. This acknowledges the remarkably broad historical sweep of this work, spanning several disciplines
(Management, Organizational Psychology, Political Science) and going back to Classical Greece and Plato’s Republic.

The conceptual overview acknowledges the basic distinction between co-located and virtual teams, and that integrated teams can be either. Virtual teams do not have to be integrated but commonly are. Integrated teams do not have to be distributed, but commonly are. Therefore, the characteristics of successful teams and successful leaders are considered for both co-located and virtual teams, culminating in the characteristics of successful leaders of integrated teams operating in virtual environments.

**Research objective:** How to develop a process reference model for integrated teams operating in virtual environments?
2.4. Research domain & approach

This section introduces the research domain and approach. A more detailed treatment of the research approach can be found in the Research Approach chapter.

Research Domain. To situate this project in the broader research context, the research domain is described as empirical software engineering. Within this broad field, the project addresses the topic of process management within the systems/software management concept group as discussed by Glass et al (2002).

Research Approach. In an Ontological sense, the approach is Design Research (Hevner et al, 2004) in which multiple contextually situated socio-technologically constructed alternative world-states are considered. Epistemologically, Design Research is concerned with knowing through the making of artefacts that are objectively constrained within a context, and which through reiterative circumscription are made to reveal meaning and derive the quality of usefulness. Contrast this with an interpretivist epistemology in which subjective meaning is elicited and clarified through researcher-participant interaction.

Research method. Hence the research approach is Design Research. The research methodology is discussed in the research approach chapter.

The Design Research methodology is adapted for this specific project in the following way.
Figure 5: Adaptation of General Methodology of Design Research for this project (Vaishnavi and Kuechler, 2004/5, Takeda et al 1990).

**Unit of analysis.** The unit of analysis is at the project level, as indicated in the overall hierarchy below:

1. International (globally distributed)
2. National (Australia)
3. Industry (IT)
4. Organisation (participating multinational organisations)

5. **Project (software and systems development project teams)**

6. Individual (analyst/programmer, project manager, user)

While opportunities might arise to study the phenomena at the organisational and individual levels, it is the project team that will be the primary unit of analysis. The interview questions and personnel involved with answering the questions will focus on specific projects, this being a practical constraint of the research event. The analysis will take place in the larger context of the organisation, recognising that effective leadership has much to do with how well a leader manages to negotiate the complex terrain of the larger organisation in which he or she operates, but it is the leader’s
performance on specific projects that will be focussed on as a manageable unit of analysis for a project of this nature.

The research participants must either have experience as a manager of virtual project team(s) for the stage 1 and 2 reviews, and be a recognized expert in process models for the Stage 5 Expert Review. The organisations in which the Stage 1 & 2 participants operate must be in the business of conducting virtual-team based IT development projects.

**Related reference disciplines** include management and organisational psychology. Management studies have contributed a considerable amount of material to this project in the area of leadership personality factors. Software engineering literature has little to contribute on this topic.
Chapter 3: Literature review

3. Literature review

The literature review chapter examines and discusses in terms of the research objectives a range of literature relevant to the problem; namely:

1. Leadership
2. Process and process models in software engineering
3. Teams (co-located and virtual)
4. Characteristics of successful teams
5. Applying Behavior Engineering to process modelling

3.1. Leadership

Until 'kings were philosophers or philosophers were kings' there will be injustice in the world. (Plato)

The classical period of ancient Greece is widely recognized as having produced concepts and modalities that are the bedrock of western civilisation. The philosopher Plato (427-347 BC) in his renowned dialogue The Republic outlined certain leadership principles that Western administrative thinking has based itself upon (Takala, 1998). Plato developed systematic administrative thinking for the efficient running of the city-state (polis) which over time allowed the evolution of democracy. Plato described in detail the appropriate relationship between the State and individual citizens. This relationship was so close that it was not possible to think of a citizen living outside of his State (Takala, 1998). The purpose (telos) of this State is to educate people to become ‘good’. The State is like the human body in which parts complement each other and act harmoniously. In terms of organisational theory, Plato would be regarded as a pre-modern functionalist.

In perhaps his best known tract The Republic (Polis), Plato states that politicians are the rulers of the new ideal state because they have (or should have) real knowledge (episteme) of what is ‘the form of good’.
The art of ruling (leadership) can be based on scientific principles. In other words, it can be learned. The leader (ruler) uses the dialectic method to rationally analyse situations to determine appropriate courses of action with wisdom and understanding.

### 3.1.1. Overview of leadership research

The question of effective leadership of virtual teams is considered in the historical context of previous leadership theories and research.

Leadership has been observed and studied for countless generations, yet interestingly little consensus exists as to what constitutes true leadership. It has been the subject of intense on-going controversy among psychologists, sociologists, historians, political scientists and management researchers (Yukl, 1994). Despite this ongoing discussion, no consensus has been reached on how leadership is defined. The operational definition of leadership has much to do with the purpose of the researcher (Yukl, 1994). This view is confirmed by Stodgill (1974) in his comprehensive review of leadership studies which points out that there are almost as many definitions of leadership as there are persons who have attempted to define the concept. Hence for the purposes of this review, the matter of defining leadership will be left open-ended.

It appears the combined efforts of these researchers from sociology, psychology, political science, management etc have tended to cancel each other out. What follows is a sample of the opinions of some highly regarded scholars since the 1940’s.

Bernard (1948) considers that leadership studies has resulted in a great deal of dogmatically stated nonsense. Burns (1978) believes that leadership is one of the most observed but least understood phenomena on earth. Bennis and Nanus (1985) observe that despite the thousands of empirical studies performed on leadership over the previous 75 years, no clear and unequivocal understanding has emerged as to how we can distinguish leaders from non-leaders. Yukl (1994) notes that leadership research has typically focussed on narrow issues with little effort made to integrate findings from different approaches and disciplines.
The table below is adapted from Yukl (1994) and summarises the various theories of leadership.

<table>
<thead>
<tr>
<th>Approach</th>
<th>Theme</th>
<th>Major Studies</th>
<th>Major Methodologies</th>
<th>Limitations</th>
</tr>
</thead>
</table>
| **Trait Approach (1930s to 40s)** | Personal traits of leaders (adaptability, alertness, achievement orientation etc) | McClelland, 1965  
Miner, 1965                                                                 | Compares traits of successful and unsuccessful leaders through interviews, critical incidents etc. | 1. Lack of attention to interviewing variables.  
2. Individual traits fail to strongly correlate with effectiveness |
| **Behavior Approach (1950s to 70s)** | Content of leadership behavior divided between task orientation (initiation) and people orientation (consideration). | Ohio State Leadership Studies (Stogdill and Coons, 1957)  
Michigan Leadership Studies; Management Grid (Blake and Mouton, 1964) | Behavior description questionnaires. | 1. Problems with developing meaningful behavioral categories.  
2. Emphasis on individual rather than patterns of specific behaviors.  
3. Contradictory and inconclusive results. |
| **Power Influence Approach** | Influence processes between leaders and followers. Effectiveness in terms of amount and type of power possessed by leader, and how this is exercised. | French and Raven, 1959  
Social exchange theory  
Strategic contingencies theory  
Leader-member exchange theory (LMX) (Dansereau, Graen Haga, 1975) | Questionnaires | 1. Insufficient validity for measures of leader power.  
2. Inability to deal with confounding among different sources of power; LMX theory is more descriptive than prescriptive. |
| **Situational Approach (1970s to early 80s)** | Contextual factors including: Influence of organisation-al type or managerial position on behavior. Contingency theories explaining leader effectiveness by situational moderator variables. | Mintzberg, 1973 (re influence of org type or manage position)  
Path-Goal theory (House, 1971)Leader Substitutes theory.  
Multiple-Linkage Model.  
Leadership Contingency Theory (House, 1967)  
Cognitive Resources Theory. | Comparative study of situations | 1. Insufficiently broad perspective on the demands and constraints faced by leader.  
2. Mixed results; methodological limitations, conceptual deficiencies.  
3. Meaning of Least Preferred Coworker (LPC) unclear, intervening variables ignored, weak empirical support. |
<table>
<thead>
<tr>
<th>Approach</th>
<th>Theme</th>
<th>Major Studies</th>
<th>Major Methodologies</th>
<th>Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participative Leadership</td>
<td>Power-sharing and follower empowerment</td>
<td>Vroom and Yetton (1973) Normative Decision Model</td>
<td>Laboratory and field experiments</td>
<td>1. Methodological weaknesses. 2. Inconsistent results.</td>
</tr>
<tr>
<td>(1970s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Summary of Leadership Theories (from Yukl, 1994).

3.1.1.1. Distinguishing leaders and managers

The terms leader and manager are sometimes used interchangeably, adding to the ambiguity surrounding the study of leadership. Yet studies of administrative science usually find the terms differentiated. How is this done?

Chaos and order. Abraham Zeleznik (2004) in his seminal paper on leadership suggests that the differences between managers and leaders lie at a deep level of the human psyche. Attitudes towards chaos and order are the basis of the difference. A manager aims for stability and control, seeking to resolve problems quickly, sometimes at the cost of understanding the nature of the problem fully. Leaders, by contrast, accept or at least tolerate chaos and lack of structure so that they might perceive and come to understand the underlying causes of situations. In this sense, Zeleznik argues, leaders have more in common with creative thinkers such as artists and scientists than they do with managers.

According to Takala (1998) what managers and leaders have in common is the ability to get things done. Takala distinguishes them by seeing managers as a kind of instructor who puts pieces together, and then manages the ‘things’. A manager is primarily concerned with making an organisation function by evolving routines that serve the ongoing and sometimes changing purposes of the organisation. Takala (1998) observes that management is an activity typical in larger corporations. But there
is leadership in every organisation, and not only in business organisations. A leader is a person who takes care of people and emphasises in his/her activities the social psychology of the organisation. Takala (1998) notes that this is a somewhat artificial but commonplace distinction made in the management literature between the two activities. He acknowledges however that a person who runs a business or leads an organisation acts situationally in both roles, sometimes a manager, sometimes a leader.

3.1.1.2. Social construct of leadership

The socially constructed view holds that leadership is a myth, a socially constructed agency that reinforces existing social beliefs about the need for hierarchy (Gemmill and Oakley, 1992). A consequence of this view is the de-skilling of people, the placing of them into positions of subservience in order that they might follow the leader. Evidence of this is seen in the popular wish for heroes and messianic figures who will save the people and usher in a brighter future (Gemmill and Oakley, 1992). Despite the rather bleak nature of this position, it can nonetheless be observed that members of some organisations do behave like ‘alienated robots’ in their work relationships.

3.1.2. Leadership qualities of great groups

Bennis and Beiderman (1997) discuss at length the leadership qualities required in Great Groups. They observe that the nature of group leaders can vary widely. There are facilitators, doers, contrarians. Leaders are catalytic completers; taking on roles that nobody else plays and that are needed for the group to achieve its goal. They have an intuitive understanding of the ‘chemistry’ of the group and the dynamics of the work process. Furthermore they encourage dissent in the establishment and maintenance of a shared vision. They can distinguish between healthy, creative dissent and self-serving obstructionism.

Bennis and Beiderman (1997) identify four behavioral traits of effective group leaders:

1. **Provide direction and meaning.** Group members are kept up-to-date on what is important and why their work makes a difference.

2. **Generate and sustain trust.** The group has trust in itself and its leadership. This allows members to accept dissent and tolerate the turbulence of the group process.
3. **Display a bias toward action, risk taking, and curiosity.** A sense of urgency and willingness to risk failure to achieve results.

4. **Are purveyors of hope.** Find tangible and symbolic ways to demonstrate that the group can overcome difficulties.

### 3.1.3. Personality traits & competencies of effective leaders

Bennis (1994) in a wide-ranging study determined that effective leaders display four distinct personality traits, and five specific competencies, the sum of which tends to manifest in strong and effective leadership:

<table>
<thead>
<tr>
<th>Personality Traits</th>
<th>Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guiding vision</td>
<td>Technical competence</td>
</tr>
<tr>
<td>Passion</td>
<td>Interpersonal skills</td>
</tr>
<tr>
<td>Integrity</td>
<td>Conceptual skills</td>
</tr>
<tr>
<td>Daring</td>
<td>Judgment</td>
</tr>
<tr>
<td></td>
<td>Character</td>
</tr>
</tbody>
</table>

No pairing order is implied by this table, it is a listing only.

Table 3: Personality Traits and Competencies of Effective Leader (Bennis, 1994, 1999a)

Bennis (1999a) asserts that it is *character* that is the essential element determining a leader’s effectiveness, saying ‘leaders rarely fail because of technical incompetence’ but more so for lack of character (Bennis, 1999b).

Strong character can manifest in positive and negative ways, as the lessons of history inform us. Strong character makes for a strong leader, but character can be strong and negative/destructive. Offerman et al (2001) relates that a person’s character will be determined by the sum total of his or her values. Offerman et al (2001) identified the source of an employee’s dissatisfaction and disillusionment is often the particular values held by leaders and the actions that these values motivate.

Davis and Landa (1999) surveyed workers across Canada, determining that 75% of Canadian employees did not trust their employers. Bennis (1999a) confirms the importance of trust by emphasising that employee confidence in leadership is critical in
the workplace, saying that it is ‘the emotional glue that can bond people to an organization.’

Branham (2005) surveyed 3,149 people who voluntarily quit their job to assess their reasons for leaving. The exiting employees cited the following common reasons:

- Disappointment,
- Frustration,
- Anger,
- Disillusionment,
- Resentment, and
- Betrayal

These negative emotions are thought to be responses to an unmet human need for:

- Trust,
- Hope,
- A sense of worth, and
- The need to feel competent

(Branham, 2005).

It might therefore follow that an effective leader is someone who is able to meet these fundamental human needs, avoiding the trap that awaits a less effective leader.

### 3.1.4. Effective management of technical people

The seminal figure of Watts Humphrey looms large in the history of software engineering. His contributions include the original Software Capability Maturity Model (CMM-SW), Team Software Process (TSP), and Personal Software Process (PSP); all of which were developed while with the Software Engineering Institute’s Process Program.

A lesser known, but nonetheless relevant, work by Humphrey is *Managing Technical People* (1997). While this work is based on Humphrey’s experience as a senior project manager with the IBM Corporation, rather than on empirical research, it serves as a
validation device for empirical research, given his undoubted stature in the software engineering domain. ‘Validation’ is used here in the software engineering sense, meaning to check the truth and accuracy of something in the practical world.

To summarise the behaviors and qualities of effective managers of technical teams, Humphrey (1997) observes that:

- **Vision.** The ability to clearly perceive a worthy goal in terms of organisational success, and which has the quality of making people want to be part of the effort to make it real.

- **Goals.** Identified from the vision and the ability to drive steadfastly towards their realisation.

- **Conviction.** The ability to overcome obstacles in the path towards goal achievement.

- **Attract followers.** The ability to persuade others to sign-up or otherwise commit to a project, subject to limitations of choice. Humphrey distinguishes between the power to control and the power to lead. The latter is a mutual relationship, while the former implies coercion.

- **Care about followers.** A leader manifests an interest in the lives of, and a concern for the well-being of those they lead (what has been called ‘individualised consideration’).

- **Transform followers.** To convince followers to dedicate themselves to a project, sometimes requiring great personal effort, the net effect of which is to transform all concerned into high-achievers who derive much satisfaction from the transformative process (elsewhere described as transformational leadership).

- **Transact followers.** Use transactional power (power to reward with increased salary, promotion, job assignments) to effectively motivate followers.

- **Lead from below.** The ability to motivate followers to act as leaders in their own jobs, regardless of how modest or limited in scope this may be. The cumulative effect is nonetheless powerful.
3.1.5. **Underlying qualities of effective leaders**

The qualities that inspire people to persevere in the face of great difficulty, that engender trust and a sense of worth among team members are not always readily identifiable. These are qualities that are not easily detected, but which are found in the best of leaders.

Champy (2003) identify these underlying qualities as:

- Empathy,
- Personal responsibility, and
- Openness to discovering truth

### 3.1.5.1. **Empathy**

Macaluso (2003) suggests that empathy is the secret weapon of corporate success, an indispensable quality for any successful leader. Empathy is described as the ability to see the world through another’s eyes, to experience it as they would. ‘To walk a mile in another’s shoes’. Macaluso (2003) says ‘They use it to form strong relationships, pick up early warning signs, and recognize opportunities to influence.’ It is this caring aspect of the leader that makes people want to stay with them, inspiring loyalty.

### 3.1.5.2. **Personal responsibility**

Effective leaders accept that the circumstances in which they find themselves are largely the result of their own previous actions. They recognise the cause and effect relationships that have created the current situation, and understand how to engineer future desirable effects by performing certain actions in the present. They do not blame others (Macaluso, 2003). They are able to see how their behavior affects corporate vision and how their leadership can affect the profitability of the organisation. Effective leaders are proactive, rather than reactive, taking the initiative to improve matters (Macaluso, 2003).
3.1.5.3. Open to the truth

Effective leaders fearlessly search for truth, knowing that sometimes the truth will not be pleasant to face (Macaluso, 2003). They encourage discussion and do not resilient from the outcomes of those discussions. The value of truth is recognised as the supreme antidote to delusion, or wishful thinking.

Macaluso (2003) concludes with the point that really effective leaders are those that maximise human capital by displaying empathy, personal responsibility and truthfulness in all of their dealings. These traits appear to engender in people a favourable emotional state that is the foundation for effective team operation.

3.1.6. Transformational vs. Transactional

Zhang, Fjermestad and Tremaine (2005) identify two parallel dimensions of leadership: transformational vs. transactional, and participative vs. directive. These have been derived from a body of foundational work in the area of leadership styles in a virtual team context.

On the Transformational / Transactional dimension we see the Transformational element as comprising four behavioral components (Bass, 1985) (Bass, Avolio, Goodheim, 1987) (Lowe, Kroeck, Sivasubramaniam, 1996):

- **Charisma or idealized influence.** The leader engenders in the members a sense of pride, respect, faith and respect, together with a sense of purpose/mission.
- **Individualized consideration.** The leader manifests a deep concern for the well-being of team members, and provides mentoring.
- **Intellectual stimulation.** The leader stimulates members to think in original ways, emphasising the triumph of reason over irrationality, and challenging established ways of thinking.
- **Inspirational motivation.** The leader creates high standards, communicating high expectations.

Continuing with the Transformational / Transactional dimension we see the Transactional element as comprising three behavioral elements (Bass, 1985) (Bass, Avolio, Goodheim, 1987) (Lowe, Kroeck, Sivasubramaniam, 1996):
• **Contingent reward.** The leader rewards performance on the basis of it having fulfilled prescribed obligations.

• **Management-by exception.** The leader ensures the standards are met.

• **Management-by-exception (passive).** The leader adopts a *laissez-faire* attitude until non-compliance of standards has occurred.

### 3.1.7. Participative vs. directive

On the participative vs. directive dimension, Bass (1990) defines participative leadership as the equalization of power and sharing of problem solving with followers by consulting them before making a decision.

Bass (1990) defines directive leadership as providing and seeking compliance with directions for accomplishing a problem solving task. Participative leadership and directive leadership are considered parallel to transformational leadership and transactional leadership respectively.

### 3.1.8. Review of leadership findings

Zhang, Fjermestad and Tremaine (2005) discuss at length the findings from various literatures about the distinctions that can be made between Transformational / Transactional and Participative / Directive Leadership styles. In particular, they relate the following:

Bass and Avolio (1993) discuss that in general, supportive, encouraging communication from the leader to team members were made under participative leadership rather than directive leadership. In dealing with a semi-structured or poorly defined problem, proposed solutions were more forthcoming in a participative leadership situation. On the other hand, solutions to structured or well-defined problems were more forthcoming with directive leadership (Bass and Avolio, 1993).

In terms of group effectiveness or potency, higher level transformational leadership resulted in greater effectiveness than lower levels of transformational leadership (Kahai, Sosik and Avolio, 1997). The group potency difference was larger when groups were engaged in interdependent tasks rather than independent tasks. Interdependence resulted in greater potency. Anonymous groups working under high transformational
leadership and identified groups working under low transformational leadership were most effective (Kahai, Sosik and Avolio, 1997).

Elaboration (or the extent to which work was developed to a higher degree of complexity) was observed to improve significantly, while originality improved marginally when higher levels of transformational leadership were present (George, Easton, Nunamaker and Northcraft, 1990). Moreover, identified groups or teams with high transformational leadership were more flexible than identified groups in low transformational situations. Flexibility tended to vanish when groups were anonymous (George, Easton, Nunamaker and Northcraft, 1990).

Transactional leadership is identified (as opposed to anonymous) groups was positively related to the flow of information within the group, while in terms of transformational leadership, flow was not a significant issue (Ho and Raman, 1997). In the identified groups, flow had little or no effect on creativity, while in the anonymous condition; both kinds of leadership (transformational and transactional) had positive effects on flow. This in turn had a positive effect on creativity (Ho and Raman, 1997).

Lim, Raman and Wei (1994) indicate that anonymity by itself does not alter the effects of leadership style on (a) participation, (b) cooperation or (c) the originality of the solution. With transactional leadership, anonymity was negatively associated with participation and association due to social loafing (idle chit-chat, gossip etc), but it was positively related to originality of solutions when a group reward as opposed to an individual reward situation exists (Lim, Raman and Wei, 1994). It appears that giving members time to engage in apparently idle communication when group-based solutions are rewarded results in more focussed outcomes. With transformational leadership, anonymity did not significantly change the rate or degree of participation, cooperation, and originality when a group rewards situation exists (as opposed to an individual rewards condition) (Lim, Raman and Wei, 1994). Team member satisfaction with the leader did not apparently differ across leadership styles; however transactional leadership did appear to result in greater group efficacy and task satisfaction than does transformational leadership. These advantages associated with transactional leadership (over transformational leadership) diminished when anonymity was introduced.

Team members working under the influence of transformational leaders tended to produce quality over quantity (Avolio, Kahai and George, 2000). Output improved, though the quantity of it decreased. Members also tended to be more satisfied and
displayed greater group cohesiveness than those led by transactional leaders (Avolio, Kahai and George, 2000). Leadership satisfaction (highest in the face-to-face setting) was relatively high in virtual environments that approached full-immersion. Transformational leadership was associated with higher levels of trust in the leader and value congruence (Avolio, Kahai and George, 2000).

McColl-Kennedy and Anderson (2002) report that both participative and directive leaderships were positively related to degree of participation. This in turn produced higher team performance, but with paradoxically lower levels of leadership satisfaction. The positive relationship between participation and team performance as well as the negative relationship between participation and team performance became stronger as the problem turned to be less structured (McColl-Kennedy and Anderson, 2002).

3.1.9. Leadership of virtual teams

The concept and practice of distributed work is not new, enjoying a long and colourful history as discussed by O’Leary, Orlikowski and Yates (2002) in their extended case study of the Hudson Bay Company from 1670 to 1826. Yet it has been the advent and subsequent advances in communications technology that has been a critical enabler of the development of this organisational form and practice (Ahuja et al, 1997).

It has been observed (Cascio and Shurygailo, 2003) that distributed teams, (or virtual teams as they might be called), face particular problems in relation to leadership. Organisational and management research has focussed intensively on the issue of leadership, as seen in a previous section, yet there is relatively little research done thus far on the emerging challenge of leadership in virtual teams (Cascio and Shurygailo, 2003).

3.1.10. Leadership of knowledge workers

Discussion of leadership in the globalized economy of the 21st century is not complete without examination of the way in which the new generation of workers who contribute to the global economy are best led and managed. Arguably, project team members on complex virtual teams fall into the category of knowledge worker for the reasons discussed below.

Knowledge workers are broadly defined as persons contributing to the knowledge economy (a post-industrial, post-service economic system). They are self-motivated,
challenge-seeking persons who capture, manipulate and apply knowledge to create value. Knowledge workers usually know more about their job than their manager or anyone else in the organisation, and who often do not consider themselves to be subordinates in the traditional sense (Dubrin et al, 2006:160). Knowledge workers cannot therefore be managed/lead in the same way as industrial or service workers.

One of Australia’s leading academics, Professor Glyn Davis is recognised as an outstanding leader in a knowledge environment, having been described in those terms by former Queensland Premier Peter Beattie (Dubrin et al, 2006:151). Professor Davis, who is currently the Vice Chancellor of Melbourne University, says that leaders should not tell knowledge workers what to do, but rather need to understand what they do and then lead by persuasive vision. This can be effected by:

- The views and visions of the knowledge workers are aggregated and shaped into a consistent theme,
- A vision based on these embedded values is developed,
- The vision thus formulated is articulated back to the knowledge workers with empathy and enthusiasm,
- The leader demonstrates high credibility,
- An understanding of the business and,
- Clear support for the business,
- The leader must be perceived as the embodiment of the values of the organisation,
- The leader skilfully uses multiple channels of communication to convey a consistent message that makes people feel good about working for the organisation. (This sounds similar to Eisenhower’s idea of leadership being about getting people to want to do what it is you want them to do).

(Dubrin et al, 2006:151)

Skryme (1998) outline some guidelines for the leadership of knowledge workers, distilled from the management literature. At a high-level, the critical leadership factors are a well articulated vision, a clear understanding of the link between knowledge and business benefits, together with effective marketing promotion. The leader must have a deep belief in the value of knowledge management to the
organisation, and a commitment to innovative thinking and acting (including the willingness to commit resources).

DuBrin et al (2006) summarise the leadership factors for knowledge workers as follows:

- Individual development plans for staff,
- Acquisition of innovative projects,
- Team composition; multi-disciplinary roles and mentoring/coaching,
- Use of quality systems,
- Systematic project evaluations,
- Planning for both formal and informal communications,
- Culture in which success and failure are discussed openly,
- Specific knowledge may become redundant but the ability to learn always remains valuable to the organisation,
- Knowledge workers’ values must be aligned with those of the organisation,

3.1.10.1. Leadership in online communities

At a general level, it can be said that the proliferation of virtual teams has been driven by the wide-ranging benefits for organisations that practice them. These include access to previously unavailable expertise and enhanced cross-functional interaction (Townsend, DeMarie, Hendrickson, 1998). Despite the benefits however, they do present certain significant challenges, including the readiness of management to adapt to the work context of virtual teams. In their extensive review of 230 group support system (GSS) experimental studies, Fjermestad and Hiltz (1999) reported that leadership is a key variable in small-group decision-making.

3.1.10.2. Leadership challenges for virtual teams

An in-depth study into the typology of virtual teams, and the implications therein for effective leadership is found in Bell and Kozlowski’s (2002) work. This work proposes 11 distinct challenges for the leadership of virtual teams. It is interesting to note that
there is significant overlap between these challenges (or propositions) and the integrated teaming practices of the CMMI-IPPD as will be seen.

As previously discussed in the section dealing with virtual team definition, it should be noted that for the purposes of this study ‘integrated team’ is a broad term that includes ‘virtual team’ as a subset.

Bell and Kozlowski (2002) identify four broad categories of leadership challenge in virtual teams; (a) temporal distribution, (b) boundary spanning, (c) life cycle and (d) member roles. The categories are described by Bell and Kozlowski (2002) in the following way:

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporal Distribution</td>
<td>Virtual teams operating in real-time use rich, synchronous communication media and temporal entrainment to effect performance management.</td>
</tr>
<tr>
<td>Boundary spanning</td>
<td>Individualised consideration for and performance management of team members who span different functional areas, organizations and/or cultures.</td>
</tr>
<tr>
<td>Member Roles</td>
<td>Members holding multiple roles within and across virtual teams.</td>
</tr>
<tr>
<td>Lifecycle</td>
<td>Performance management effectiveness is improved when team membership is stable and on-going, allowing time for relationships to be established and developed.</td>
</tr>
</tbody>
</table>

Table 4: Bell and Kozlowski’s (2002) four categories of leadership challenge in virtual teams

The table below elaborates the 11 propositions relating to leadership challenges in virtual teams outlined by Bell and Kozlowski (2002). They are grouped into the four categories discussed above.

<table>
<thead>
<tr>
<th>Category</th>
<th>Leadership challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporal Distribution</td>
<td>Distributed virtual teams are more likely to use synchronous, richly textured communications media.</td>
</tr>
<tr>
<td>Temporal Distribution</td>
<td>Effective virtual team leaders are more likely to develop substitutes for face-to-face contact.</td>
</tr>
<tr>
<td>Temporal Distribution</td>
<td>The more complex the virtual project, the more likely it will be performed in real time, not distributed time.</td>
</tr>
<tr>
<td>Boundary spanning</td>
<td>The more complex the task, the more likely the team will be distributed.</td>
</tr>
</tbody>
</table>
Boundary spanning
Virtual team boundaries will be less permeable in complex projects where established operating procedures and stable relationships are needed.

Boundary spanning
Effective team leaders are likely to create proactive performance management functions, AND be good at using technology to provide members with team development experiences.

Boundary spanning
Effective leaders are good at evaluating the effectiveness of self regulation mechanisms, AND that these developmental functions will be more difficult to implement across multiple boundaries.

Boundary spanning
More complex projects are likely to require stable team membership.

Member Roles
More complex projects are likely to require clearly defined singular roles for members.

Member Roles
Multiple roles and boundaries are likely to make performance management more difficult, AND effective leaders are more likely to clearly specify roles and role interrelationships, particularly in more complex projects.

Lifecycle
Discrete life cycle of virtual projects will be experienced integrated difficulty with establishing performance regulating functions, AND leaders will therefore focus on the most critical issue of establishing effective working relationships with members.

Table 5: Bell and Kozlowski’s (2002) eleven propositions of leadership challenge in virtual teams

3.1.10.3. Distance dimensions and challenges of global software development

Holmstrom et al (2006) discuss three kinds of distance in the arena of global software development – temporal, geographical, and socio-cultural – and present a useful view of how this distance dimension can relate to the software development process dimension. While this is not specifically about leadership, it can be argued that like the integrated teaming material from the CMMI-IPPD, these factors represent leadership challenges. An effective virtual team leader will find ways to address these issues effectively.

It can be seen also that there is overlap with the explicit leadership challenges outlined by Bell and Kozlowski (2002) (see previous sections).
The table below outlines Holmstrom et al’s (2006) view of the interaction between the distance and software development process dimensions. This is drawn from earlier work by Agerfalk et al (2005).

### Distance Dimension

<table>
<thead>
<tr>
<th>Communication</th>
<th>Temporal Distance</th>
<th>Geographical Distance</th>
<th>Sociocultural Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Improved record of communication</td>
<td>+ Potential for closer proximity to and utilization of remote skilled workforce</td>
<td>+ Potential for innovation and sharing best practice</td>
<td></td>
</tr>
<tr>
<td>- Reduced opportunity for synchronous communication</td>
<td>- Increased cost and logistics of holding face-to-face meetings</td>
<td>- Risk of misunderstandings</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Coordination</th>
<th>Temporal Distance</th>
<th>Geographical Distance</th>
<th>Sociocultural Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Decreased coordination needs due to division of labour</td>
<td>- Increased coordination costs</td>
<td>+ Access to rich skill set and various practices</td>
<td></td>
</tr>
<tr>
<td>- Increased coordination costs</td>
<td>- Reduced informal contact can lead to lack of task awareness</td>
<td>- Inconsistency in work practices can impinge on effective coordination, as can reduced cooperation through misunderstandings</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Control</th>
<th>Temporal Distance</th>
<th>Geographical Distance</th>
<th>Sociocultural Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ opportunities for round-the-clock development</td>
<td>+ Communication channels often leave an audit trail</td>
<td>+ Access to rich skill set and authority</td>
<td></td>
</tr>
<tr>
<td>- Management of project artefacts may be subject to delay</td>
<td>- Difficult to convey vision and strategy</td>
<td>- Different perceptions of authority/hierarchy can undermine morale</td>
<td></td>
</tr>
</tbody>
</table>

Note + (plus sign) indicates an opportunity, - (minus) indicates a challenge.
Source after Agerfalk et al (2005)

Table 6: Interaction between distance and development process dimensions (Holmstrom et al, 2006)

### 3.1.10.4. Contextual variables influencing effective virtual team leadership

Zhang, Fjermestad and Tremaine (2005) in their review of earlier virtual team leadership studies suggest that given the inconsistencies inherent in the results, that a ‘contingency’ approach to studying team leadership might be appropriate. Contingency in this context refers to there being no single set of leadership skills that bring about effective virtual team leadership; rather that effectiveness is contingent upon contextual variables and situational complexity.
The contextual variables identified by Zhang, Fjermestad and Tremaine (2005) from their review of the literature include:

1. **Communication media richness facilitating Trust.** The technology’s ability to provide an environment that provides a rich perceptual experience for the participants. This includes immediate feedback, the number of perceptual cues and communication channels used, and the personalization of messages. Media richness facilitates trust between leadership and team member by minimizing team process degradation while maximizing motivation and commitment to a successful project outcome.

2. **Goal-frustrating events managed by Optimism.** Obstacles and set-backs like technical problems, deadline pressures that threaten the accomplishment of the prescribed project objectives. This creates negative affect among team members, which can amplify itself over time to create a significant problem for the team. Inspirational motivation, optimism, individualized consideration and contingent reward all appear to optimise team performance by creating a positive affective climate.

3. **Leader/follower gender, improved individualised consideration.** Female leaders have been shown to improve virtual team performance by exhibiting a higher degree of Individualized consideration behavior which causes higher levels of team satisfaction with the leadership. Combining individualized consideration with contingent reward further improves the leadership effectiveness of female virtual team leaders. In addition, in female-only groups, the effect of a charismatic virtual team leader is enhanced through effective trust-building.

### 3.1.10.5. Summary of empirical studies of leadership in virtual teams

Dube and Pare (2004) surveyed virtual team characteristics published in empirical studies. Misiolek (2006) used this as a basis for further investigation into leadership aspects of virtual teams. The combination of these two sources plus additional investigation results is shown in the table below. It summarises the broad sweep of theoretical perspectives developed in these empirical studies.
<table>
<thead>
<tr>
<th>Authors</th>
<th>Main research method</th>
<th>Theoretical perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balthazard et al. (2004)</td>
<td>Lab experiment</td>
<td>Shared leadership; leadership style; transformational and transactional leadership</td>
</tr>
<tr>
<td>Cogburn et al., (2002)</td>
<td>Quasi-experimental field study</td>
<td>Behavioral; two-factor theory</td>
</tr>
<tr>
<td>Connaughton &amp; Daly (2004)</td>
<td>Interviews</td>
<td>Implicitly behavioral</td>
</tr>
<tr>
<td>Hoyt &amp; Blascovich (2003)</td>
<td>Lab experiment</td>
<td>Transformational and transactional leadership</td>
</tr>
<tr>
<td>Kayworth &amp; Leidner (2002)</td>
<td>Field experiment</td>
<td>Behavioral; behavioral complexity theory; trust</td>
</tr>
<tr>
<td>Pauleen (2003)</td>
<td>Case study</td>
<td>General theoretical discussion</td>
</tr>
<tr>
<td>Pauleen (2004)</td>
<td>Interviews &amp; 2 10-week action learning sessions + grounded theory analysis</td>
<td>General theoretical discussion with focus on relationship-building and trust</td>
</tr>
<tr>
<td>Piccoli &amp; Ives (2000); Piccoli et al. (2004)</td>
<td>Field experiment</td>
<td>Team control structure; self-managing teams</td>
</tr>
<tr>
<td>Sarker et al. (2002); Nicholson et al. (2002)</td>
<td>Field experiment</td>
<td>Emergent leadership; propose new theoretical model incorporating culture, communication, technical ability, trust, gender, performance, and client location</td>
</tr>
<tr>
<td>Sudweeks &amp; Simoff (2005)</td>
<td>2 case studies</td>
<td>Behavioral; implied two-factor theory; emergent leadership</td>
</tr>
<tr>
<td>Tyran et al. (2003)</td>
<td>Field experiment</td>
<td>Behavioral; two-factor theory; emergent leadership</td>
</tr>
<tr>
<td>Weisband (2002)</td>
<td>Field experiment</td>
<td>Behavioral; two-factor theory; group awareness</td>
</tr>
<tr>
<td>Yoo &amp; Alavi (2004)</td>
<td>Field experiment + grounded theory analysis of transcripts of team interactions</td>
<td>Behavioral; two-factor theory; emergent leadership</td>
</tr>
</tbody>
</table>

Table 7: Characteristics of empirical studies of leadership in virtual teams (adapted from Misiolek (2006) and Dube & Pare (2004).
3.1.10.6. Sloan Distributed Leadership Model

Ancona, Malone, Orlikowski and Senge (2007) at the Sloan School of Management have developed a Distributed Leadership Model that offers an approach to understanding and practicing leadership.

The Sloan Model basically outlines four dimensions of leadership (Ancona, Malone, Orlikowski and Senge, 2007):

Sense making -- the process of making sense of the world around us, understanding the context in which we are operating:

1. Get data from multiple sources: customers, suppliers, employees, competitors, other departments, and investors.
2. Involve others in your sense making. Say what you think you are seeing, and check with people who have different perspectives from yours.
3. Use early observations to shape small experiments in order to test your conclusions. Look for new ways to articulate alternatives and better ways to understand options.
4. Do not simply apply existing frameworks but instead be open to new possibilities. Try not to describe the world in stereotypical ways, such as good guys and bad guys, victims and oppressors, or marketers and engineers.

Relating -- developing strategic relationships within and across organizations:

1. Spend time trying to understand others' perspectives, listening with an open mind and without judgment.
2. Encourage others to voice their opinions. What do they care about? How do they interpret what's going on? Why?
3. Before expressing your ideas, try to anticipate how others will react to them and how you might best explain them.
4. When expressing your ideas, don't just give a bottom line; explain your reasoning process.
5. Assess the strengths of your current connections: How well do you relate to others when receiving advice? When giving advice? When thinking through difficult problems? When asking for help?
Visioning -- creating a compelling and feasible vision of the future as it might apply to the organization

1. Practice creating a vision in many arenas, including your work life, your home life, and in community groups. Ask yourself, ‘What do I want to create?’

2. Develop a vision about something that inspires you. Your enthusiasm will motivate you and others. Listen to what they find exciting and important.

3. Expect that not all people will share your passion. Be prepared to explain why people should care about your vision and what can be achieved through it. If people don’t get it, don’t just turn up the volume. Try to construct a shared vision.

4. Don’t worry if you don’t know how to accomplish the vision. If it is compelling and credible, other people will discover all sorts of ways to make it real – ways you never could have imagined on your own.

5. Use images, metaphors, and stories to convey complex situations that will enable others to act.

Inventing – creating new ways of working together to realize the vision.

1. Don’t assume that the way things have always been done is the best way to do them.

2. When a new task or change effort emerges, encourage creative ways of getting it done.

3. Experiment with different ways of organizing work. Find alternative methods for grouping and linking people.

4. When working to understand your current environment, ask yourself, ‘What other options are possible?’

All of the previous paragraphs derived from Ancona, Malone, Orlikowski and Senge, (2007)

The authors go on to describe the indications of when these activities are not being performed well:
Signs of weak sense making

1. You feel strongly that you are usually right and others are often wrong.
2. You feel your views describe reality correctly, but others’ views do not.
3. You find you are often blindsided by changes in your organization or industry.
4. When things change, you typically feel resentful. (that’s not the way it should be!)

Signs of weak relating

1. You blame others for failed projects.
2. You feel others are constantly letting you down or failing to live up to your expectations.
3. You find that many of your interactions at work are unpleasant, frustrating, or argumentative.
4. You find many of the people you work with untrustworthy.

Signs of weak visioning

1. You feel your work involves managing an endless series of crises.
2. You feel like you’re bouncing from pillar to post with no sense of larger purpose.
3. You often wonder, ‘Why are we doing this?’ or ‘Does it really matter?’
4. You can’t remember the last time you talked to your family or a friend with excitement about your work.

Signs of weak inventing

1. Your organization’s vision seems abstract to you.
2. You have difficulty relating your company’s vision to what you are doing today.
3. You notice dysfunctional gaps between your organization’s aspirations and the way work is organized.
4. You find that things tend to revert to business as usual.

All of the previous paragraphs derived from Ancona, Malone, Orlikowski and Senge, (2007).
3.1.11. Integrated team leadership principles derived from CMMI-IPPD

The CMMI-IPPD, as discussed previously, contains detailed material in relation to integrated teaming without mentioning leadership specifically. And yet, when the nature and scope of this material is examined, it becomes apparent that much of this IPPD material describes de facto leadership practices. These are activities that must be performed by someone. If a leader takes ultimate responsibility for successful project outcomes, it is he or she that is responsible for making sure these activities are done.

The CMMI-IPPD is derived from the IPD-CMM (Integrated Product Development Capability Maturity Model) developed by the Software Engineering Institute in the 1990’s (Garcia, 1997). Looking further back, IPD-CMM itself derived from Concurrent Engineering from the 1980’s, which can trace its origins back to the late 19th Century. This chronology is mentioned to indicate the strength and accumulated wisdom of CMMI-IPPD.

What follows is an adaptation of the goals and practices from CMMI-IPPD to have a leadership-orientation. The original CMMI-IPPD Specific Goal and Practice numbers are included for reference purposes.

An effective leader of an integrated team will:

1. **Establish the project’s work environment** (IPM+IPPD SP1.3) by creating an environment in which all virtual team members have access to and use (preferably broadband) two-way communications media.

2. **Establish the project’s shared vision** (IPM+IPPD SP3.1) by understanding and communicating to team members the mission, goals expectations and constraints of the project in a way that creates a sense of common purpose and enthusiasm.

3. **Establish the integrated team structure** (IPM+IPPD SP3.2) by considering the nature and scope of the project to arrive at an appropriate team structure (for example based on the product work breakdown structure). The team structure should be dynamic, able to adapt to emergent circumstances.
4. **Allocate requirements to integrated teams** (IPM+IPPD SP3.3) by assigning requirements, responsibilities, tasks, and interfaces to teams in the integrated team structure.

5. **Establish integrated teams** (IPM+IPPD SP3.4) within the larger team structure (team leaders and members assigned, team charter established, resources allocated).

6. **Ensure collaboration among interfacing teams** (IPM+IPPD SP3.5) by creating an environment of collaboration, informed by the shared vision, facilitated by communications technology and brought together by the leader with the help of interface control working groups.

7. **Establish empowerment mechanisms** (OPD+IPPD SP2.1) that allow team leaders and members to recognise clear channels of responsibility and authority. These mechanisms shall avoid situations where people assume too much or too little authority and when it is unclear who is responsible for making decisions.

8. **Establish rules and guidelines for integrated teams** (OPD+IPPD SP2.2) by maintaining a clearly defined set of criteria for structuring and forming integrated teams. These operating rules and guidelines define how teams interact.

9. **Balance team and home organization responsibilities** (OPD+IPPD SP2.3) by having clear guidelines for how members can balance their team and home organization responsibilities. A ‘home organization’ is the part of the organization to which team members are assigned when they are not on an integrated team.
3.2. Process and process models in software engineering

3.2.1. Early process research

Osterweil (1987) in an influential early paper describes the essential nature of process as being a systematic approach to the accomplishment of some task; in fact any mechanism used to carry out work or achieve a goal in an orderly way. Put another way, processes can be applied to generalized problem-solving. Humans solve problems by creating process descriptions and then instantiating processes to solve individual problems. Osterweil (1987) observes that the notion of process is a pervasive one in the broad field of human activities. We create generalized solution specifications and make them available for instantiation (often by others) to solve individual problems directly.

It can be seen that this broad definition of process is far more embracing than the commonly perceived idea of process as a description of how to do something; a procedure. By Osterweil’s definition, the accomplishment of some task, surely encompasses project leadership.

Scacchi (2001) makes a distinction between software lifecycle models and software process models. The latter are descriptive or prescriptive characterisations of how software is developed, whereas the former represent a networked sequence of activities, objects, transformations, and events that embody strategies for accomplishing software evolution (Scacchi, 2001).

Fuggetta (2000) outlines the evolution of software process research as a discipline that sprang up in the 1980’s (in particular, the International Software Process Workshop) to strategise solutions to the increasing complexity and criticality of software development activities. Other workshops and journals in the discipline have emerged, including the European Workshop on Software Process Technology and the Software Process – Improvement and Practice journal (Fuggetta 2000). Augmenting these, institutions such as the Software Engineering Institute (SEI, Pittsburgh, USA) and the European Software Institute (ESI, Bilbao, Spain) have been created.
In addition to this, standardization organizations such as ISO/IEC have focussed considerable effort on software processes, for example ISO/IEC 12207 (software lifecycle activities) and ISO/IEC 15504 (software process assessment) (Fuggetta 2000). One observable effect of this effort is the trend towards more formalised process descriptions and a broadening of their applicability to include such areas as service management.

Models evolved that serve the needs of process assessment. Such reference processes, consistent with the nature of the processes in this project, are in effect abstract descriptions of ideal behavior that if performed in some way will produce the desired outcomes. Such abstractions must capture the essence of the desired behavior if they are to be implemented appropriately in different situations. As ISO/IEC 15504-2 prescribes, the process is expressed in terms of a purpose with a set of outcomes that if performed in an appropriate will achieve the purpose.

Given the broadly defined nature of process (Osterweil, 1987) and the deliberately open approach to the development and application of process reference models, the leadership PRM that is the focus of this project arguably falls within the definition of a PRM (ISO/IEC 15504).

*Software process is therefore defined* as the coherent set of policies, organizational structures, technologies, procedures, and artefacts that are needed to conceive, develop, deploy, and maintain a software product (Fuggetta 2000).

### 3.2.2. Model-Based Process Improvement (MBPI)

Of critical importance to this project is the choice of Model-Based Process Improvement (MBPI) as the vehicle for pursuing the research objectives. Are there grounds to believe that Process Reference Models (PRMs) are applicable in addressing leadership in a software engineering environment? It will be seen from the review that PRMs and MBPI can arguably be applied to a range of software engineering challenges, including the challenge of project leadership.

Model-Based Process Improvement (MBPI) aims generally to improve the performance and maturity of an organisation’s processes. It combines the discipline of process improvement with the several international standards and frameworks now in use (i.e. CMMI, ISO/IEC 15504). Combining this awareness of process performance with internationally recognised standards is advantageous to organisations. It affords a
structured and comprehensive framework as a way forward and prescribes in general terms the scope of activities required to systematically improve their process maturity.

Heston and Phifer (2009) ascribe the following organisational benefits to MBPI:

- Improving consistency and repeatability: consistency and repeatability assist with minimising process variation, a major source of product defects. It also allows project staff to move into and out of projects more easily by having clearly defined roles and responsibilities.

- Improving communication: achieved through the adoption of a common vocabulary with clearly prescribed meanings that allows project staff, clients and business partners to communicate with less ambiguity.

- Enabling more improvement: process improvement programs create an environment which is conducive to further improvement. Beyond consistency and repeatability comes the ability to measure and record process performance. This performance data can then be used to plan further improvements and to benchmark against best practice.

- Providing motivation: objective targets, for example being assessed at a certain level of maturity, become a visible motivator for project staff to maintain their efforts to improve process performance.


As U.S. industry became increasingly concerned with maintaining competitive advantage in the post-WW2 period against resurgent Japanese and German manufacturing industries, the field of quality control emerged as an important strategic tool. Seminal work by Deming (2000), Crosby (1979) and Juran (1974, 1988) laid the foundation for MBPI with the basic concept of continuous improvement. Deming was to some extent influenced by the Japanese Kaizen principle (Imai, 1986) of continuous improvement that had been applied to good effect in that country to improving the quality of manufactured goods.

The Deming Cycle (design the product, make it; test it thoroughly, release it to the market, test it in service and determine the user’s view of it, and why the nonuser has not bought it, then feed the results back into an improved design) became a commonly practiced approach to product quality (Deming, 2000). Like the Deming Cycle, the Juran Trilogy (quality planning, quality control, and quality improvement) defines an iterative feedback loop that results in continuous improvement. Crosby’s (1979)
management-centric approach focuses on strategic planning for quality based on an iteratively improved understanding of product requirements. All three of these quality leaders seem to point in the same general direction by defining what quality means and using feedback to measure, manage and achieve quality.


In keeping with the earlier work by Deming (2000), Crosby (1979) and Juran (1974, 1988) in which quality objectives are defined, MBPI and the derived PRMs allows organisations to set objectives and priorities for process improvement. Process maturity can be cultivated, a shared language of process improvement adopted and when coupled with an Assessment Model, the means become available for organisations to benchmark the current state of their improvement methods.

Wang and King (2000) define the discipline in the following way; ‘model-based process improvement model is an operational model that describes process improvement methods based on model or standard-based assessment results.’

This definition accords with Clouse, Ahern & Turner (2003) who define MBPI as ‘…the use of a model to guide the improvement of an organisation’s processes … growing out of the quality management work of Deming, Crosby and Juran and … aimed at increasing the capability of work processes.’

Clouse et al (2003) go on to discuss that process improvement derives from significant long-term self-reflective focus on how the work is done, underscored by senior management support for process improvement efforts, and the use of capability maturity models (or PRMs generally) to provide a common set of process requirements that capture best practice and practical experience in ways that are useful.

Seen in this context, it is arguable that the use of Model-Based Process Improvement in this project is justified.
As discussed by Clouse et al (2003) the environment in which software engineering is performed in the new millennia has become (a) steadily more complex, (b) performed by multi-disciplinary, distributed teams, and (c) is more influenced by process models. The development of the CMMI is evidence of a more integrated approach to software engineering, based on MBPI in general and process models in particular. MBPI and process models are apparently well-suited to dealing with the rising complexity and demands of today’s software engineering, and therefore possibly a fitting approach to dealing with the problem of optimising the leadership of integrated teams in virtual environments. To clarify the distinction between process models and process reference models, not all models in MBPI are PRMs. A PRM is a sub-set of process models, a specific type of process model that supports MBPI.

The literature on developing process reference models is limited. Rout and Simms (1997) discuss the development of ISO/IEC 15504 against a background in the 1990’s of increasing pressure to develop a unified and consensus-driven approach to software process assessment in order to mitigate the difficulties associated with frequent, costly and disruptive capability evaluations instigated by customers. The SPICE project was launched to expedite the development of such a standard. The nascent standard recognised two classes of process model; Process Reference Models and Process Assessment Model. The PRM provides descriptions of the process entities to be evaluated. The PAM supports the conduct of an assessment. PAMs can be flexible in design, having significant differences in structure and content, but are referenced to a common source (a PRM) thus providing a flexible mechanism for harmonisation between different approaches to assessment (Rout and Simms, 1997). Technical Report (TR) 15504, Part 2, released in 1998 contains the first example of a PRM. The concept of the PRM was more fully elaborated as the Technical Report matured into an international standard (Rout, 2003).

ISO/IEC TR 24774:2007 Software and systems engineering -- Life cycle management - Guidelines for process description provides a uniform guide to the elements used to correctly describe a process (the title, purpose statement, outcomes, activities and tasks). ISO/IEC 24774 started out as guide to process descriptions. The source of the material on Purpose and Outcomes was ISO/IEC 15504-2.

The purpose of ISO/IEC 24774 is to encourage consistency in the way Process Reference Models (PRMs) are defined across a variety of industries. It is a general purpose standard that may be applied to any process model developed for any purpose.
3.2.3. Evolution of process models in software engineering

Software process models have been applied to software development process for several decades, driven initially by U.S. Department of Defense imperatives applied to contractors and aimed at improving the overall quality, timeliness, and cost-effectiveness of Defense acquisition projects. Since these early beginnings, other software process models have been developed and adopted more broadly in the commercial software development domain, as discussed below. The purpose of these efforts is the pursuit of the goal of having repeatable, predictable processes that enhance productivity and software quality.


The strength of ISO/IEC 12207:1998 (and its later releases) as a process model is that provides stakeholders (buyers, suppliers, developers, maintainers, operators, managers and technicians) with a flexible approach to development and a common understanding and language (defined processes) with which to harmonise their efforts.

Rout and Bernus (1999) note that a lack of consensus for an underlying architecture is an impediment to attempts to establish consistency in the way reference models for system and software lifecycle processes are defined. Existing enterprise architecture models (specifically GERAM, or Generalised Enterprise Reference Architecture and Methodology) is proposed as a solution. Using GERAM, an enterprise-based model for the software lifecycle is outlined which would help to minimise or eliminate the unresolved inconsistencies with existing and proposed reference models for system and software lifecycle processes (Rout and Bernus, 1999).
The rationale for using GERAM is that it has proved useful and robust in spheres beyond systems and software engineering. It is asserted that a common architecture for life-cycle process models is a pre-requisite if such models are to become universally applied (Rout and Bernus, 1999).

A well-known assessment model is the Capability Maturity Model Integration (CMMI) as developed by Carnegie-Mellon’s Software Engineering Institute (SEI). It describes the essential characteristics of an effective process (SEI, 2008). It is worth noting that there is no formal mapping between CMMI and ISO/IEC 12207, though work is currently being done in this direction (Rout and Tuffley, 2007).

CMMI derives from earlier capability maturity models (most notably the Software CMM) developed since the 1980’s by the SEI. The current CMMI (V1.2) is expressed in three constellations; CMMI for Development (CMMI-DEV) released in August 2006, CMMI for Acquisition (CMMI-ACQ) released in November 2007 and CMMI for Services (CMMI-SVC) released in August 2008. CMMI was initially a largely North American phenomenon, although in recent years its use in the Asia-Pacific region has become widespread.

ISO/IEC 15504 Information Technology: Process Assessment (also known as SPICE or Software Process Improvement and Capability dEtermination) is a framework for the assessment of processes. It was developed by a Joint Technical Subcommittee comprising members from the International Organization for Standardization and the International Electrotechnical Commission.

ISO/IEC 15504 derives from the process lifecycle standard ISO 12207 and from several pre-existing maturity models (CMM, Bootstrap, and Trillium). It was developed to prescribe an international standard for software process improvement that represents a consensus blend of the multiple national maturity models.

### 3.2.4. Requirements for Process Reference Models

The requirements for PRMs are specified in ISO/IEC 24774 and ISO/IEC 15504.

The purpose of ISO/IEC 24774 is to encourage consistency in the way Process Reference Models (PRMs) are defined across a variety of industries. It is a general purpose standard that may be applied to any process model developed for any purpose.
The scope of application of ISO/IEC 24774 is highly inclusive. Section 1 says *this document is intended for use by all parties that define process models … these process models may be for the purpose of process definition, implementation or assessment.* It does not exclude developing PRMs for activities such as leadership.

On the question of whether leadership process may be rightly called processes for the processes of reference modelling, section 2, ISO/IEC 24774 clarifies by saying *the distinction between a process and a procedure is a simple one. A procedure is a set of steps to be followed that, when completed, might or might not achieve the intended objective. This is similar to following a recipe when cooking. On the other hand, a process is executed with knowledge of the intended purpose and outcomes to achieve the desired result.* What is being defined in the Leadership PRM is definitely a process by this definition and not a procedure.

### 3.2.4.1. ISO/IEC 24774:2007

This section outlines the essential criteria derived from ISO/IEC 24774:2007 and applied in this project during the review stage.

ISO/IEC 24774:2007 *Software and systems engineering -- Life cycle management -- Guidelines for process description* outlines a standard format for any process reference model, including those intended for process implementation and process assessment. This general purpose standard outlines the elements used to describe a process; title, purpose statement, outcomes, activities and tasks.

- **The title** conveys the scope of the process as a whole. It is expressed as a short noun phrase that summarize the scope of the process, identify the principal concern of the process, and distinguish it from other processes within the scope of a process model.

- **The purpose** describes the goal of performing the process. It is expressed as a high level goal for performing the process, preferably stated in a single sentence. The implementation of the process should provide measurable, tangible benefits to the stakeholders through the expected outcomes.

- **The outcomes** express the observable results expected from the successful performance of the process. Outcomes are expressed in terms of a positive, observable objective or benefit. The list of outcomes associated with a process shall be prefaced by the text, ‘As a result of successful implementation of this
process:’ The outcomes should be no longer than two lines of text, about twenty words. The number of outcomes for a process should fall within the range 3 to 7. Outcomes should express a single result. The use of the word ‘and’ or ‘and/or’ to conjoin clauses should be avoided. Outcomes should be written so that it should not require the implementation of a process at any capability level higher than 1 to achieve all of the outcomes, considered as a group.

- The activities are a list of actions that may be used to achieve the outcomes. Each activity may be further elaborated as a grouping of related lower level actions;

- The tasks are specific actions that may be performed to achieve an activity. Multiple related tasks are often grouped within an activity.

ISO/IEC 24774:2007 makes it clear that the outcomes should not go beyond what is stated in the purpose. There should be no capability level issues expressed in the outcomes.

Secondly the outcomes must address all of the issues that are apparent in the purpose statement. Nothing should be missed. The outcomes must therefore be necessary and sufficient to satisfy the purpose.

**3.2.4.2. ISO/IEC 15504-2:2003**

In section 6.2.3 Requirements for Process Reference Models, a Process Reference Model shall contain *(quoting from the standard in italics)*:

- a) a declaration of the domain of the Process Reference Model;
- b) a description, meeting the requirements of 6.2.4 of this International Standard, of the processes within the scope of the Process Reference Model;
- c) a description of the relationship between the Process Reference Model and its intended context of use;
- d) a description of the relationship between the processes defined within the Process Reference Model.

6.2.3.2 The Process Reference Model shall document the community of interest of the model and the actions taken to achieve consensus within that community of interest:

- a) the relevant community of interest shall be characterized or specified;
b) the extent of achievement of consensus shall be documented;

c) if no actions are taken to achieve consensus, a statement to this effect shall be documented.

6.2.3.3 The processes defined within a Process Reference Model shall have unique process descriptions and identification.

NOTE Any elements contained in a Process Reference Model that are not included in this Clause are to be considered informative.

6.2.4 Process descriptions

The fundamental elements of a Process Reference Model are the descriptions of the processes within the scope of the model. The process descriptions in the Process Reference Model incorporate a statement of the purpose of the process which describes at a high level the overall objectives of performing the process, together with the set of outcomes which demonstrate successful achievement of the process purpose. These process descriptions shall meet the following requirements:

a) a process shall be described in terms of its purpose and outcomes;

b) in any process description the set of process outcomes shall be necessary and sufficient to achieve the purpose of the process;

c) process descriptions shall be such that no aspects of the measurement framework as described in Clause 5 of this International Standard beyond level 1 are contained or implied.

An outcome statement describes one of the following:

- production of an artefact;
- a significant change of state;
- meeting of specified constraints, e.g. requirements, goals etc.
3.2.5. Process models & types

Expanding our view from the definition of Process Reference Models, as prescribed by ISO/IEC 15504-2, it may be instructive to consider the nature of process models more generally, as a way of placing discussion of PRMs into context. Feiler and Humphrey (1992) define a process model as an abstract representation of a process architecture, design or definition. Process models in this broad sense can be seen as process elements at an architectural, design and definitions level. The abstraction inherent in process models serves to capture and represent the essential nature of processes. Any representation of the process can be said to be a process model. Process models can be analysed, validated, and if enactable can simulate the modelled process (Feiler and Humphrey, 1992).

Scacchi (2001) distinguishes software process models from software lifecycle models. The former are descriptive or prescriptive characterisations of how software is developed, whereas the latter represent a networked sequence of activities, objects, transformations, and events that embody strategies for accomplishing software evolution (Scacchi, 2001). This definition is not inconsistent with that of Feiler and Humphrey (1992) discussed above. Process models are useful for developing more precise and formalized descriptions of software life cycle activities, using a rich notation, syntax, or semantics, often suitable for computational processing (Scacchi, 2001). This idea lends support for the use of Behavior Engineering (Dromey, 2007a) and its notation that might be accurately described as rich notation, syntax, or semantics to develop the Process Reference Model that is the subject of this project.

Scacchi (2001) further distinguishes two kinds of software production process models; operational and non-operational. The former can be viewed as computational scripts or programs that implement a specific regimen of software engineering, while the latter denote conceptual approaches that have not yet been sufficiently articulated in a form suitable for codification or automated processing (Scacchi, 2001). There are two classes of non-operational software process models; the spiral model and the continuous transformation models. Three classes of operational software process models are identified; operational specifications for rapid prototyping, software automation, and software process automation and programming (Scacchi, 2001).

In relation to process types, Maleyeff (2009) analyses service processes across a broad range of organisations, examining 168 service systems in total. The table below
summarises Maleyeff’s findings, identifying six process types; troubleshooting, gathering, evaluation, analysis, planning and consultation.

| Type             | Description                                      | Examples                                                      | No. |
|------------------|--------------------------------------------------|                                                               |     |
| Troubleshooting  | Solves customer problems                         | IT Help desk, Parts return, Root cause investigation, Complaints handling | 26  |
| Gathering        | Summarises and codifies information for people to use. | Installation instructions, Maintenance guidelines, Accounting statements, Accident reporting, Environmental compliance | 21  |
| Evaluation       | Allows determination of whether a specification or standard is being met. | Auditing, Design change, Laboratory testing, Part inspection, Bill payment | 38  |
| Analysis         | Determine if resources should be allocated for a specific requested purpose | Proposal writing, Sales quoting, Data analysis, New business analysis | 20  |
| Planning         | Monitoring and control of project activities.     | Software integration, Project management, Metric tracking, Employee orientation, Recruitment | 40  |
| Consultation     | Provide consultancy / how-to advice for customers or other stakeholders. | Tool design, Forecasting, Software development, Supplier selection, Logistics support | 23  |

Table 8: Service process types (Maleyeff, 2009).

An implication drawn by Maleyeff from the above study is that different process types may require different process improvement approaches. This implication opens the door wider to the possibility that processes may take a wide variety of specific forms, and that flexibility is required in the way that these processes are implemented and improved. Narrow definitions of process are therefore not particularly helpful.

This proliferation of process category and type has led inevitably to a situation known as the frameworks quagmire. As Sheard (2001) observes, in the US, the Capability Maturity Models in their various forms were created in the 1980’s to assist software developers, particularly defence contractors, to better meet contractual requirements. Meanwhile the international community developed diverse groups of process improvement and quality standards. The collective effect was the so-called frameworks
quagmire (Sheard, 2001). The presence of such diversity is an indication that process models were seen as a useful tool in the process improvement effort.

Figure 6: The Frameworks Quagmire (Sheard, 2001)

Paulk (2004) discusses the underlying drivers for this diversity of frameworks and points to the general move towards integrating this diversity into a more harmonious whole, as evidenced by the CMM Integration (CMMI).

Sheard (2001) outlines a way to make sense of the quagmire by categorising the frameworks by purpose. One or more of the following six categories apply to most of the frameworks:

- **Standards and guidelines** which establish contractual requirements.
- **Process Improvement Models and Internal Appraisal Methods** which define characteristics of good processes but do not prescribe how they should be enacted. A roadmap from where we are now to where we want to be in the future (in a process maturity sense).
- **Contractor Selection Vehicles** which specify the assessment of an organisation’s processes by a second or third party.
• Quality Awards instigated by governing bodies to recognise achievement (i.e. Malcolm Baldrige National Quality Award in the U.S., and the European Quality Award).


• Systems Engineering Models. The SE-CMM (developed in 1994) and SECAM (developed by INCOSE around same time).

(Sheard, 2001)

In addition to classifying the frameworks by the six categories listed above, Sheard (2001) compares and contrasts the essential characteristics of the seven most significant frameworks, as shown below:

<table>
<thead>
<tr>
<th>Framework</th>
<th>Scope</th>
<th>Purpose</th>
<th>Length, pages</th>
<th>Major Focus</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMM</td>
<td>Software</td>
<td>PI (Process Improved)</td>
<td>500</td>
<td>SW Process</td>
<td>Staged architecture provides &quot;Triptik&quot; (after the AAA map with exact roads, stops, and times highlighted) for improvement.</td>
</tr>
<tr>
<td></td>
<td>developing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SE-CMM</td>
<td>Organization</td>
<td>PI</td>
<td>250</td>
<td>SE Process</td>
<td>Continuous architecture provides map of terrain.</td>
</tr>
<tr>
<td></td>
<td>developing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>systems</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPD-CMM</td>
<td>Enterprise</td>
<td>PI</td>
<td>220</td>
<td>Process</td>
<td>Staged-continuous architecture provides map plus &quot;Triptik.&quot;</td>
</tr>
<tr>
<td>ISO 9000</td>
<td>Product producing organization</td>
<td>Trade</td>
<td>16</td>
<td>Quality Process</td>
<td>Registration certifies a minimum quality system compliance.</td>
</tr>
<tr>
<td>SDCE</td>
<td>Bidding</td>
<td>Contractor selection</td>
<td>600</td>
<td>Process, Capacity, Technology</td>
<td>Evaluates risks to acquire for each bid and reduces risks with winning contractor.</td>
</tr>
<tr>
<td></td>
<td>organization</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Software Lifecycle Standards</td>
<td>Software developing organization</td>
<td>Contract compliance</td>
<td>60-200</td>
<td>Management Process</td>
<td>Standards are evolving to include role of acquirer and other as well as supplier.</td>
</tr>
<tr>
<td>Trillium</td>
<td>Enterprise</td>
<td>PI</td>
<td>130</td>
<td>Process</td>
<td>Combines requirements from CMM, ISO, Baldrige, and software quality standards.</td>
</tr>
</tbody>
</table>

Figure 7: Characteristics of seven frameworks (Sheard, 2001)
CMMI is a process model for software development worthy of consideration. Most notable is ISO/IEC 15504 which contains two Process Assessment Models – ISO/IEC 15504-5, which uses ISO/IEC 12207:1998 as the PRM, and 15504-6, which uses ISO/IEC 15288:2005 as the PRM. A further PAM (15504-8) is under development, based on a PRM derived from ISO 20000 *Information Technology Service Management based on the Information Technology Infrastructure Library (ITIL)*.

Rout and Tuffley (2007) discuss the need to establish a comprehensive mapping between the Process Assessment Model and the relevant Process Reference Model and the Measurement Framework described in ISO/IEC 15504. Equipped with such a mapping, it becomes possible to translate the outputs from an assessment using the Process Assessment Model into the standard process profiles defined in ISO-IEC 15504. Rout and Tuffley (2007) conclude that while a complete mapping can be established, it is not without its weaknesses. The CMMI can be used as a Process Assessment Model in ISO/IEC 15504 Conformant assessments, but the weaknesses must be taken into account.

Also well-known and widely used is the Information Technology Infrastructure Library (ITIL) that has evolved since the 1980’s into ISO/IEC 20000 (from an earlier version of British Standard 15000). Or more accurately, ISO/IEC 20000 covers the IT Service Management elements of ITIL. Other best practice process models of the same ilk include the Information Services Procurement Library (ISPL), the Application Services Library (ASL), and the Dynamic Systems Development Method (DSDM).

So CMMI is in good company. While these previously mentioned process models to some extent deal with the topic of integrated teaming and to a lesser extent the challenges of operating in a virtual environment, the CMMI-IPPD has been selected as a component of this project due to its overall completeness in identifying and modelling the issues surrounding integrated teaming. Its suitability derives from the maturity of the concepts embodied within the model, having been derived from the IPD-CMM and Concurrent Engineering.

Essentially, Concurrent Engineering places emphasis on including consideration of process design when making design decisions, the formation of cross-functional teams and a focus on ensuring customer needs are being met during the development effort (Smith, 1997).
3.2.6. Current & future process research

From modest beginnings, a thriving international community of process research scholars and practitioners has evolved. The Software Engineering Institute sponsored International Process Research Consortium’s (IPRC) roadmap for future SE process research (SEI, 2006) identifies the future direction of process research. As such it is an invaluable resource for contributors to this research domain seeking to inform their work with relevance and context.

The result of this collaboration (six workshops involving 27 IPRC members between 2004 and 2006) is a thematic guide to critical process research, described as the Process Research Framework (SEI, 2006). It is worth mentioning these in the context of this research project to show that this project is consistent with the aims of the IPRC.

Four broad research themes emerged from the IPRC’s work:

- **Process and product quality relationships** – emphasising the product perspective, how process affects product characteristics.

- **Process engineering** – with emphasis on how to define processes.

- **Managing project processes** – emphasising the project organisation perspective, including the political, economic and/or social values of stakeholders.

- **Process deployment** – emphasising the people perspective, how to deploy the right processes into the right organisational structures so that the people concerned have optimal opportunities.

These four themes are comprised of 20 research nodes addressing around 230 research questions. They act together to support structured thinking in the process domain (SEI, 2006). Underpinning these themes and nodes is a set of nine driving forces, derived from an original set of more than 100; value add, business diversification, technology change, system complexity, product quality, product turnaround, regulation, security and safety, and globalization.

The leadership PRM under development in this project has particular relevance to the process engineering and managing project processes – research themes.
As seen in the table below, **Theme E: Process Engineering**, the following seven research questions have particular relevance to this project, while in **Theme P: Managing Project Processes**, five questions are relevant.

<table>
<thead>
<tr>
<th>IPRC Research Framework</th>
<th>Relevance to Leadership PRM project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research questions</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Theme E: Process Engineering</strong></td>
<td></td>
</tr>
<tr>
<td>E-1 How can usable best practice be identified?</td>
<td>Literature review and review cycles identify and validate usable best practice.</td>
</tr>
<tr>
<td>E-2 What kinds of processes are needed for value-creating networks; virtual teams, partnering, outsourcing, multi-site development, end-user development?</td>
<td>PRM specifically identifies processes needed to facilitate effective virtual teams in multi-site development contexts.</td>
</tr>
<tr>
<td>E-4 How to perform a gap analysis between today’s state and desirable future state?</td>
<td>PRM has the potential to be developed into a Process Assessment Model subsequent to this project. PAM offers the ability to perform such gap analysis.</td>
</tr>
<tr>
<td>E-5 How can we best specify a process?</td>
<td>Posits that using an ISO/IEC 24774 compliant process specification method is effective. This position is evaluated in light of the results.</td>
</tr>
<tr>
<td>E-6 How can process definitions be packaged together with a quantitative /qualitative model describing their behavior?</td>
<td>Leadership PRM defines processes, as in E-5 into a model that describes the qualities and characteristics of an effective leader.</td>
</tr>
<tr>
<td>E-8 Can a process be analysed to determine if it is implementable?</td>
<td>Leadership PRM initial review (V0.1 to V0.2) validates the draft PRM by asking practitioner project managers if the process outcome can be validated with objective evidence in the form of activities and/or artefacts. Only validated processes remain in the PRM as it progresses through review cycles.</td>
</tr>
<tr>
<td>E-9 What process evidence is required?</td>
<td>The collected results of the validation review referred to above are instantiations of the process outcomes, and as such constitute evidence of process performance.</td>
</tr>
<tr>
<td><strong>Theme P: Managing Project Processes</strong></td>
<td></td>
</tr>
<tr>
<td>P-3 What are the needed competencies for the required tasks on a specific project?</td>
<td>Leadership PRM specifically describes the competencies (or characteristics) of effective leaders on projects.</td>
</tr>
</tbody>
</table>
### Table 9: IPRC Research Framework Research questions (SEI 2006) and relevance to Leadership PRM project

<table>
<thead>
<tr>
<th></th>
<th>Research question</th>
<th>Relevance to Leadership PRM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P-5</strong></td>
<td>How do we make optimal use of available competencies? How do we effectively combine competencies available in different companies?</td>
<td>Leadership PRM specifically describes optimal usage patterns for HR competencies.</td>
</tr>
<tr>
<td><strong>P-7</strong></td>
<td>How do we manage development between different locations?</td>
<td>Leadership PRM specifically addresses the issue of how to lead non-co-located and/or complex project teams.</td>
</tr>
<tr>
<td><strong>P-15</strong></td>
<td>How do we make processes that are compliant with accepted standards?</td>
<td>This project posits that a ISO/IEC 24774 should be used for wide-scale PRM usage.</td>
</tr>
<tr>
<td><strong>P-23</strong></td>
<td>How do we manage virtual teams? How are VT’s formed?</td>
<td>PRM is fundamentally about leading (enhanced management) virtual teams.</td>
</tr>
</tbody>
</table>

In addition to the above, there are a number of other research questions in both themes that are too marginal to mention here, though nonetheless relevant to some degree.

It may be seen from the table above that this project is aligned in at least 12 ways with the broader process research framework, as outlined in *A Process Research Framework: The International Process Research Consortium* (2006). This substantiates that this project has relevance to the academic research agenda, in addition to the relevance to the practitioner community discussed in Chapters 1 and 2.
3.3. **Teams (co-located and virtual)**

This section examines the broad topic of virtual and co-located teams. Note that an integrated team can fit into either category. More detailed discussion, including important distinctions will come in later sections.

3.3.1. **Definition of team**

Watts Humphrey, author of the Team Software Process (2000), observes that there are many definitions of teams. This is hardly surprising given the importance of team-work stretching back to our evolutionary past.

A survey of the commonly understood meaning of ‘team’ suggests that it is a co-operative unit of some kind (humans or animal) linked by a common purpose. Complex projects can be comprised of multiple teams with an interdisciplinary focus.

For an empirical definition, one that is not based on the ‘wisdom of the crowd’, we turn to Watts Humphrey. In terms of teams engaged in the development of technology, the definition selected by Humphrey as an operational definition in this well-respected model of team software process is:

A team consists of:

1. At least two people, who
2. Are working towards a common goal/objective/mission, where
3. Each person has been assigned specific roles or functions to perform, and where
4. Completion of the mission requires some form of dependency among group members.

(Humphrey, 2000)
3.3.2. Co-located Teams

The factors discussed in this section are not necessarily confined to co-located teams. They come from the management tradition that existed before virtual teams became commonplace. It is stressed that the literature does not in general preclude the application of team principles to virtual teams.

3.3.2.1. Trust

The concept of trust is mentioned repeatedly as an indispensable aspect of successful projects. Trust can be defined as confidence. In terms of project groups we can make a distinction between bilateral trust between individual group members (one-to-one trust) and general trust (one-to-all) in the project group (Humphrey, 2000).

The importance of trust to successful project outcomes is indicated by it being mentioned frequently in much of the literature on network theory (Mønsted 1994, 1994a, and Powell and Smith-Doerr 1994). Trust is seen in this literature as being key to the success of networks.

The importance of trust is also acknowledged and discussed in knowledge management theory on co-operative knowledge creation (e.g. Wathne et al. 1996).

3.3.2.2. Group interdependence

Bennis and Biederman (1997) explore the importance of interdependence in a series of six case studies of ‘Great Groups’. One notable project among these was the Manhattan Project. Bennis and Biederman (1997:190) make the critical observation that ‘members of Great Groups submerge their egos for the mission’ in the spirit of self-sacrifice. The Manhattan project team members described their leader J. Robert Oppenheimer as charismatic, a man with an ‘intense presence’ and ‘poetic vision’. Oppenheimer was apparently capable of motivating, even inspiring the team members with a powerful team spirit. ‘Inspiration’ (or to infuse with spirit) is used in the same sense that ‘charisma’ is said to be a ‘gift from God’ in the original Greek. Evidence of this is heard in the description by one scientist who went so far as to comment that in Oppenheimer’s presence ‘I became more intelligent, more vocal, more intense, more prescient, more poetic.... ’ (Bennis and Biederman, 1997:188). Oppenheimer as team
leader/project manager acted as a kind of ‘spiritual midwife’ with his ability to bring forth and realise the potential of the team members.

It is not clear whether Oppenheimer acted consciously in this regard, or that he was exercising an instinct. Most likely it was combination of the two. Oppenheimer managed to create and instil among a collection of gifted scientists a sense of common purpose, interdependency and of being on an important mission together. This appeared to go well beyond what might be expected under the serious circumstances in which they found themselves. It was strongly suspected by the Americans that Nazi Germany was pursuing similar research, and not only the outcome of the Second World War, but conceivably the future of humankind depended on their being first to realise their objectives.

Bennis and Biederman (1997:185) note that team spirit and interdependence was engendered not only through the scientific work, but also through recreational pursuits like skiing in the mountains of New Mexico, square dancing and general partying in which people had ‘enormous amounts of fun’. It is not reported how readily the European members of the team adapted to American square dancing.

### 3.3.2.3. Operational definition of an integrated team

The CMMI defines an Integrated Team as *a group of people with complementary skills and expertise who are committed to delivering specified work products in timely collaboration. Integrated team members provide skills and advocacy appropriate to all phases of the work products’ life and are collectively responsible for delivering the work products as specified. The integrated team should include empowered representatives from organizations, disciplines, and functions that have a stake in the success of the work products* (Chrissis, Konrad and Shrum, 2003).

It can be seen from this definition that an integrated team is a broadly defined concept that potentially includes either/or a combination of co-located and distributed teams working together to realise a complex project outcome. A virtual team is therefore included in this catchall definition because it is analogous to a distributed team.
3.3.2.4. **Capability Maturity Model Integration IPPD addition**

The current version of the CMMI (V1.2) as developed by Carnegie-Mellon University’s Software Engineering Institute offers a basis for thinking about integrated teams.

Integrated Product and Process Development (IPPD) evolved from the earlier IPD (Integrated Product Development) Capability Maturity Model (CMM) which was amalgamated with the Software CMM and the Systems Engineering CMM in the late 1990’s to form the CMMI, hence the term ‘Integration’. This was an effort to reduce the complexity and number of individual Capability Maturity Models (Sheard, 2001).

The precursor of IPPD was therefore the IPD-CMM. The IPD-CMM itself evolved from earlier work done in the area of Concurrent Engineering in the 1980’s (Garcia, 1997). The IPD-CMM is characterised as a *systematic approach to product development that achieves a timely collaboration of necessary disciplines throughout the product life cycle to better satisfy customer needs* (Konrad et al, 1996). IPD thus involves:

1. setting up and managing multi-disciplinary work units (e.g., teams) charged with developing a product, and
2. integrating the disciplines needed to conduct the technical work, (Konrad et al, 1996).

The precursors of Concurrent Engineering stretch back to the late 19th century. The term Concurrent Engineering applies to a design philosophy of cross-functional cooperation to create products that are better, cheaper, and more quickly brought to market (Smith, 1997). The over-arching concern of the concurrent approach is the ability of the developer to accurately assess and respond to the real product requirements by being sufficiently open-minded and adaptable under any given set of circumstances and constraints.

Backhouse and Brookes (1996) define Concurrent Engineering as a *systematic approach to the integrated, concurrent design of products and their related processes, including manufacture and support. Typically, concurrent engineering involves the formation of cross-functional teams, which allows engineers and managers of different disciplines to work together simultaneously in developing product and process design. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from concept through disposal, including quality, cost, schedule, and user requirements.*
The CMMI-IPPD can be seen to have a long history, having been developed incrementally over many decades through a variety of stages (IPD-CMM, Concurrent Engineering and earlier forms). It is arguably a very mature and effective approach to the matter of integrated teaming and an appropriate choice for this project.

### 3.3.2.5. Relationship of CMMI to People CMM

The People CMM (Capability Maturity Model) offers in-depth treatment of team operation, though in People CMM the word ‘team’ is avoided, with ‘workgroup’ being substituted to avoid the sometimes incorrect connotations for the word ‘team’.

According to Curtis et al (2001) it is possible to integrate People CMM improvement programs with those guided by CMMI in general, and with those guided by CMMI-IPPD in particular. The table below illustrates the process area mappings between CMMI-IPPD and People CMM. Note that the subsequent version (V1.2) of the CMMI reorganizes and simplifies some IPPD-related process areas, making the mappings illustrated below obsolete in terms of the current version of CMMI. They are included here to reinforce the point that People CMM is useful for integrated project teams.

<table>
<thead>
<tr>
<th>CMMI Process Area (V1.1)</th>
<th>People CMM Process Area (V2.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Project Management</td>
<td>Workgroup Development</td>
</tr>
<tr>
<td></td>
<td>Competency Analysis</td>
</tr>
<tr>
<td>Integrated Teaming (now incorporated into Integrated Project Management)</td>
<td>Communication and Coordination</td>
</tr>
<tr>
<td></td>
<td>Workgroup Development</td>
</tr>
<tr>
<td>Organizational Environment for Integration Work Environment (now incorporated into Organizational Process Definition)</td>
<td>Communication and Coordination</td>
</tr>
<tr>
<td></td>
<td>Compensation</td>
</tr>
<tr>
<td></td>
<td>Workgroup Development</td>
</tr>
<tr>
<td></td>
<td>Participatory Culture</td>
</tr>
<tr>
<td></td>
<td>Workforce Planning</td>
</tr>
<tr>
<td></td>
<td>Competency Development</td>
</tr>
<tr>
<td></td>
<td>Competency-Based Practices</td>
</tr>
</tbody>
</table>

Table 10: People CMM Process Areas that Support the CMMI IPPD (Curtis et al, 2001)

Yet while both models may be useful for developing integrated teams, it is significant that neither deal in any detail with the issue of leadership, at least not explicitly.
3.3.2.6. **CMMI Process areas, specific goals and practices related to integrated teaming**

This section outlines the specific goals and practices from the CMMI that are relevant to IPPD. Version 1.2 of CMMI was introduced in 2006, superseding V1.1 which outlined IPPD in three distinct levels; organisational, project, and team levels. V1.2 improves on this approach by more closely integrating IPPD into the process areas of Integrated Project Management (IPM) and Organisational Process Definition (OPD).

When comparing the content of this section, which is derived directly from the CMMI, with the rest of this literature review (sections derived from the literature of the mainstream management domain, and also the literature of software engineering), it will be seen that some of the principles and practices outlined in the CMMI are clearly reflected in the other literature.

This includes matters such as the establishment of shared vision, commitment to the vision, the establishment is of an integrated work environment (or the organisational commitment of resources), commitment to training.

In addition, correspondence between CMMI and mainstream management literature works to strengthen the claim that the CMMI is an appropriate model to use for the purposes of this project.

**Important Note**, the sections that follow have been extracted from the CMMI-IPPD V1.2 model. For clarity, the wordings have not been changed. All such text is italicised to indicate that it has been quoted verbatim from the CMMI-IPPD V1.2. The bracketed code at the end of each minor heading is the CMMI process area (eg. IPM = Integrated Project Management) specific goals and practices relevant to IPPD.

**Establish the Project's Work Environment (IPM+IPPD SP1.3)**

An effective work environment helps projects employing IPPD to conduct work using collocated or distributed integrated teams. Two-way communications media should be readily accessible by all relevant stakeholders in the project.
**Apply IPPD Principles (IPM+IPPD SG3)**

The purpose of this specific goal and its practices is to create an IPPD environment that enables integrated teams to efficiently meet the project’s requirements and produce a quality product.

**Establish the Project’s Shared Vision (IPM+IPPD SP3.1)**

Establish and maintain a shared vision for the project. A project does not operate in isolation. Understanding organizational mission, goals, expectations and constraints allows the project to align its direction, activities, and shared vision with the organization and helps create a common purpose within which project activities can be coordinated. To enable this, it is critical to understand the interfaces between the project and stakeholders external to the project and the objectives and expectations of all relevant stakeholders (internal and external).

When creating a shared vision, consider:

1. external stakeholder expectations and requirements
2. the aspirations and expectations of the project leader, team leaders, and team members
3. the project’s objectives
4. the conditions and outcomes the project will create
5. interfaces the project needs to maintain
6. the visions created by interfacing groups
7. the constraints imposed by outside authorities (e.g., environmental regulations)
8. project operation while working to achieve its objectives (both principles and behaviors)

**Establish the Integrated Team Structure (IPM+IPPD SP3.2)**

Establish and maintain the integrated team structure for the project. Product requirements, cost, schedule, risk, resource projections, business processes, the project’s defined process, and organizational guidelines are evaluated to establish the basis for defining integrated teams and their responsibilities, authorities, and interrelationships.
A typical integrated team structure may be based on the product oriented hierarchy found in the WBS. More complex structuring occurs when the WBS is not product oriented, product risks are not uniform, and resources are constrained.

The integrated team structure is a dynamic entity that is adjusted to changes in people, requirements, and the nature of tasks, and to tackle many difficulties. For small projects, the integrated team structure can treat the whole project as an integrated team. The integrated team structure should be continuously monitored to detect malfunctions, mismanaged interfaces, and mismatches of the work to the staff. Corrective action should be taken when performance does not meet expectations.

**Allocate Requirements to Integrated Teams (IPM+IPPD SP3.3)**

Allocate requirements, responsibilities, tasks, and interfaces to teams in the integrated team structure.

This allocation of requirements to integrated teams is done before any teams are formed to verify that the integrated team structure is workable and covers all the necessary requirements, responsibilities, authorities, tasks, and interfaces. Once the structure is confirmed, integrated team sponsors are chosen to establish the individual teams in the structure.

**Establish Integrated Teams (IPM+IPPD SP3.4)**

Establish and maintain integrated teams in the structure. The integrated teams within the integrated team structure are established by the team sponsors. This process encompasses choosing team leaders and team members, and establishing the team charter for each integrated team based on the allocation of requirements. It also involves providing the resources required to accomplish the tasks assigned to the team.

**Ensure Collaboration among Interfacing Teams (IPM+IPPD SP3.5)**

The success of an integrated team-based project is a function of how effectively and successfully the integrated teams collaborate with one another to achieve project objectives. This collaboration may be accomplished using interface control working groups.

See the Coordinate and Collaborate with Relevant Stakeholders specific goal of this process area for more information about managing stakeholder involvement, critical dependencies, and resolving coordination issues.
Enable IPPD Management (OPD+IPPD SG2)

Organizational rules and guidelines, which govern the operation of integrated teams, are provided.

An organizational infrastructure that supports and promotes IPPD concepts is critical if it is to be successfully sustained over the long term. These rules and guidelines promote concepts such as integrated teaming and allow for empowered decision making at many levels.

Through its rules and guidelines, the organization demonstrates commitment to IPPD and the success of its integrated teams. IPPD rules and guidelines become part of the organization’s set of standard processes and the project’s defined process. The organization’s standard processes enable, promote, and reinforce the behaviors expected from projects, integrated teams, and people. These expected behaviors are typically communicated in the form of policies, operating procedures, guidelines, and other organizational process assets.

Establish Empowerment Mechanisms (OPD+IPPD SP2.1)

Establish and maintain empowerment mechanisms to enable timely decision making.

In a successful IPPD environment, clear channels of responsibility and authority must be established. Issues can arise at any level of the organization when integrated teams assume too much or too little authority and when it is unclear who is responsible for making decisions. Documenting and deploying organizational guidelines that clearly define the empowerment of integrated teams can prevent these issues.

Implementing IPPD introduces challenges to leadership because of the cultural changes required when people and integrated teams are empowered and decisions are driven to the lowest level appropriate. Effective and efficient communication mechanisms are critical to timely and sound decision making in the integrated work environment. Once an integrated team project structure is established and training is provided, mechanisms to handle empowerment, decision making, and issue resolution also need to be provided.

Establish Rules and Guidelines for Integrated Teams (OPD+IPPD SP2.2)

Establish and maintain organizational rules and guidelines for structuring and forming integrated teams.
Operating rules and guidelines for the integrated teams define and control how teams interact to accomplish objectives. These rules and guidelines also promote the effective leveraging of the teams’ efforts, high performance, and productivity. Integrated team members must understand the standards for work and participate according to those standards.

**Balance Team and Home Organization Responsibilities (OPD+IPPD SP2.3)**

Establish and maintain organizational guidelines to help team members balance their team and home organization responsibilities.

A ‘home organization’ is the part of the organization to which team members are assigned when they are not on an integrated team. A home organization may be called a ‘functional organization,’ ‘home base,’ ‘home office,’ or ‘direct organization.’ Home organizations are often responsible for the career growth of their members (e.g., performance appraisals and training to maintain functional and discipline expertise).

In an IPPD environment, reporting procedures and rating systems assume that members’ responsibilities are focused on the integrated team, not on the home organization. However, the responsibility of integrated team members to their home organizations is also important, specifically for process implementation and improvement. Workloads and responsibilities should be balanced between projects and functions, and career growth and advancement. Organizational mechanisms should exist that support the home organization while aligning the workforce to meet business objectives in a teaming environment.

Sometimes teams persist beyond their productive life in organizations that do not have a home organization for the team members to return to after the integrated the team is dissolved. Therefore, there should be guidelines for disbanding the integrated teams and maintaining home organizations.

### 3.3.3. Virtual Teams

A virtual team can be broadly described as a group of people who perform their work using information and communication technology to bridge time, space, and organizational boundaries. In common with co-located teams, virtual teams have complementary skill-sets, are interdependent and share a common purpose. A working definition based on the relevant literature is given in the following section.
Virtual teams can include integrated teams by definition. The previous sections discuss at length the characteristics of integrated teams, and while this discussion is located in the 'co-located' team category, it should not be perceived as belonging solely in that category.

### 3.3.3.1. Distinguishing virtual teams from co-located teams

Bell and Kozlowski (2002) quoting a widely cited earlier study by Townsend et al (1998) defines virtual teams as:

*Groups of geographically and/or organizationally dispersed co-workers that are assembled using a combination of telecommunications and information technologies to accomplish and organizational task.*

Virtual teams can therefore be distinguished from conventional teams in two fundamental ways; their *spatial proximity* and the *communications technologies* employed.

When contrasting Townsend et al’s (1998) definition of virtual teams with that of conventional teams (Humphrey, 2000), we see that the Humphrey definition offers a good general purpose view of what a team is:

*Reiterating, a team consists of:*

1. At least two people, who
2. Are working towards a common goal/objective/mission, where
3. Each person has been assigned specific roles or functions to perform, and where
4. Completion of the mission requires some form of dependency among group members.

### 3.3.3.2. Operational definition of virtual team

It is reasonable therefore to combine these two definitions to form an operational definition for the purposes of this project:

*A virtual team consists of:*

1. At least two mutually interdependent people, who
2. Are geographically dispersed, and who
3. Are working towards a common goal/objective/mission, where
4. Each person is assigned specific roles or functions to perform, and where
5. Communication is facilitated by a combination of telecommunications and information technologies to work towards the completion of the project/mission.

**Important Note**, the preceding italicised sections have been extracted from the CMMI-IPPD V1.2 model. For clarity, the wordings have not been changed. All such text is italicised to indicate that it has been quoted verbatim from the CMMI-IPPD V1.2. The bracketed code at the end of each minor heading is the CMMI process area (eg. IPM = Integrated Project Management) specific goals and practices relevant to IPPD.

### 3.4. Characteristics of successful teams

#### 3.4.1. Bennis & Beiderman’s characteristics of Great Groups

In their widely-discussed book, Bennis and Beiderman (1997) examine six high performance project teams (called ‘Great Groups’) that in one way or another changed the world. These include teams at Xerox’s PARC labs pioneers in human-computer interface research), the Manhattan Project (development of A-bomb for US DoD), the 1992 Clinton campaign (defeated GHB for President), Lockheed Skunk Works (innovative aircraft, including U-2, SR-71, F-117, F-22), and Disney animation studios (standard-setting animation techniques). Their examination aims to encapsulate the characteristics of successful team-work. Their findings can be summed up in the quote ‘All great teams--and all great organizations--are built around a shared dream or motivating purpose.’

Bennis and Beiderman (1997) distil their findings into ten principles, as summarised below:

1. **At the heart of Great Groups is a shared dream.** Great Groups are convinced they are engaged in important work, sometimes nothing short of being on a ‘mission from God’. The work becomes an abiding obsession, a
quest that goes well beyond mere employment. This intensely shared vision and sense of purpose endows cohesion and persistence.

2. **Conflict is constructively managed by submerging individual egos for the greater good.** Inevitable conflict between team members is managed by reminding members of the over-arching importance of the mission. For example, during the Manhattan Project, George Kistiakowsky, a pivotal member of the team threatened to leave over conflict with another member. Project leader Robert Oppenheimer said, ‘George, how can you leave this project? The free world hangs in the balance.’ Kistiakowsky was thus persuaded to submerge his individual concerns for the greater good of the project.

3. **Team members are insulated from bureaucracy.** Great Groups have a dislike and disdain for their corporate overseers, who are perceived as functionaries with little real vision who must not be allowed to interfere with the real work. The important task of insulating the team is performed by a leader – though not necessarily the same person who promulgates the galvanising dream. For example, on the Manhattan Project it was General Leslie Grove who insulated the team from the Pentagon, while Oppenheimer kept the team focused on its mission. At Lockheed, Kelly Johnson had himself appointed to the board of directors in order to insulate his beloved Skunk Works. Physical distance from corporate headquarters is an important aspect.

4. **There is a real or perceived enemy.** The presence of an enemy who must be defeated is a powerful motivator and unifier of effort. This is seen most clearly on the Manhattan Project where there was indeed the Imperial Japanese and the Nazis. Indeed, most organizations have an explicit and/or implicit objective to overwhelm their competitors. For example, Apple Computer’s implicit mission was, ‘Bury IBM’.

5. **Great Groups regard themselves as having underdog status.** High performance groups seem to be often constituted by unconventional people. So-called mavericks, people at the edges of their disciplines. They are at the edge through a process of self-marginalisation, being unwilling to subscribe to mainstream values, and marginalisation by the larger discipline through their aforementioned refusal to be conventional. For these people,
there is no sacred cow that is beyond criticism. ‘Membership in a Great Group isn't a day job; it is a night and day job.’

6. **Team members often pay a personal price.** Membership in high performance teams, or Great Groups seems to exact a high price. Because the work is not only a day job; but a night and day job, it is not uncommon for divorces, affairs, and other extreme emotional matters to be common, particularly when the project finishes. At Lockheed’s Skunk Works, for example, team members were not allowed to tell their families what they were working on. The energy and intensity that such groups generate can lead to unfortunate, sometimes socially dysfunctional consequences in their lives outside of the project.

7. **Great Groups produce strong leaders.** While group leaders tend to be non-hierarchical, open, and egalitarian, they nonetheless display strength. There cannot be a Great Group without a great leader -- and vice versa. In an important way, Bennis and Beiderman (1997) observe that it is the groups that make the leaders great. The willing and unified support of the group endows the leader with strength and authority. Leaders are connoisseurs of talent, more like curators than creators.

8. **Great Groups are the product of meticulous recruiting.** Selecting the right people for a group means being clear about what is required, and how to recognize it in potential team members. Potential members can be put through a very rigorous selection process, in order that the right person goes into the right job.

9. **Great Groups are usually young.** Youth provides the physical stamina demanded by Great Groups. The average age of the physicists at Los Alamos was around 25. Great Groups are also young in their spirit, ethos, and culture. Importantly however, because they are young and naive, group members don't know what's supposed to be impossible, which gives them the ability to do the impossible. The inflexibility of mind, the setting-in of habitual ways in the minds of older people is the real enemy here, not the nominal age of a person.

10. **Successful groups deliver the goods.** Great Groups must, in the end, produce a tangible outcome external to themselves. Most groups dissolve after the product is delivered. Steve Jobs was fond of reminding his Apple
team that their work meant nothing unless they brought a great product to market.

(Bennis and Beiderman, 1997)

### 3.4.2. Successful self-directed project teams

Capozzoli (1998) discusses nine success factors that are identified to optimize team functioning, as summarised below:

1. **A well thought-out vision of how these teams will fit into the scheme of the entire organization.** There must be a shared vision of the team leadership, and this must be supported by everyone in management.

2. **Commitment to vision.** The whole organization must be willing and prepared to change their culture to support the teams. This may be radically different from what the organisation is accustomed to doing. This change should be incremental, with everyone concerned understanding the reasons behind the need for change.

3. **Organizational commitment of resources.** The organization from the highest level must have the resources necessary to commit to this type of change in time, money and people. A substantial initial investment will usually be needed, and the length of time required will be in the long-term. These resources include trainers (from inside or outside the organisation) who will develop the teams.

4. **Commitment to training.** Team members must receive comprehensive training on how they can function together. This should include conflict management skills, assertiveness, communication (listening in particular), problem-solving and decision-making part of the key skills. There must also be facilitators or mentors trained who can work with the teams.

5. **Getting to know you.** When training is completed, enough time must be spent allowing team members to become well acquainted with each other, in effect to bond. It is important to avoid the pitfall of thinking that once training is finished, the teams are ready to function. Some teams take longer to develop than others. Management needs to have the patience and people available to help this development.
6. **Performance targets established.** The team members need to understand clearly what is expected of them in terms of performance. These expectations should be realistic but challenging.

7. **Feedback mechanisms established.** The means to derive feedback that allows teams to identify what they are doing correctly and incorrectly must be established. This allows the teams to achieve continuous improvement by benchmarking their efforts against knowledge and standards.

8. **Team boundaries established.** It must be clearly understood where the limits are of a team's authority.

9. **Self-directed teams still require management supervision.** Self-directed teams still require management oversight, even though they have taken over some of the functions of management but they still require guidance.

(Capozzoli, 1998)

### 3.4.3. Successful integrated teams

Cusick (1997) in a wide-ranging survey of organisations engaged in integrated product development identified six factors that distinguished effective Integrated Product Development (IPD) from ineffective IPD. In this context IPD refers to complex development projects requiring effort and input from multi-disciplinary team members. These are as follows:

1. **Focus on people and personal commitment.** The organisation must be committed to training and personal development, developing productivity tools that promote personal accountability. Successful companies use training to communicate desired value to develop new culture. Many companies underestimate how much training is necessary, or found that the wrong type of training had been provided. Special emphasis on training the team leader. Often inadequate training on interpersonal skills was a problem.

2. **An organizational structure that is consistent with company goals.** Avoid the use of tools that do not work in IPD environment. Avoid the use of team structures that are not clearly aligned with the work breakdown structure. Cross-functional team structure that followed the product from
end to end, with an ideal team size of around 10 people. Full-time team members were preferred, though this is not always practical. Also included in this is communication and data-sharing.

3. **An emphasis on planning.** Planning becomes more important in IPD environment due in part to the involvement of diverse stakeholders and relatively autonomous product teams. Effective resource allocation requires a front loaded funding profile.

4. **The focus on measurement and processes.** Successful IPD organisations demonstrate clear commitment to improving their processes, and adhering to them strictly.

5. **Careful monitoring of the decision-making process.** Stakeholders are always involved in decisions that affect them, while avoiding becoming bogged down in the decision-making process. Successful companies have clearly defined decision-making processes, with clearly defined input, involvement and decision authority of various types of decision. Consensus needs to be defined.

6. **Leadership dedicated to IPD.** Management sets and communicates measurable, attainable goals. Effective leadership cannot be underestimated in and IPD environment. Unclear mixed signals from leaders keeps organisations stuck in a transition phase never achieving the expected benefits of IPD. Effective leadership also includes providing rewards and recognition will stop the degree of correlation between rewards and recognition and the organisational goals often appeared to be distinguishing factor in the degree of success.

(Cusick. 1997)

Specific observations are summarised as follows (Cusick, 1997):

1. **Team makeup and structure.** Effective IPD teams used some form of cross functional team that followed the product from beginning to end. The ideal team size was agreed to be about 10 people.

2. **Training.** A commitment to ample training was critical. Effective IPD teams and their parent companies used training to communicate desired values and institutionalise a new culture.
3. **Decision-making.** Effective IPD teams and their parent companies spent much time working out how the decision making processes changed in the new IPD environment. Effective IPD teams and their parent companies had clearly defined decision making process clearly defining input, involvement and decision authority for various types of decisions.

4. **Organizational structure.** Effective IPD teams and their parent companies maintain a highly functional organisational structure. This clearly defined the role of the functional organization, which typically was to act as process owners, maintain a core competency, and focus on personnel development and job assignments.

5. **Communication and data sharing.** All participants in Cusick’s (1997) survey agreed that data sharing and communication was initially more difficult under the revised organisational structure. The challenges of data sharing increase as people go through a period of feeling overwhelmed, followed by a more productive period in which adjustments have been made to meet the challenges of increased data sharing.

6. **Stakeholder involvement.** All participants in Cusick’s (1997) survey agreed that having the customer (or direct customer surrogate) on the team, while at times painful, was critical. However, it is very important to define the role of the customer early on.

7. **Leadership.** The importance of leadership in transitioning and maintaining an IPD environment cannot be understated. Management commitment is recognised as the number one factor in IPD success.

8. **Rewards and recognition.** The degree of correlation between rewards and recognition and the organizational goals often appeared to be a distinguishing factor in the degree of success. Companies that were promoting old behavior were precluding the possibility of being really successful.

9. **Policies procedures and tools.** It is important to remember to change the tools to be compatible with the new organizational structure. For example some companies continued to use a functional/discipline based WBS, not a product based WBS, tracking cost by functional organization.
10. **Resource allocation.** All participants in Cusick’s (1997) survey agreed that to be effective IPD requires a front loading funding profile. Some Defense contractors found it to be difficult to convince the government to front load a multi-year procurement contract.

(Cusick. 1997)

### 3.4.4. Successful cross functional teams

Taninecz (1996) discusses the general in engineering disciplines of moving engineers into team environments, rather than-isolating them in ‘technical, cerebral cubicles’. The trend to downsize and flatten organisations requires cross functional teams in order to facilitate product development. This trend emphasises engineers acquiring a wide range of cross disciplinary skills, as well as the importance of partnering with clients. This latter trend has been termed client-teaming. The end result, and the underlying motivation for client-teaming is the desire to achieve for the customer a product that is acceptable, at a good price, delivered on time, and that fits the design parameters they need.

Taninecz (1996) emphasises that in order to make the transition to engineering teamwork, and derive the benefits of reducing the product development time frame, the motivation to change must emanate from and be driven by management. The obstacles to this include engineering silos and all engineers who are unwilling or unable to leave those ‘towers of isolation’. This unwillingness is most often seen in engineers who have been in the job for a long time, living and working in a solely technical world. However once they realise the impact on the long-term job prospects of being a good team player, of acquiring soft skills, they often want to ‘get on board’. Essentially it is about engineers needing to ‘be connected to the overall vision of the company’.

### 3.4.5. Importance of shared vision

*The last thing IBM needs now is a vision!* (Lou Gerstner, IBM CEO, ca. 1990).

Potts and Catledge (1996) describe a case in which a large industrial software project is observed as the development team performs design activities over a three month period, with follow-up observations and discussions over a further eight months. Potts
and Catledge (1996) focus on the patterns of collaboration as they impact on their ability to converge on a ‘common vision’.

Potts and Catledge (1996) discuss three observations. The first, convergence on a common vision was both laboriously slow and was demarcated by several reorientations of direction. Second, the design process displayed aspects of inherent forgetfulness, with repeated resurfacing of previously discussed issues needing to be re-discussed. Third, there was an ongoing conflict of values between team members involved with system development and those responsible for overseeing the development process.

This process was not spontaneous, requiring considerable effort to bring about, though it was recognized as being necessary for a successful project outcome.

### 3.4.6. Characteristics of unsuccessful teams

As a final word on the subject of what characterises a successful team, it is instructive to review Ed Yourdon’s oft-cited ‘death-march’ project characteristics (2005).

By knowing what a successful project is not, we are in a better position to understand what a successful project is.

A ‘death march’ is defined by Yourdon as being one in which the project parameters are exceeded by at least 50% (Yourdon, 2005). Said parameters include the schedule, staffing, budget and system functionality aspects of the project. While individual death march projects can technically succeed from an outcomes perspective, it is the death march culture that ultimately fails.

Yourdon cites the following reasons for death march projects:

- Politics, politics, politics
- Naïve and/or devious promises made by marketing, senior executive, inexperienced project managers, etc.
- Naïve optimism of youth: ‘We can do it over the weekend’
- The ‘startup’ mentality of fledgling entrepreneurial companies
- The ‘Marine Corps’ mentality: Real programmers don't need sleep
- Intense competition caused by globalization of markets
• Intense competition caused by the appearance of new technologies
• Intense pressure caused by unexpected government regulations
• Unexpected and/or unplanned crises eg., your hardware/software vendor just went bankrupt, or your three best programmers just died of bubonic plague

(Yourdon, 2005)

‘Death march’ projects, or failed projects in general terms may be characterised as combining some or all of the above elements. The onus is on the project leader to take action to avoid or mitigate the effects of these elements, where present.

### 3.5. Applying Behavior Engineering to process modelling

#### 3.5.1. Rationale for using Behavior Engineering (BE)

Process models are abstract representations of a process architecture, design or definition (Feiler & Humphrey, 1992). They are abstractions, not direct representations of reality. The language that people use when developing these abstractions, these process models, are prone to ambiguity due to the fallible way in which people use language. George Box famously observed that *all models are wrong but some are useful* (Box, 1979). Models are simplifications of reality and in the process of simplifying, essential information might be left out resulting in ambiguity. Even with ambiguity, models can be useful, but this ambiguity points to a need for a way to reduce or eliminate it. Such a way might be found in a formal method such as Behavior Engineering. *Positivist studies apply well to the testing*

In seeking a solution to the problem of ambiguous language in process modelling, one sees a similar problem with the requirements specifications for software systems. Ambiguous language, incomplete descriptions, repetition and redundancies in the way specifications are expressed inevitably leads to sub-optimal project outcomes (systems that do not meet the user’s requirements). Behavior Engineering (Dromey, 2006) successfully addresses the problems faced by software developers seeking to translate a set of user requirements into a complete and consistent requirements specification.
Behavior Engineering uses a formally-grounded graphical notation with the capability to represent a wide range of system behaviors in unambiguous terms. Its strength is its ability to accommodate complexity and detail, ease of use, and in particular for this project its ability to expose defects.

![Diagram]

**Figure 8: Use formal method to remove ambiguity from abstract model**

**Exploratory use of BE.** Using Behavior Engineering (BE) to verify a Process Reference Model is a relatively new application of this formal method; the method for doing so is not prescribed. This lack of precedent notwithstanding, there are sufficient grounds to include this fifth (of five) research objective in this project; to evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.

**Full BE method is not used.** It should be noted that only the notation associated with the Behavior Tree and Composition Tree aspects of BE are used in this project because (a) compliance with the normative reference ISO/IEC 24774:2007 is a primary objective of this project, (b) a full Behavior Engineering analysis of the entire Leadership PRM would be prohibitively large for this thesis, and should be the subject of a later project, and (c) the individual processes in the leadership PRM are not performed in any particular sequence. Arguably this lack of dependencies and sequence does not warrant the development of fully elaborated tree-structures. Some processes are not relevant in some situations, such as when the project team is simple and co-located. These factors notwithstanding, the notation’s capability to:
• re-express natural language into semi-structured language that conforms with normative standards for PRM-development, and

• identifying incongruities in statements that should be congruent

may prove useful in clarifying the wording of individual process purposes and outcomes.

**Benefit to SE model builders.** There are significant potential benefits that might be derived in the software engineering domain should a derived application of Behavior Engineering prove an effective method of verification that developers of process models might use in addition to the peer and editorial review methods currently in use. Using BE in this way is also consistent with the Design Research approach (Hevner et al, 2004), specifically guideline 3 Design Evaluation in which the utility, quality and efficacy is rigorously evaluated.

The draft process model in this project will have Behavior Engineering applied after two rounds of peer review, one round of expert review, and a necessity/sufficiency analysis using ISO/IEC 24774 to check for conformance to the prescribed format for PRMs. By the time Behavior Engineering is applied, the language of the draft process model will have been rendered into language acceptable to, and understood by the intended user community.

### 3.5.2. Introduction to Behavior Engineering (BE)

Historically, the practices now described as Behavior Engineering evolved from earlier work in which an approach for clarifying and integrating requirements for complex systems was developed (Dromey, 2001). This remains a significant application of the approach (Dromey, 2006); however, as the technique evolved, it became apparent that it could be applied to more general descriptions of systems behavior (Milosevic and Dromey, 2002). While there has been some preliminary exploration into applying the technique to the analysis and validation of process models, there is currently no set of prescriptions for how this might best be done. This project aims to contribute this body of knowledge.

In a broad sense, Behavior Engineering is a method for assembling individual pieces to form integrated component architecture. Each requirement is translated into its corresponding ‘behavior tree’ which describes unambiguously the precise behaviors of this particular requirement (Glass, 2004). The ‘tree’ is built up from (a) components, (b)
states the components become, (c) events and decisions/constraints associated with the components, and (d) the causal, logical and temporal dependencies associated with the component (Glass, 2004).

Duplications and redundancies are identified and removed, for example, when the same requirement is expressed twice using different language in different places. Another benefit is that traceability becomes more manageable. A detailed description of the naming conventions, elements and syntax follow after the section below.

3.5.3. Derived subset of BE used in this project

The full scope of Behavior Engineering is not applied in this project, so it cannot be said that BE is being used per se, rather a derived subset is used as outlined below. Two specific aspects of BE are used primarily to facilitate compliance with the normative reference ISO/IEC 24774:2007. The notation associated with Behavior Tree and Composition Tree are used in this regard, as discussed below. The ‘Tree’ aspect, which implies a network of interconnected entities, with precedence and dependencies, is not applied here, since (a) the processes in the leadership model do not depend on each other and can be performed in any sequence, and (b) not all processes need be used in all situations.

Another significant factor supporting the use of a derived subset of BE in this project is that a full Behavior Engineering analysis of the entire Leadership PRM is an enormous undertaking that is well beyond the scope of this thesis given its already considerable size and scope (developing a PRM for leadership employing a novel application of Design Research). Such an analysis would however be desirable and should be the subject of a later project.

3.5.3.1. Prescribed requirements of ISO/IEC 24774:2007

Before discussing how the derived notation is used, this section outlines the relevant articles of ISO/IEC 24774:2007 Software and systems engineering -- Life cycle management -- Guidelines for process description:

Section 4.2 the title of a process description is a short noun phrase that presents a descriptive heading for the process. The title identifies the principle concern of the process and distinguishes the process from other processes in the model
Section 4.3 the purpose of the process is stated as a high level, overall goal for performing the process. In cases where processes might be thought to overlap, the purpose should be used to characterize the scope or bounds of the process.

Section 4.4 (for conciseness only article with explicit relevance are listed)

4(b) An outcome shall be phrased as a declarative sentence using a verb in the present tense,

4 (c) Outcomes should be expressed in terms of a positive, observable objective, e.g. the production of an artefact, the provision of a service, a significant change of state, the successful maintenance of a desired state (e.g. safety), or the meeting of specified constraints (such as requirements, goals, etc),

4 (d) Outcome statements should be no longer than two lines of text, about twenty words,

4 (g) An outcome should express a single result,

4(i) Outcomes should be written in a manner that is meaningful for any scope of applicability,

4 (j) Outcomes should avoid requiring any specific method, technique or tool., 4 (k) Outcomes should avoid requiring any specific process measures or management methods,

4(l) Outcomes should avoid presuming any particular sequence of execution and the reader should not be expected to presume any sequence,

4(n) Although outcomes should be meaningful and understandable when viewed in isolation, they should be based on terminology and concepts that are further explained by other material in the document,

4 (o) As a test of completeness, the set of outcomes should be sufficient to achieve the stated purpose of the process,

4(p) As a test of relevancy, each outcome should be phrased so that it is necessary to the achievement of the purpose of the process.

3.5.3.2. Derived Behavior Tree notation

Behavior Tree notation is developed in this project by applying the following rationale to develop a simple two column table. This process is broadly consistent with the way BT notation is developed (Dromey, 2007a):

• begin with the main entity (leader in almost all cases) expressed as a noun,
• follow this by a *verb* that describes what the entity does (eg. develops, or verifies, or provides etc), then

• follow this by the specific *what*, or *who* or *when* etc as makes sense for each outcome in order to build up a complete unit of sense,

• where a statement contains *more than one* unit of sense, it is split into two or more statements so that one statement contains one unit of sense,

Broadly speaking, the Behavior Tree approach is based on the systematic application, with associated formal notation, of the principle of comprehensive factual description of an event known as the Five W’s (and one H) whose origins extend back to classical antiquity. In the 1st Century BC, Hermagoras of Temnos quoted the ‘elements of circumstance’ as the loci of an issue (Wooten, 1945):

Quis, quid, quando, ubi, cur, quem ad modum, quibus adminiculis
(Who, what, when, where, why, in what way, by what means)

In the modern world, this dictum has evolved into *who, what, when, where, why and how*. This principle is widely recognised and practiced in diverse domains such as journalism and police work, indeed almost anywhere that comprehensive and unambiguous description of events or attributes is needed. BT notation is a formal implementation of this general principle.

This application of BT notation in this way enables conformance with the provisions of ISO/IEC 24774:2007 *Software and systems engineering -- Life cycle management -- Guidelines for process description*, in particular in relation to the way Outcomes are expressed as an implementation of this standard:

<table>
<thead>
<tr>
<th>Ambiguous Statement</th>
<th>BT Notation</th>
<th>Unambiguous Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leader creates a shared vision of what is to be accomplished, ideally seen as an accomplished fact.</td>
<td>LEADER [creates] 1.1.1</td>
<td>Leader creates a shared vision of the goal(s).</td>
</tr>
<tr>
<td>what</td>
<td>SHARED VISION/</td>
<td></td>
</tr>
<tr>
<td>what (of)</td>
<td>GOAL(S)</td>
<td></td>
</tr>
</tbody>
</table>

Rationale for change:
Goal(s) not ‘what is to be accomplished’
Remove qualification (ideally seen as an accomplished fact ) to Informative Material

Leader clearly communicates the shared vision with the team, ideally seen as an accomplished fact.

| leader clearly communicates the shared vision with the team, ideally seen as an accomplished fact. | LEADER [communicates] 1.1.2 | Leader communicates the shared vision of the goal(s) with the team. |
| what | SHARED VISION/ | |
| / what (of) | GOAL(S)/ | |
| / who (with) | TEAM | |

Rationale for change:
Goal(s) included
Remove qualification ‘ideally seen as accomplished fact’ altogether - redundant
Leader facilitates strong commitment in team to achieving the shared vision, encouraging resilience in the face of goal frustrating events.

1.1.3 LEADER
[gains]
what COMMITMENT /
/ who (with) TEAM/
/ what (of) GOAL(S)

Leader gains commitment from team to achieve the goal(s).

Rationale for change:
Shared vision become goals.
Create a new outcome about resilience (it should be a stand-alone outcome rather than a qualification of the commitment to goals outcome.

<table>
<thead>
<tr>
<th>1.1.3</th>
<th>LEADER [gains]</th>
</tr>
</thead>
<tbody>
<tr>
<td>what</td>
<td>COMMITMENT</td>
</tr>
<tr>
<td>/ who</td>
<td>TEAM</td>
</tr>
<tr>
<td>/ what</td>
<td>GOAL(S)</td>
</tr>
</tbody>
</table>

Table 11: Example of process outcome disambiguation using Behavior Tree notation

3.5.3.3. Derived Composition Tree notation

Composition Tree notation uses the same basic notation as BT, but which identifies the:

- components (and their associated)
- attributes on a process by process, outcome by outcome basis, then
- aggregates these to identify duplications and redundancies, and
- remove duplicates where two or more statements contain the same basic unit of sense (though expressed differently) they shall be merged to form one unit of sense that is not present elsewhere.

Again, this process is broadly consistent with the way the notation is developed (Dromey, 2007a): Essentially a vocabulary list is developed in which synonyms and similar terms are identified and subsequently rationalised so that a single, unambiguous term is used consistently throughout. This is also consistent with the requirements of ISO/IEC 24774:2007.

A Composition Tree contains the complete system (or in this case model) vocabulary derived from the Behavior Tree analysis. Composition Tree notation uses the same naming conventions, elements and syntax as Behavior Tree notation. This behavioral information is now arranged compositionally, thus allowing the identification of different classes of defects that are not readily seen in behavior trees. So the components of each process and their associated attributes are identified and arranged using the notation. Aggregation then allows for the identification of duplications and redundancies.
In the example below, the component is *Vision*, the attributes are that the vision exists, is shared, is committed to etc. This aggregation effect works at a process level, while the Behavior Tree notation is applied at the individual outcome level.

This activity implements the requirements of ISO/IEC 24774:2007 as listed previously.

### 1.1 Shared vision

**Purpose:** The purpose of the shared vision process is to create and communicate a shared vision in ways that inspires people to realise that vision.

**Outcomes:** As a result of the successful implementation of shared vision process:

1. A shared vision of the goal(s) is created.
2. A shared vision of the goal(s) is communicated to the team.
3. Commitment by team to achieving the goal(s) is gained.
4. Resilience by team to goal-frustrating events is encouraged.
5. Practical objective(s) for goal(s) achievement are developed.

### 1.1 Vision

**Purpose:** The purpose of the vision process is to create and communicate a shared vision in ways that inspires people to realise that vision.

**Outcomes:** As a result of the successful implementation of shared vision process:

1. A vision of the goal(s) is created.
2. The vision of the goal(s) is communicated to the team.
3. Commitment by team to the shared vision is gained.

**Moved to 1.4 Action orientation**

- **Removed outcome to a more relevant Process – composition tree identifies that this is dealt with in 1.4 Action orientation.**
  - More logical to deal with resilience there. No need to double up, in any case.

**Becomes**

- **Outcome 1 of a new Process 1.2 Objectives.**
  - Objectives are a derivative of vision and goals. Logically belong in their own process. Therefore create new process 1.2 Objectives and delete this outcome from here.
6. Positive expectation for achieving objective(s) is encouraged.

Becomes Outcome 2 of a new Process 1.2 Objectives.

Objectives are a derivative of vision and goals. Logically belong in their own process. Therefore create new process 1.2 Objectives and delete this outcome from here.

Table 12: Example of process outcome disambiguation using Composition Tree notation

Essentially this means a vocabulary list is developed in which synonyms and similar terms are identified and subsequently rationalised so that a single, unambiguous term is used consistently throughout the model, in keeping with the provisions of ISO/IEC 24774:2007.

3.5.3.4. **BT & CT naming conventions, elements & syntax**

*For reference*, BT naming conventions, elements and syntax are illustrated below:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, N&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Behavior Tree Nodes</td>
</tr>
<tr>
<td>T, T&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Behavior Trees</td>
</tr>
<tr>
<td>C, C&lt;sub&gt;i&lt;/sub&gt;</td>
<td>Components</td>
</tr>
<tr>
<td>C#</td>
<td>A Component Instance</td>
</tr>
<tr>
<td>s</td>
<td>A State of a Component</td>
</tr>
<tr>
<td>e</td>
<td>An Event</td>
</tr>
<tr>
<td>a</td>
<td>An Attribute of a Component</td>
</tr>
<tr>
<td>b</td>
<td>A Branching Condition of a Component</td>
</tr>
</tbody>
</table>

Table 13: Variable naming conventions (Dromey, 2007b)

<table>
<thead>
<tr>
<th>Label</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Component Name</td>
<td>Specifies a component</td>
</tr>
<tr>
<td>B</td>
<td>Behavior</td>
<td>Specifies the behavior associated with the component</td>
</tr>
</tbody>
</table>
Table 14: Elements of a Behavior Tree node (Dromey, 2007b)

Figure 9: Behavior Tree Node concrete syntax example (Dromey, 2007b)
4. **Research approach**

The research approach chapter outlines the means by which a rigorous and comprehensive investigation of the research question and objectives is carried out. For reference, the research question and objectives are reiterated from Chapter 2:

**Research question:** What are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments?

**Research objectives:**

1. To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments.

2. Based on the identified qualities and characteristics, to develop a Process Reference Model (PRM) for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007.

3. To determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior.

4. To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior and/or Process Reference Models in the software engineering domain.

5. To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.
4.1. Design Research: constraints & limitations

4.1.1. Constraints

One aim of this project is to produce a Process Reference Model that has both theoretical value to an academic audience and practical value for a practitioner audience. This latter point suggests using an interventionist approach such as Action Research or Design Research rather than the observational approach taken with, for example, Case Studies.

Positivist research approaches lack the ability to consider context, insights and observations that may not be quantifiable.

The pros and cons of positivist and anti-positivist research approaches need to be considered; these are outlined in the table below:

<table>
<thead>
<tr>
<th></th>
<th>Positivist</th>
<th>Anti-Positivist (Action Research)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scope</td>
<td>Context-free :: static</td>
<td>Context-based :: dynamic</td>
</tr>
<tr>
<td>Methods</td>
<td>Cause/effect relations</td>
<td>Insights/observations may not be quantifiable</td>
</tr>
<tr>
<td>Role of Researcher</td>
<td>Detached observer</td>
<td>Actively involved</td>
</tr>
<tr>
<td>Goals</td>
<td>Set by researcher and selected participants</td>
<td>Negotiated with whole group</td>
</tr>
<tr>
<td>Outcomes</td>
<td>Laws, generalisations</td>
<td>Context-dependent insights</td>
</tr>
</tbody>
</table>

Table 15: Positivism vs. Anti-Positivism

Both Design Research and Action Research offer the necessary degree of participant engagement in a dynamic context in which a degree of ambiguity may be inherent.

Design Research emerges as an appropriate method due to its long-standing track record in the engineering / technology development domain, as evidenced by its use by such renowned research institutions as the Software Engineering Institute and other respected institutions (MIT’S Media Lab and others) to produce artefacts not dissimilar to the Leadership PRM.
4.1.2. Limitations

Design research has certain inherent limitations that should be acknowledged (Hevner, 2007). With his knowledge, the effects of these limitations may be minimised.

Hevner (2007) discusses these limitations and may be summarised by the following points:

- **There is an inadequate theory base for a joining of the scientific and engineering disciplines** (Basili, 1996). On-going work is needed that is aimed at building on the theoretical DR research foundations already laid by researchers such as Hevner. The project described in this thesis is able to contribute to this theoretical base.

- **There are not enough constructs, models, methods, and tools in the Design Research knowledge base to adequately represent real-world problems and solutions.** This project adds significantly to the knowledge base by outlining comprehensively a DR-based method for developing ISO/IEC 24774-conformant Process Reference Models in the software engineering/model-based process improvement domain, and for Models of Organisational Behavior more generally applicable in domains beyond SE (Management for example).

- **Design is still an undisciplined craft relying on intuition, experience, and trial-and-error** (Newell and Simon, 1976). This project develops a process-driven method for developing reference models and organisational behavior models. Design in the broader sense is becoming more process-driven, as seen in the curriculums of well-regarded Industrial Design degree-level courses.

- **The results of design research are of only transitory value as the pace of technology development and innovation accelerates.** Again, a process-driven application of DR is applicable to categories of activity, not specific instances of activity.

- **Rigorous evaluation methods are difficult to apply in design research.** This project adopts a rigorous six stage review process, each of which examines the PRM from a different angle, including real-world input from partitioners, application of ISO/IEC standards, and the application of formal methods (Dromey’s Behavior Engineering). The six review stages produce empirical results that are used to evolve the PRM, with any and all changes being logged and explained in order to achieve full traceability.
• Communication of design research results to the world of practice is essential but a major challenge. The resulting PRM from this project will be adapted into a book for a practitioner audience. The intended audience is project managers from any sector who run complex virtual teams. The potential readership is therefore in the hundreds of thousands internationally.

4.2. Design research: relevance & rigour

The important issue of relevance and rigour in design research is addressed by applying Hevner’s (2004) Guidelines for design Science research. The seven guidelines outlined by Hevner inform the conduct of this entire project; however Guidelines 2 and 5 are particularly relevant and will be discussed in detail.

The guidelines and the strategy by which each is addressed in this project are shown in the following table:

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Description</th>
<th>How addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guideline 1: Design as an Artefact</td>
<td>Design-science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.</td>
<td>The second research objective aims to develop a leadership model for use by project managers.</td>
</tr>
<tr>
<td>Guideline 2: Problem Relevance</td>
<td>The objective of design-science research is to develop technology-based solutions to important and relevant business problems.</td>
<td>An increasing portion of the estimated US$600 billion (Cusamano, 2004) global software industry is being performed by virtual teams. The mechanics and dynamics of virtual team operations is a new area of study, there is a clear need for research into ways of improving the coordination of integrated teams operating in virtual environments.</td>
</tr>
<tr>
<td>Guideline 3: Design Evaluation</td>
<td>The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.</td>
<td>This Design Research project has six design evaluation reviews: two by users, one by experts, one by ISO standards conformance, and two by formal method (Behavior Engineering). All reviews are documented and any changes from one draft to the next is recorded, and explained.</td>
</tr>
<tr>
<td>Guideline</td>
<td>Description</td>
<td>How addressed</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Guideline 4: Research Contributions</td>
<td>Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.</td>
<td>Project contributes (a) a Leadership PRM, (b) a new DR approach to PRM development, and (c) a novel application of Behavior Engineering. Project contributes to answering &gt;10 IPRC research questions.</td>
</tr>
<tr>
<td>Guideline 5: Research Rigor</td>
<td>Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.</td>
<td>Project uses rigorously applied and documented review methods, including Behavior Engineering and ISO/IEC 24774/ISO/IEC 15504-2 conformance. Project also uses a rigorously performed academic literature review.</td>
</tr>
<tr>
<td>Guideline 6: Design as a Search Process</td>
<td>The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.</td>
<td>Project uses practitioners and experts operating in their normal environments to apply rationale review of PRM for efficacy. Project also accesses relevant academic and practitioner literature in the drafting of the PRM.</td>
</tr>
<tr>
<td>Guideline 7: Communication of Research</td>
<td>Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.</td>
<td>Project has resulted in 10 scholarly publications (seven of them refereed, three conference papers) A practitioner-oriented book is planned aimed at project managers.</td>
</tr>
</tbody>
</table>

Table 16: Guidelines for conducting Design-Science Research. (Hevner et al, 2004).

In relation to **relevance**, it will be noted that Guideline 2 addresses this point. Technology-based solutions to important and relevant business problems. This project recognises the challenges experienced by project managers trying to coordinate complex virtual teams in an increasingly globalised environment. Given the billions of dollars spent each year on complex virtual projects, the development of a Process Reference Model that can be generically applied to IT projects, and possibly projects from a broad range of other sectors can rightly be described as being relevant, if not highly relevant.

**Rigour** is addressed in Guideline 5 … the application of rigorous methods in both the construction and evaluation of the design artefact. As discussed in the Limitations section below, this project includes six design cycle iterations, elsewhere described in this thesis as review stages. Each stage examines the PRM from a different angle,
including real-world input from partitioners, application of ISO/IEC standards, and the application of formal methods (Dromey’s Behavior Engineering). Furthermore the results of each design cycle review are empirically-based. The results are used to rationally evolve the PRM using evidence-based empirical data, with all changes being logged and explained in order to achieve full traceability as the PRM progresses from Version 0.1 in increments through to V0.6.

The interaction and information flow of the Environment-Research-Knowledge Base, including the topics of Relevance and Rigour is seen in the figure below.

- Recognition of problems and needs in the practitioner environment informs research with relevance.
- Coming from the other direction from the knowledge base into the research domain is the knowledge (in the form of foundational concepts and methodologies) that is applicable to a particular problem or need identified in the practitioner environment.
- In the research domain we see reiterative assessment and refinement of the designed artefacts, subject to the evaluative methods available.

Relevance and rigour in the context of Design Research in Information Systems (IS) is illustrated below. Arguably this can be extended to include SE; the terms are generic and applicable in domains other than IS. It recognises the need for DR to solve real-world problems while extending the theory base.
Figure 10: Hevner’s (2004) Information Systems Research Framework
4.3. Critical review of other research approaches

While Design Research (DR) has been rationally selected as most appropriate for this project, and reasons given in support, it is nonetheless necessary to demonstrate that sufficient awareness of and familiarity with other research methods informs this decision to use DR. This section is therefore a comprehensive survey of qualitative research epistemologies.

Orlikowski & Baroudi (1991) suggest that research is positivist if formal propositions, quantifiable variables, hypothesis testing and inferential reasoning based on the results is performed. A positivist research approach is not seen as appropriate to this project since it makes a fundamental assumption that ‘reality’ can be objectively defined, and that this objectively defined reality possesses measurable properties that exist independently of the researcher.

Positivist studies apply well to the testing of theories as a way of increasing their predictive value, but not as well to an exploration of social phenomena where ‘reality’ is defined by the perceptions of the participants. There can be as many realities as there are participants.

A review of the following research approaches is made, with discussion relating to their suitability to the proposed research project:

- Critical research
- Action research
- Case Study
- Ethnographic
- Grounded theory
- A conceptual-analytical study
- Mathematical modelling

Critical research takes the view that (social) reality is constructed by a historically constituted process in which it (reality) is produced and reproduced by generations of people. Critical research sees the participants in this social reality as having a degree of autonomy, but is nonetheless constrained by a range of social, cultural and political
forces. Critical research has as its goal the identification of the causes of conflict, which inhibit a social system with a view to finding a remedy. Critical research is not seen as appropriate to this research project since it emphasises conflict at the expense of the positive aspects of consensus and collaboration.

**Action research** involves the researcher becoming proactively involved in a real problem situation, working collaboratively with participants towards a solution, and then retrospectively seeking to gain practical and theoretical insights from the experience. The critical elements of action research include there being collaborative problem-solving interaction between researcher and the other people in the situation. It is a process of critical enquiry in which problems are actively searched for and identified, followed by the formulation of a possible solution or set of solutions, the implementation of the solution(s) then an evaluation of the effectiveness of the solution(s) in the context of reflective learning.

**Case Study** examines contemporary phenomena in its real context when the boundaries between the phenomena and the context can not be clearly defined. A case study would therefore be appropriate to this research question had not the opportunity to test the question directly, as leading change agent, presented itself. Such an opportunity clearly favours the action research method. A case study could also have been completed in the allowable timeframe, unlike an ethnographic study.

**Ethnographic research** has its origins in work done earlier this century by cultural anthropologists in which the researcher immerses him or herself for an extended period in the milieu of the organisation (or ethnic group) being studied (Lewis, 1985). In ethnography, a distinction must be made between so-called first-order and second-order concepts. First order concepts are the ‘facts’ of an ethnographic investigation, and the second –order concepts are the ‘theories’ constructed by the analyst to explain the first-order concepts (Järvinen 1999). One difficulty with ethnography is that the derivation of first-order concepts relies on the contextually and biographically mediated interpretations of the actors to explain the first-order ‘fact’ (Järvinen 1999). While it is well suited to IS research in organisational contexts, and in particular to the design of information systems, the constraints and timeframe of the research event do not permit an ethnographic study. A suitably complete treatment of the research question would not be possible.

**Grounded theory** develops theory based on data that has been systematically gathered and analysed. Grounded theory allows the development of a theoretical
account of the general features of a topic based on empirical data (Martin and Turner, 1986). In this sense, it is an inductive, theory discovery methodology. As with the ethnographic approach, there is insufficient time in this project to develop grounded theory. The researcher simultaneously develops a theoretical account of the general features of a topic while grounding the account in empirical observations or data. A well-constructed grounded theory meets four criteria; fit, understanding, generality, and control. If the theory accords with ‘everyday reality’ and has been induced from sufficiently diverse data, then it should fit the substantive area and be abstract enough to be able to generalise it to a variety of contexts (Järvinen 1999). Such a research approach would, in common with ethnography and conceptual-analytical study, take too long with respect to the proposed project. It may be worthwhile approach where a series of action research projects performed that built a body of theory were performed. A grounded theory approach might be applied to this situation over time.

The object of theory-testing research is to try to establish causal relationships that can explain, predict and control the phenomena being studied (Järvinen, 1999). A difficulty with this approach is that it is not always possible to clearly distinguish between what factors contribute to cause and which to effect (Järvinen, 1999). Such a difficulty might well apply to the proposed research project in which the distinction between cause and effect in complex social situations becomes blurred, particularly when in an on-going situation, one effect becomes a cause in itself, which creates another effect and so on.

A conceptual-analytical study is concerned with the collection, integration and systematisation of theory derived from previous research (Järvinen, 1999). A typical form taken by the conceptual-analytical study is the formation of an axiom(s). The propositions of the theory are distilled to a set of basic principles from which the other propositions of the theory may be logically derived (Järvinen, 1999). Ideas arrived at by the application of these axiom(s) can be said to have been derived deductively. Järvinen (1999), citing earlier work by Eierman et al (1995) indicate that a theory is comprised of; a boundary that describes the domain of interest, key constructs within that domain, the values that these constructs may take, and some kind of relationship between the constructs. A conceptual-analytical study would take too long to complete, given the volume of material that would need to be read and taken into consideration. In terms of IS research, a conceptual study might include a broad-ranging literature review in the area of primary interest, as well as surrounding, related areas. From this large amount of information, deductions might be made. It is doubtful whether this approach could be successfully applied to the proposed research event.
Mathematical modelling is not an appropriate approach in the social context of this project since one of the conditions of mathematical modelling is that no human subjects are needed (Wood-Harper, 1984). Another condition is that all independent and dependant variables are known, which is not possible in this research context. This approach fits into the third category or ‘family’ of research approach discussed by Järvinen (1991). As Järvinen (1999) observes, mathematical modelling uses notations that have no direct connection with reality. It seeks to establish a mathematical argument that is ‘watertight’ and difficult to refute. This is clearly going to be difficult when dealing with people in a dynamically changing and ambiguous social setting, one in which it may very well be impossible to arrive at a set of absolutely correct presuppositions upon which to base the mathematical reasoning.

4.4. Design research: the proposed approach

Design Research (DR) is the research method selected for its fitness for purpose and good reputation for building models under circumstances such as those that prevail on this project. DR’s evolution helps explain its fitness; emerging in post-WW2 Britain from operational research methods.

Influential early Design Research proponent Bruce Archer advocated DR as a systematic approach to design and operational problems producing appropriate design solutions (Archer, 1965). DR is now well-established in the computing domain, having branched out from its origins in architecture and industrial design, as evidenced by it’s use at such technology-oriented laboratories and research institutes as MIT’s Media Lab, and Carnegie-Mellon’s Software Engineering Institute, Xerox’s PARC and Brunel’s Organization and System Design Centre (Vaishnavi and Kuechler, 2004/5).

Design Research focuses on the development and performance-enhancement of (designed) artefacts with the explicit intention of improving the functional performance of the artefact. The domain of software development process improvement (using Model-based Process Improvement) can arguably be seen as a category of artefact whose improvement is facilitated by the design research approach.

DR is typically applied to categories of artefact including (but not limited to) algorithms, human/computer interfaces, design methodologies (including process models) and languages. Its application is most notable in the Engineering and Computer Science
disciplines, though is not restricted to these and can be found in many disciplines and fields (Vaishnavi and Kuechler, 2004/5).

Action Research (AR) would also offer a viable approach to a project of this nature. Like Design Research, AR is iterative and proceeds on the basis of collaborative data collection and reflective improvements to develop solutions to problems (Reason & Bradbury, 2001). However, Design Research focuses on the development of usable artefacts with an emphasis on design, while Action Research is less closely linked to technology development (more closely linked to Educational research) and has the inherent limitation of being perceived by some in the broader research community as ‘consultancy by another name’.

**Research method taxonomy.** Järvinen’s widely cited taxonomy of research methods (2001) locates Design Research in the vein of those methods that study reality and focus on utility and innovation by first taking an innovation building approach, then, through the process of circumscription performs evaluation of the innovation.

![Figure 11: Järvinen’s taxonomy of research methods (2001)](image-url)
4.5. Software engineering reference discipline

This section surveys the research approaches commonly taken in the reference discipline of Software Engineering (SE). This places the design research approach into its larger context, helping to validate it as an appropriate research approach.

Software engineering as a research discipline has come under scrutiny since the 1990’s to lift the standard of rigour and make the results more valid and usable. Kitchenham et al (2002) propose a rigorous set of research guidelines aimed at providing a starting point for discussion among the SE research community. These 36 guidelines are listed in the literature review chapter and shall not be repeated here.

The design research approach used in this project is consistent with Kitchenham et al’s (2002) guidelines to the extent they apply. Not all guidelines apply, for example those dealing with the statistical analysis of complex data sets, the use of control groups and the application of ‘interventions’ or treatments. Consideration of Kitchenham et al’s (2002) guidelines serve to validate the Design Research approach taken in this project.

Shaw (2002) notes that research questions in the field of software engineering research range widely. Research questions range from methods for developing and analysing software, the design, implementation and evaluation of systems, the feasibility of tasks and generalizations about whole classes.

The research question in this project is included in the Generalisation or characterisation category.

<table>
<thead>
<tr>
<th>Type of Question</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method or means of development</td>
<td>How can we do/create X?</td>
</tr>
<tr>
<td></td>
<td>What is a better way to do/create X?</td>
</tr>
<tr>
<td>Method for analysis</td>
<td>How can I evaluate the quality/correctness of X?</td>
</tr>
<tr>
<td></td>
<td>How do I choose between X and Y?</td>
</tr>
<tr>
<td>Design, evaluation, or analysis</td>
<td>What is a better design/implementation for application X?</td>
</tr>
<tr>
<td>of a particular instance</td>
<td>What is property X of artefact/method Y?</td>
</tr>
<tr>
<td></td>
<td>How does X compare to Y?</td>
</tr>
<tr>
<td></td>
<td>What is the current state of X / practice of Y?</td>
</tr>
<tr>
<td>Generalisation or characterisation</td>
<td>Given X, what will Y necessarily be?</td>
</tr>
<tr>
<td></td>
<td>What, exactly, do we mean by X?</td>
</tr>
<tr>
<td></td>
<td>What are the important characteristics of X?</td>
</tr>
<tr>
<td></td>
<td>What is a good formal/empirical model for X?</td>
</tr>
</tbody>
</table>
What are the varieties of X, how are they related?

<table>
<thead>
<tr>
<th>Feasibility</th>
<th>Does X even exist, and if so what is it like?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Is it possible to accomplish X at all?</td>
</tr>
</tbody>
</table>

**Table 17: Research questions in software engineering, from Shaw (2002)**

Shaw (2002) notes that as the software engineering research domain matures the types of research questions are changing. For example generalisations in the form of models are increasingly frequent, while feasibility studies are becoming less frequent. The nature of the research project under discussion in this thesis is consistent with this trend, being concerned with the development of a formal (process reference) model. A further consistency between this project and Shaw’s findings is the method of validation. Shaw (2002) points out that the most common kind of validation among SE papers surveyed is experience in actual use. This project seeks to validate the leadership process reference model through interviews with working project managers with a view to determining whether the practices outlined in the model can be validated by the existence of an activity and/or artefact from their own experience. Other forms of validation besides experience include analysis, example, evaluation, persuasion and blatant assertion.

**Research in computing.** Research in computing has been generally categorised into three overlapping domains; Information Systems, Software Engineering and Computer Science (Glass, Vessey and Ramesh, 2002).


The research approach used in each of these papers (369 in total) was broadly categorised by Glass et al (2002) as descriptive (27.9%), evaluative (13.8%) and formulative (55.3%).

The authors concluded that SE research is characterised as follows:

- Diverse in content, covering wide-ranging topics,
• Narrowly focussed on a set of research approaches (>50% were formulative, see table below),

• Narrow range of research methods,

• Introspective in terms of reference disciplines. 98% of papers surveyed cited no external reference discipline. The remainder cited Cognitive Psychology at 0.54%, Social and Behavioral Science, Management and Management Science each at 0.27%. Other possible reference disciplines at 0% include Computer Science, Science, Engineering, Economics, Library Science, and Public Administration, and

• Technical and computing-focussed in nature, as opposed to behavioral.

The table below shows a summary of research methods employed across the 369 papers, with an associated percentage frequency:

<table>
<thead>
<tr>
<th>Research Method</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action research</td>
<td>0%</td>
</tr>
<tr>
<td>Conceptual analysis</td>
<td>43.5%</td>
</tr>
<tr>
<td>Conceptual analysis/mathematic</td>
<td>10.6%</td>
</tr>
<tr>
<td>Conceptual implementation (proof of concept)</td>
<td>17.1%</td>
</tr>
<tr>
<td>Case study</td>
<td>2.2%</td>
</tr>
<tr>
<td>Data analysis</td>
<td>2.2%</td>
</tr>
<tr>
<td>Discourse analysis</td>
<td>0%</td>
</tr>
<tr>
<td>Ethnography</td>
<td>0%</td>
</tr>
<tr>
<td>Field experiment</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Field study</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Grounded theory</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Hermeneutics</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Instrument development</td>
<td>0%</td>
</tr>
<tr>
<td>Laboratory experiment (human subjects)</td>
<td>3.0%</td>
</tr>
<tr>
<td>Literature review/analysis</td>
<td>1.1%</td>
</tr>
<tr>
<td>Laboratory experiment (software)</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Meta-analysis</td>
<td>0%</td>
</tr>
<tr>
<td>Mathematical proof</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>
Table 18: Research methods in 369 high-impact journals (Glass et al, 2002)

<table>
<thead>
<tr>
<th>Method</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protocol analysis</td>
<td>0%</td>
</tr>
<tr>
<td>Phenomenology</td>
<td>0%</td>
</tr>
<tr>
<td>Simulation</td>
<td>1.1%</td>
</tr>
<tr>
<td>Descriptive/exploratory survey</td>
<td>1.6%</td>
</tr>
</tbody>
</table>

### 4.6. Empirical research in software engineering

In the interests of promoting greater consistency and rigour in the field of software engineering research, Kitchenham et al (2002) propose a provisional set of research guidelines aimed at providing a starting point for discussion among the SE research community. These guidelines are derived largely from the domain of medical research (Kitchenham et al, 2002) where an absence of rigour can have serious consequences.

Kitchenham et al's (2002) guidelines are summarised verbatim below to indicate the substance and depth of the said guidelines. As mentioned, the guidelines derive from medical research, so some terminology is specific to that domain (for example where mention is made of 'treatment' being applied to test subjects). As a general set of guidelines, these are comprehensive and rigorous as might be expected where safety critical work is being done.

The important point in relation to this project is that following a detailed examination of the guidelines, no inconsistencies with the research approach taken in this project was found. Not all guidelines were relevant, for example those dealing with the statistical analysis of complex data sets, the use of control groups and the application of 'interventions' or treatments. Consideration of Kitchenham et al's (2002) guidelines serve to validate the Design Research approach taken in this project.

<table>
<thead>
<tr>
<th>Category &amp; Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental Context</strong></td>
</tr>
<tr>
<td>C1: Be sure to specify as much of the industrial context as possible. In particular, clearly define the entities, attributes, and measures that are capturing the contextual information.</td>
</tr>
<tr>
<td>C2: If a specific hypothesis is being tested, state it clearly prior to performing the study and discuss the theory from which it is derived, so that its implications are apparent.</td>
</tr>
</tbody>
</table>
### C3: If the research is exploratory, state clearly and, prior to data analysis, what questions the investigation is intended to address and how it will address them.

### C4: Describe research that is similar to, or has a bearing on, the current research and how current work relates to it.

#### Experimental Design

**D1:** Identify the population from which the subjects and objects are drawn.

**D2:** Define the process by which the subjects and objects were selected.

**D3:** Define the process by which subjects and objects are assigned to treatments.

**D4:** Restrict yourself to simple study designs or, at least, to designs that are fully analyzed in the statistical literature. If you are not using a well-documented design and analysis method, you should consult a statistician to see whether yours is the most effective design for what you want to accomplish.

**D5:** Define the experimental unit.

**D6:** For formal experiments, perform a pre-experiment or pre-calculation to identify or estimate the minimum required sample size.

**D7:** Use appropriate levels of blinding

**D8:** If you cannot avoid evaluating your own work, then make explicit any vested interests (including your sources of support) and report what you have done to minimize bias.

**D9:** Avoid the use of controls unless you are sure the control situation can be unambiguously defined.

**D10:** Fully define all treatments (interventions).

**D11:** Justify the choice of outcome measures in terms of their relevance to the objectives of the empirical study.

#### Conducting the Experiment and Data Collection

**DC1:** Define all software measures fully, including the entity, attribute, unit and counting rules.

**DC2:** For subjective measures, present a measure of inter-rater agreement, such as the kappa statistic or the intra-class correlation coefficient for continuous measures.

**DC3:** Describe any quality control method used to ensure completeness and accuracy of data collection.

**DC4:** For surveys, monitor and report the response rate and discuss the representativeness of the responses and the impact of non-response.

**DC5:** For observational studies and experiments, record data about subjects who drop out from the studies.
DC6: For observational studies and experiments, record data about other performance measures that may be affected by the treatment, even if they are not the main focus of the study.

**Analysis**

A1: Specify any procedures used to control for multiple testing.

A2: Consider using blind analysis.

A3: Perform sensitivity analyses.

A4: Ensure that the data do not violate the assumptions of the tests used on them.

A5: Apply appropriate quality control procedures to verify your results.

**Presentation of Results**

P1: Describe or cite a reference for all statistical procedures used.

P2: Report the statistical package used.

P3: Present quantitative results as well as significance levels. Quantitative results should show the magnitude of effects and the confidence limits.

P4: Present the raw data whenever possible. Otherwise, confirm that they are available for confidential review by the reviewers and independent auditors.

P5: Provide appropriate descriptive statistics.

P6: Make appropriate use of graphics.

**Interpretation of Results**

I1: Define the population to which inferential statistics and predictive models apply.

I2: Differentiate between statistical significance and practical importance.

I3: Define the type of study.

I4: Specify any limitations of the study.

Table 19: Guidelines for empirical research in SE (Kitchenham et al, 2002)

In reviewing 25 years of empirical software engineering, Jeffery and Scott (2002) conclude that *empirical software engineering can have an impact in developing sound and practical theories of software engineering phenomena*. For a theory to be useful and sound in nature, it should be broad-based and employ wide-ranging methods of enquiry. It should also be thoroughly evaluated, preferably by third parties, using a variety of verification techniques (Jeffery and Scott, 2002).
4.7. Design research: ontology & epistemology

The ontology and epistemology of design research contrasts with that of Positivist and Interpretivist studies in a number of important ways. Most notably, Design Research makes appropriate allowance for multiple, contextually situated world states, the existence of which might explain why leadership is so difficult to describe; it differs depending on context.

The following table illustrates the nature of these differences:

<table>
<thead>
<tr>
<th>Basic Belief</th>
<th>Positivist</th>
<th>Interpretive</th>
<th>Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ontology</td>
<td>A single, knowable, probabilistic reality.</td>
<td>Multiple, socially constructed realities.</td>
<td>Multiple, contextually situated alternative world states, sociotechnically enabled.</td>
</tr>
<tr>
<td>Epistemology</td>
<td>Objective and dispassionate: detached observer of truth.</td>
<td>Subjective: values and knowledge emerge from observer-participant interaction.</td>
<td>Knowing truth through making: objectively constrained construction within a context. Iterative circumscription reveals meaning.</td>
</tr>
<tr>
<td>Axiology</td>
<td>Truth: universal and beautiful, predictive capability.</td>
<td>Understanding: situated and descriptive.</td>
<td>Control: creation, progress (i.e. improvement), understanding.</td>
</tr>
</tbody>
</table>

Table 20: Assumptions of Positivism, Interpretivism and DR (Vaishnavi et al, 2004/5).

4.8. Design research: broad strategy

Herbert Simon in his oft-cited book *The Sciences of the Artificial* (1996) observes that Design as an activity creates something new that does not already exist in Nature. ‘Schools of architecture, business, education, law, and medicine, are all centrally concerned with the process of design’ (Simon, 1996). Further, he argues strongly for a vigorous science of design to be re-established in disciples including IT. What is called for is a ‘body of intellectually tough, analytic, partly formalizable, partly empirical teachable doctrine about the design process’ (Simon, 1996).
Simon distinguishes between Natural Science and Artificial Science in the following way. *Natural science* is a corpus of knowledge describing class(es) of things -- objects or phenomenon -- occurring in the natural world (including society). A *science of the artificial*, contrastingly, is knowledge about artefacts and phenomena that can be turned to various uses in order to achieve certain goals. The science of the artificial can be further distinguished in terms of an *inner environment*, an *outer environment*, and the *interface* between them that meets certain desired goals (Simon, 1996).

**Is Design Research an appropriate methodology for conducting research in software engineering?**

Design disciplines such as software engineering have demonstrated a capacity over decades to produce, test and improve in a re-iterative way design artefacts. Aeronautical engineering, a related discipline in the engineering sense offers an example; from the Montgolfier brothers and onwards to World War I, the aeronautical engineering knowledge base was established and added to by analysing the results of intuitively guided designs – working prototypes. A marriage of engineering disciplines is also seen in the ongoing efforts of NASA extending back to the 1960s to design, build and operate ever more high performance space vehicles. Software components were and are an integral part of this extended design effort.

![Knowledge Building Process](image1)

**Knowledge Building Process**

![Knowledge Using Process](image2)

**Knowledge Using Process**

Figure 12: A General Model for Generating and Accumulating Knowledge (Vaishnavi and Kuechler, 2004/5)
The diagram above illustrates the re-iterative nature of the knowledge-building process of incremental design improvement. Situated in a certain paradigm and mediated by appropriate channel(s) the flow of design improvement proceeds cyclically. Simply put, knowledge is generated through the action involved with building something, which is then evaluated in order to build more knowledge. It should be noted that the channels referred to in this process are the systems and conventions of the discipline (in this case SE in general), and model-based process improvement specifically.

Vaishnavi and Kuechler, quoting earlier work by Takeda et al. (1990) analyze the reasoning that goes on during this process generating knowledge and illustrates it in the way seen below (Reasoning in the Design Cycle). This diagram is an expansion of the ‘Knowledge Using Process’ element of the general model above.

**Knowledge Flows** | **Process Steps** | **Logical Formalism**
---|---|---

| Awareness of Problem (Abduction) | Abduction |
| Suggestion | |
| Development | Deduction |
| Evaluation | |
| Conclusion | |
Suggestions for improvement are abductively derived (inference to the best explanation) from the existing knowledge base. Suggestion is a creative process in which something new is envisioned based on some new, or a combination of new and existing components (Ardakan and Mohajeri, 2009).

In this project the literature on teams and leadership is reviewed and a draft process reference model is developed according to the prescribed standard (ISO/IEC 15504-2) for doing so.

The Development stage takes the abductively-derived design from the previous stage and elaborates this into a design artefact. In this project, this is the development of a draft Process Reference Model.

Evaluation. When developed, the artefact, in this case a Process Reference Model, is evaluated using a method appropriate to the nature of the artefact. A PRM is normally reviewed by stakeholders (users and experts) for usability and accuracy. Deviations from expectations are carefully documented and tentatively explained (Ardakan and Mohajeri, 2009).

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observational</td>
<td>Case study (in-depth in the intended usage environment)</td>
</tr>
<tr>
<td></td>
<td>Field study (monitor use in multiple projects)</td>
</tr>
<tr>
<td>Analytical</td>
<td>Static analysis (examine structure for static quality)</td>
</tr>
<tr>
<td></td>
<td>Architectural analysis (study fit in larger IS architecture)</td>
</tr>
<tr>
<td></td>
<td>Optimization (demonstrate optimal performance properties)</td>
</tr>
<tr>
<td></td>
<td>Dynamic analysis (study artefact’s dynamic in-use properties)</td>
</tr>
<tr>
<td>Experimental</td>
<td>Controlled experiment (study performance in laboratory)</td>
</tr>
<tr>
<td></td>
<td>Simulation (execute with artificial data)</td>
</tr>
<tr>
<td>Testing</td>
<td>Functional testing (black box testing of interfaces for faults)</td>
</tr>
<tr>
<td></td>
<td>Structural testing (white-box testing covering testing of specified metrics)</td>
</tr>
<tr>
<td>Descriptive</td>
<td>Informed argument (use knowledge-base data to build argument for efficacy/utility)</td>
</tr>
<tr>
<td></td>
<td>Scenarios (construct detailed scenarios around artefact to demonstrate utility)</td>
</tr>
</tbody>
</table>

Table 21: Design evaluation methods (Hevner, 2004).
Development, Evaluation and further Suggestion are re-iterated through multiple cycles in which the draft Process Reference Model is tested in various different organizations and contexts. Circumscription feeds information back into the awareness stage that could only be derived through the specific act of process reference model construction.

**Conclusion.** After multiple review cycles, the artefact is evaluated to now be good enough for practical purposes (Ardakan and Mohajeri, 2009).

### 4.9. **Design research: outputs**

Design Research is characterised by its outputs, although Vaishnavi and Keuchler (2007) observe there is a lack of consensus on the precise nature of these outputs. They compile a list of outputs from a variety of sources, seen in the table below.

The *Models* output most closely fits the Process Reference Model (PRM) of this project. PRMs in software engineering express themselves in terms of Purpose and Outcome which is comparable to Problem and Solution.

<table>
<thead>
<tr>
<th>Output</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Constructs</td>
<td>A conceptual vocabulary of a domain arising from the conceptualisation of the problem.</td>
</tr>
<tr>
<td>2 Models</td>
<td>A set of propositions or statements expressing relationships between constructs, most notably between problem and solution. This output most closely describes this project.</td>
</tr>
<tr>
<td>3 Methods</td>
<td>A set of steps used to perform a task – how-to knowledge that realise the Solution.</td>
</tr>
<tr>
<td>4 Instantiations</td>
<td>The operationalisation of constructs, models and methods in their use environment.</td>
</tr>
<tr>
<td>5 Better theories</td>
<td>Artefact construction as analogous to experimental natural science.</td>
</tr>
</tbody>
</table>

Table 22: Outputs of Design Research (Vaishnavi and Kuechler, 2007)
4.10. **Design research: PRM development**

The general methodology for design research is modelled on the *Reasoning in the Design Cycle*. It is founded on the rationale that when performing design research, knowing (reasoning) is making (outputs).

<table>
<thead>
<tr>
<th>Knowledge Flows</th>
<th>Process Steps</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Awareness of Problem (Abduction)</td>
<td>Proposal</td>
</tr>
<tr>
<td></td>
<td>Suggestion (Abduction)</td>
<td>Tentative Design</td>
</tr>
<tr>
<td></td>
<td>Development (Deduction)</td>
<td>Artefact</td>
</tr>
<tr>
<td></td>
<td>Evaluation (Deduction)</td>
<td>Performance Measures</td>
</tr>
<tr>
<td></td>
<td>Conclusion</td>
<td>Results</td>
</tr>
</tbody>
</table>

Figure 14: General Methodology of Design Research for this project (Vaishnavi and Kuechler, 2004/5), (Vaishnavi and Kuechler, 2007), (Takeda et al 1990).
The general methodology is adapted for this project in the following way:

Hevner (2007) describes Design Research as a pragmatic research method, predicated on being relevant to real-world situations and making a clear contribution to the application environment. Hevner (2007) describes Design Research as the embodiment of three inter-related cycles, these being the Relevance, Rigor and Design Cycles.

The table below summarises Hevner’s description of the three cycles:

<table>
<thead>
<tr>
<th>Cycle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Relevance</strong></td>
<td>DR is motivated by the desire to improve the world by introducing innovative artefacts and processes. Application domains are comprised of people, organisational and technical systems that combine to produce a result. Relevance cycle provides requirements and acceptance criteria for the evaluation of results in the field. Results of field testing determine whether further iterations of the Relevance Cycle are needed, and whether the requirements were correct in the first place.</td>
</tr>
<tr>
<td><strong>Rigor</strong></td>
<td>DR draws from canon of basic scientific theory and engineering methods for basis of rigorous DR. The knowledge base also provides something beyond this, what is ‘state of the art’ in the application domain, and what are the existing artefacts in said domain?</td>
</tr>
</tbody>
</table>
Chapter 4: Research approach

4.1. Cycle Description

The Rigor Cycle inputs past knowledge into a research project to ensure innovation. Contingent on a thorough literature and knowledge-base review.

Research rigor contingent on researcher selecting appropriate theories and methods for constructing and evaluating the artefact.

Design

Activities in this cycle iterate between the construction of an artefact, its evaluation, and subsequent feedback. This effectively generates design alternatives and allows these alternatives to be evaluated (derived from rigor cycle) against the requirements (derived from relevance cycle) until a satisfactory design is achieved.

Balance must be achieved between construction effort and the effort of evaluating the evolving design artefact. Both aspects must be solidly based in relevance and rigor when achieving this balance. A solid argument for the construction of an artefact is insufficient if the subsequent evaluation is weak.

Table 23: A three cycle view of Design Research (Hevner, 2007).

4.11. Design research: guidelines for performing

Hevner et al (2004) cite Design Research (or Design-Science research paradigm) as an activity that tries to ‘extend the boundaries of human organizational capabilities by creating new and improved artefacts’. They discuss design research in the domain of Information Systems (IS) research. Sufficient overlap exists between the domain activities and research methods of IS and Software Engineering (SE) to establish the credibility of design research in the SE domain. Indeed the engineering domain in general has been the focus of much design-based research over time, as discussed above.

In the design-science paradigm our understanding of a problem within a prescribed domain together with a derived solution are achieved by building an artefact, applying it, and evaluating its efficacy under controlled conditions.

Hevner et al (2004) outline a conceptual framework and a set of guidelines for understanding, executing, and evaluating design-science research that are used in this project to validate that the proposed research approach conforms with and satisfies the accepted requirements for design research. The guidelines and the strategy by which each is addressed in this project are shown in the following table:
<table>
<thead>
<tr>
<th>Guideline</th>
<th>Description</th>
<th>How addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guideline 1: Design as an Artefact</td>
<td>Design-science research must produce a viable artefact in the form of a construct, a model, a method, or an instantiation.</td>
<td>The second research objective aims to develop a leadership model for use by project managers.</td>
</tr>
<tr>
<td>Guideline 2: Problem Relevance</td>
<td>The objective of design-science research is to develop technology-based solutions to important and relevant business problems.</td>
<td>An increasing portion of the estimated US$600 billion (Cusamano, 2004) global software industry is being performed by virtual teams. The mechanics and dynamics of virtual team operations is a new area of study, there is a clear need for research into ways of improving the coordination of integrated teams operating in virtual environments.</td>
</tr>
<tr>
<td>Guideline 3: Design Evaluation</td>
<td>The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.</td>
<td>This Design Research project has six design evaluation reviews; two by users, one by experts, one by ISO standards conformance, and two by formal method (Behavior Engineering). All reviews documented and any changes from one draft to the next is recorded, and explained.</td>
</tr>
<tr>
<td>Guideline 4: Research Contributions</td>
<td>Effective design-science research must provide clear and verifiable contributions in the areas of the design artefact, design foundations, and/or design methodologies.</td>
<td>Project contributes (a) a Leadership PRM, (b) a new DR approach to PRM development, and (c) a novel application of Behavior Engineering. Project contributes to answering &gt;10 IPRC research questions.</td>
</tr>
<tr>
<td>Guideline 5: Research Rigor</td>
<td>Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.</td>
<td>Project uses rigorously applied and documented review methods, including Behavior Engineering and ISO/IEC 15504-2 and ISO/IEC 24774 conformance. Project also uses a rigorously performed academic literature review.</td>
</tr>
<tr>
<td>Guideline 6: Design as a Search Process</td>
<td>The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.</td>
<td>Project uses practitioners and experts operating in their normal environments to apply rationale review of PRM for efficacy. Project also accesses relevant academic and practitioner literature in the drafting of the PRM.</td>
</tr>
</tbody>
</table>
Guideline 7: Communication of Research

Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences. Project has resulted in 10 scholarly publications (seven of them refereed, three conference papers)

A practitioner-oriented book is planned aimed at project managers.

Practitioner-oriented public lectures and training courses have been delivered.


Leadership in the software engineering domain is a social activity. In this social context, design research fits in column 4 of Mumford, Hirschheim, Fitzgerald and Wood-Harper's (1984) continuum of social science research approaches. Mumford et al's matrix illustrates the continuum of research approaches, from the most subjective to the most objective. It provides useful perspective with which to place the proposed research approach in its larger context.

<table>
<thead>
<tr>
<th>Subjective approaches to social science</th>
<th>Objective approaches to social science</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Core ontological assumptions</td>
<td>Reality as a projection of human imagination</td>
</tr>
<tr>
<td>Assumption about human nature</td>
<td>Human as a pure, spiritual consciousness</td>
</tr>
<tr>
<td>Basic epistemological stance</td>
<td>To obtain phenomenological insight</td>
</tr>
<tr>
<td>Some favoured metaphor</td>
<td>Transcendental</td>
</tr>
<tr>
<td>Examples of research methods</td>
<td>Exploration of pure subjective</td>
</tr>
</tbody>
</table>

Table 25: Continuum of social science research approaches (Mumford, Hirschheim, Fitzgerald and Wood-Harper, 1984)
4.12. Design research: data collection method

A Process Reference Model (PRM) is characterised by a statement of *purpose* and *outcome*, with the outcomes collectively achieving the purpose. Each outcome is characterised by indicators of process performance comprising base practices and work products (ISO/IEC 15504-2:2003).

The draft PRM is developed in accordance with this standard. An example is seen in the table below. In addition to the process name, purpose and outcome(s), informative material is included to provide context and clarification of the purpose and outcomes to assist the user. The draft PRM is then ready for review (data collection).

Data collection is by a series of interviews in which the PRM is worked through with project manager participants from organisations operating integrated virtual teams in order to investigate whether there is *objective evidence* of process performance (base practices and work products) to indicate that the outcomes are being achieved. A record of any evidence is made in the space provided for each outcome.

1.1 Create and communicate a shared vision

**Purpose:** to perceive and communicate a guiding principle/idea that captures the imagination of members to create a shared vision and inspire them with the enthusiasm to realise that vision. An aspect of charisma.

**Outcomes:** as a result of the successful implementation of creating a shared vision:

1. The leader perceives and formulates a unified vision of what is to be accomplished, ideally seen as an accomplished fact.

   *Activities and/or artefacts to support:*

2. Leader communicates shared unified vision with team, ideally seen as an accomplished fact.

   *Activities and/or artefacts to support:*

3. Leader develops strong commitment to achieving vision, based on a sense of rightness and timeliness, such that they have sufficient resilience to overcome goal frustrating events

   *Activities and/or artefacts to support:*
4. The leader develops a clear and unambiguous set of objectives or goals that are concrete and achievable.

*Activities and/or artefacts to support:*

5. Leader engenders hope/optimism towards achieving the objectives.

*Activities and/or artefacts to support:*

**Elaboration:** the shared vision is a clear and unambiguous expression of an envisioned future. It is the basis for a common understanding among stakeholders of the aspirations and governing ideals of the team in the context of that desired outcome. Conditional on being effectively communicated by the leader to the team, the shared vision grounds the team’s governing ideas and principles and allows for appropriate objectives to be derived.

**Table 26:** Extract from draft PRM to illustrate data collection method

Data collection will therefore seek to verify the PRM by establishing which of the processes can be supported by objective evidence, in keeping with the prescribed requirements for PRM’s outlined in ISO/IEC 15504-2:2003. Outcomes not supported by indicators may need to be removed from the PRM.

**Stage 1 review:** four interviews with project manager participants from organisations operating virtual teams in which the V0.1 PRM is walked-through looking for objective evidence. These will be drawn principally from the defence contracting and general commercial IT industry sectors.

**Stage 2 review:** four interviews with project manager participants from organisations operating virtual teams in which the V0.2 PRM is walked-through looking for anything that does not make sense. These will be drawn principally from the defence contracting and general commercial IT industry sectors.

**Stage 3 review:** researcher only (performing ISO/IEC 24774 compliance analysis on the V0.3 PRM).

**Stage 4 review:** researcher performing a Behavior Tree notation analysis on the V0.4 PRM.

**Stage 5 review:** Expert Panel review on the V0.5 PRM.

**Stage 6 review:** researcher performing a Composition Tree notation analysis on the V0.6 PRM producing the V1.0 PRM at the end.
4.13. Design research: review & verification techniques

Four classes of review are employed reflecting a broad-based approach to the verification of the draft Process Reference Model.

4.13.1. Peer review (V0.1 to V0.2 to V0.3 PRM)

V0.1 PRM to be subjected to four data gathering iterations. These reviews involve the intended user for the finished PRM (i.e. project managers of virtual teams).

The review proceeds by means of an interview in which the interviewee is asked whether they would be able to substantiate each outcome with objective evidence in the form of activities and/or artefacts. To accommodate degrees of substantiation, the four level framework (Jung, 2003) is applied (Fully >85 % to 100 % substantiation, Largely 50 % to 85 %, Partially 15 % to 50 %, Not at all 0% <15%).

Based on the results of this review, the PRM will be consolidated by rationalising similar or related processes to achieve a more streamlined and practical expression of the underlying principles.

V0.2 PRM to be subjected to a further four interviews to confirm the efficacy of the validated processes, examined from a different angle.

The four point measurement scale will not be applied since only those processes that passed the first stage will be present in the second stage, so the four point measurement scale is arguably inappropriate.

Further rationalisation occurs from the second review. Full traceability on how this was arrived at is provided.

4.13.2. ISO/IEC 15504-2 / ISO/IEC 24774 compliance review (V0.3 to V0.4 PRM)

A standardised approach to process description is prescribed in ISO/IEC 15504-2 and ISO/IEC 24774. This review analyses the V0.3 PRM for conformance to the various provisions of ISO/IEC 15504-2 and ISO/IEC 24774 whose purpose is to foster
uniformity in the way processes are described in the software and systems engineering domains.

The criteria used to perform this review, based on ISO/IEC 15504-2 / ISO/IEC 24774 is detailed in the Literature Review chapter, in the section on process and process models in software engineering.

4.13.3. Expert review (V0.5 to V0.6 PRM)

Version 0.5 of the PRM is subjected to review by a panel of experts drawn from academia and industry. Feedback and comments will be consolidated and changes made to the PRM accordingly. Full traceability on how this was arrived at is provided.

4.13.4. Behavior Engineering review

The Behavior Engineering review is in two parts; Behavior Tree and Composition Tree:

4.13.4.1. Behavior tree review (V0.4 to V0.5 PRM)

Dromey’s (2007a) Behavior Tree notation analysis is performed on the V0.3 PRM to determine the presence of logical inconsistencies and the correction thereof.

4.13.4.2. Composition tree review (V0.6 to V1.0 PRM)

Dromey’s (2007a) Composition Tree notation analysis is performed on the V0.6 PRM to determine the system vocabulary and the presence of duplications, double meanings and ambiguity, and the correction thereof.
5. Process Reference Model V0.1

This chapter is the synthesis of the literature-derived leadership factors and the research approach outlined in the previous chapter into the draft Process Reference Model. It incorporates the research question and objectives with the findings of the review to create the V0.1 Process Reference Model (PRM).

5.1. PRM architecture & content; rationale & approach

Little research covering the specific topic of this thesis has been located across multiple disciplines and domains after a broad survey (including but not limited to Biology, Life Sciences, and Environmental Science; Business, Administration, Finance, and Economics; Chemistry and Materials Science; Engineering, Computer Science, and Mathematics; Medicine, Pharmacology, and Veterinary Science; Physics, Astronomy, and Planetary Science; and Social Sciences, Arts, and Humanities).

Leadership of integrated teams in virtual environments therefore represents a largely vacant intersection between the areas of teams, virtual teams, integrated teams and effective leadership. This is a not unexpected outcome; indeed it was recognition of this lack that was a significant motivator for this project.

Given the largely unexplored nature of the topic area, the following architecture for the Process Reference Model is deemed appropriate.

5.1.1. Process Reference Model architecture

The Process Reference Model has three factor groups that contribute to effective integrated team leadership in a virtual environment (as outlined in the hypothesis). A foundational layer of generic leadership skills that are required in any situation requiring leadership, and a further two layers comprising leadership skills in the specific situations of virtual and integrated teams.
1. **Generic Leadership Skills.** There is a generic set of leadership skills/qualities that will apply in both face-to-face and virtual team environments. This generic set is identified and distilled from the wealth of leadership research over time.

2. **Specific examples of practices for integrated teams.** The integrated teaming goals and practices of CMMI-IPPD constitute leadership criteria by default in the sense that someone has to give effect to them, and that will be the responsibility of the leader. Integrated teams are a specific form of Concurrent Engineering (Blackburn et al, 1996).

3. **Specific Virtual Environment Challenges for Leaders.** The virtual teaming challenges outlined by Bell & Kozlowski will be successfully met by an effective leader. These factors have been hypothesised by Bell & Kozlowski (2002) as being specific factors influencing the success of virtual team leaders.

This PRM architecture also theoretically allows for application to virtual teams only, and integrated teams only by using the generic leadership layer plus the relevant virtual or integrated factor layer.

This PRM architecture would also be applicable to the generic leadership capability of a conventional co-located team that is neither virtual nor integrated.

Maximum flexibility is desirable in this project to allow for the widest range of future research possibilities and practitioner applicability.

**Environment view.** An alternative way to view the PRM is from an environmental (in contrast to the functional) perspective. Leadership factors apply to the following five environments; Individual, Project, Organizational, Socio-cultural, and International. The environments are nested concentrically, as seen in the figure below.
Leadership factors from the PRM could be re-assigned from a functional level to an environmental level. This alternative view (analogous to the way in which the CMMI can be viewed from a staged or continuous perspective) may conceivably offer greater flexibility in how the PRM is understood and applied, though it must be stressed that doing here so is outside of the scope of this research project, and should be considered a strong possibility for future research.

5.1.2. Structure & content headings of PRM

5.1.2.1. Assumptions

A PRM to describe leadership can be justified based on the following assumptions:

- Deming’s (2000) assertion that ‘If you can't describe what you are doing as a process, you don't know what you're doing.’ Effective leaders do in fact know what they are doing, and this know-how should be describable.
- Software development is facilitated by effective teams, and
- Software development is facilitated by defined processes

As summarised in the figure below.

![PRM Architecture; high level environmental view](image-url)
5.1.2.2. **ISO/IEC TR 15504-2:2003 (SPICE)**

Given the domain of Software Engineering and sub-domain of model-based process improvement, SPICE (ISO/IEC TR 15504-2:2003) is used as a prescriptive guide to developing a Process Reference Model (PRM) for leadership of integrated teams in virtual environments.

According to van Loon (2004) an ISO/IEC 15504 conformant Process Reference Model must adhere to certain prescribed requirements, namely:

- Statement of domain of application
- Description of processes including:
  - Statement of purpose,
  - Process outcomes necessary to achieve purpose
  - Unique process descriptions and identifications
- Process descriptions shall not contain aspects of the measurement framework beyond Capability Level 1.
• Description of the relationship between the Process Reference Model and its intended context of use within the reference domain.

• Description of the relationship between the processes defined within the Process Reference Model.

• The Process Reference Model shall document the community of interest of the model.

• Verification of the extent to which the model meets the requirements of ISO/IEC 15504 may be through either demonstration of conformity to ISO/IEC 15504, or demonstration of compliance with the provisions of ISO/IEC 15504.

(van Loon, 2004)

5.1.2.3. ISO/IEC TR 24774:2007

Consistent in content and structure with SPICE is ISO/IEC TR 24774:2007 Software and systems engineering -- Life cycle management -- Guidelines for process description outlines a standard format for any process reference model. This general purpose standard outlines the elements used to describe a process; title, purpose statement, outcomes, activities and tasks.

The list below is quoted from ISO/IEC TR 24774:2007:

• The **title** conveys the scope of the process as a whole. It is expressed as a short noun phrase that summarize the scope of the process, identify the principal concern of the process, and distinguish it from other processes within the scope of a process model.

• The **purpose** describes the goal of performing the process. It is expressed as a high level goal for performing the process, preferably stated in a single sentence. The implementation of the process should provide measurable, tangible benefits to the stakeholders through the expected outcomes.

• The **outcomes** express the observable results expected from the successful performance of the process. Outcomes are expressed in terms of a positive, observable objective or benefit. The list of outcomes associated with a process shall be prefaced by the text, ‘As a result of successful implementation of this process:’ The outcomes should be no
longer than two lines of text, about twenty words. The number of outcomes for a process should fall within the range 3 to 7. Outcomes should express a single result. The use of the word ‘and’ or ‘and/or’ to conjoin clauses should be avoided. Outcomes should be written so that it should not require the implementation of a process at any capability level higher than 1 to achieve all of the outcomes, considered as a group.

- The **activities** are a list of actions that may be used to achieve the outcomes. Each activity may be further elaborated as a grouping of related lower level actions;

- The **tasks** are specific actions that may be performed to achieve an activity. Multiple related tasks are often grouped within an activity.

ISO/IEC TR 24774:2007 makes it clear that the outcomes should not go beyond what is stated in the purpose. There should be no capability level issues expressed in the outcomes. Secondly the outcomes must address all of the issues that are apparent in the purpose statement. Nothing should be missed. The outcomes must therefore be necessary and sufficient to satisfy the purpose.

### 5.1.3. PRM content based on literature

Using the structure and content headings obtained from the two ISO/IEC standards mentioned above, the following sets of leadership factors, as derived from the literature are incorporated to produce the V0.1 PRM.

The leadership factors are represented in mind-map format deliberately to imply that there is no particular order that these should be performed, rather that they comprise constellations of factors that collectively represent leadership.
Figure 19: Generic Leadership Factors

Figure 20: Integrated Leadership Factors
5.1.3.1. **Generic leadership personality factors**

Generic leadership personality factors have been derived from the Leadership section of the literature review. The list is bulleted not numbered as no particular order is suggested by the literature review.

- **Create Shared Vision.** Ability to perceive a guiding principle/idea that captures the imagination of members to create a shared vision and inspire them to realise that vision. An aspect of charisma.

- **Communicate shared vision to create optimism.** Ability to communicate this shared vision to create optimism in members. This communication can take many forms in day-to-day practice but conveys an expectation of high standards. An aspect of charisma.
• **Display Integrity/good character.** Ability to act with integrity and honesty, to act consistently over time in pursuit of the shared vision, regardless of setbacks. An aspect of charisma.

• **Create Trust.** Ability to generate and sustain trust. An aspect of charisma.

• **Action-oriented.** Inclined towards action, risk-taking, curiosity.

• **Accepts responsibility.** Accepts ultimate responsibility for events even if others appear blameworthy. Requires the courage to accept the truth/reality of a situation, even when it is unpleasant.

• **Individualized consideration.** Deep concern for the well-being of individual members. Provides mentoring.

• **Original thinking.** Stimulates members to think in original ways, emphasizing the triumph of reason over irrationality, and challenging established ways of thinking.

• **Resilience.** Ability to maintain an enthusiasm for goal realisation, regardless of set-backs.

• **Conceptual ability.** Ability to conceptualise abstractly in broad sense. In more narrow sense, has ability to understand technical issues at least at the conceptual level.

• **Empathy.** Ability to empathise, to see the world through member’s eyes.

• **Judgement.** Ability to exercise good judgement

• **Self-worth & competence.** Ability to make members feel valued, competent and effective in their role, so to avoid feelings of frustration, disillusionment, anger and betrayal.

• **Rewards desirable performance.** Team behavior that works towards realization of goal (shared vision) is rewarded.

• **Management-by-exception (passive).** The leader adopts a laissez-faire attitude until non-compliance of standards has occurred.
5.1.3.2. Integrated team leadership management factors

The integrated team leadership management factors is derived from the literature review section titled CMMI process areas, specific goals and practices related to IPPD. Each factor deals with an activity that should be performed by the leader, or by someone delegated to do so by the leader.

- **Establish the project's work environment** (IPM+IPPD SP1.3) by creating an environment in which all virtual team members have access to and use (preferably broadband) two-way communications media.

- **Establish the project’s shared vision** (IPM+IPPD SP3.1) by understanding and communicating to team members the mission, goals, expectations and constraints of the project in a way that creates a sense of common purpose and enthusiasm.

- **Establish the integrated team structure** (IPM+IPPD SP3.2) by considering the nature and scope of the project to arrive at an appropriate team structure (for example based on the product work breakdown structure). The team structure should be dynamic, able to adapt to emergent circumstances.

- **Allocate requirements to integrated teams** (IPM+IPPD SP3.3) by assigning requirements, responsibilities, tasks, and interfaces to teams in the integrated team structure.

- **Establish integrated teams** (IPM+IPPD SP3.4) within the larger team structure (team leaders and members assigned, team charter established, resources allocated).

- **Ensure collaboration among interfacing teams** (IPM+IPPD SP3.5) by creating an environment of collaboration, informed by the shared vision, facilitated by communications technology and brought together by the leader with the help of interface control working groups.

- **Establish empowerment mechanisms** (OPD+IPPD SP2.1) that allow team leaders and members to recognise clear channels of responsibility and authority. These mechanisms shall avoid situations where people assume too much or too little authority and when it is unclear who is responsible for making decisions.
• **Establish rules and guidelines for integrated teams** (OPD+IPPD SP2.2) by maintaining a clearly defined set of criteria for structuring and forming integrated teams. These operating rules and guidelines define how teams interact.

• **Balance team and home organization responsibilities** (OPD+IPPD SP2.3) by having clear guidelines for how members can balance their team and home organization responsibilities. A ‘home organization’ is the part of the organization to which team members are assigned when they are not on an integrated team.

### 5.1.3.3. Leadership challenges in virtual environments (Bell & Kozlowski)

Leadership challenges specific to virtual environments are derived from Bell and Kozlowski’s (2002) work:

• Ability to devise suitably structured and resourced virtual teams to realise complex project outcomes.

• Ability to devise synchronous, richly-textured communications media to enable virtual teams to communicate as if face-to-face.

• Previous point notwithstanding, ability to devise structures and routines that provides alternatives to and substitutes for face-to-face contact.

• Ability to devise suitable ways for virtual teams to operate in real-time (related to point 2 above)

• Ability to devise operating procedures that are conducive to stable relationships resulting in less-permeable team boundaries.

• Ability to devise ways of promoting stable team membership, particularly in relation to complex projects.

• Ability to devise clearly defined singular roles, particularly in relation to complex projects.

• Ability to devise proactive performance management functions, AND be good at using technology to provide members with team development experiences.
• Ability to devise effective member self regulation mechanisms, AND be able to manage the greater difficulty of implementing these across multiple boundaries.

• Ability to devise critically important team development opportunities, particularly in relation to developing positive relationships in a complex project environment with a discrete life cycle.

• Ability to devise multiple roles for members in ways that avoid role ambiguity and conflict.

• Ability to devise ways of managing team members with multiple roles, particularly in relation to complex projects.

5.2. **Generic leadership personality factors**

**Purpose**: to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).

**Outcomes**: as a result of the successful implementation of Generic leadership personality factors the degree to which a leader embodies such factors and is able to practice them may be identified.

**Elaboration**: generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams.

5.2.1. **Create a shared vision**

**Purpose**: to perceive a guiding principle/idea that captures the imagination of members to create a shared vision and inspire them to realise that vision. An aspect of charisma.

**Outcomes**: as a result of the successful implementation of creating a shared vision:

1. The leader perceives and formulates a unified vision of what is to be accomplished, ideally seen as an accomplished fact.
2. The leader develops a strong commitment to the achievement of that vision, based on a sense of rightness and timeliness, such that they have sufficient resilience to overcome goal frustrating events.

3. The leader develops a clear and unambiguous set of objectives or goals that are concrete and achievable.

**Elaboration:** the shared vision is a clear and unambiguous expression of an envisioned future. It is the basis for a common understanding among stakeholders of the aspirations and governing ideals of the team in the context of that desired outcome. Conditional on being effectively communicated by the leader to the team, the shared vision grounds the team’s governing ideas and principles and allows for appropriate objectives to be derived.

Highly effective groups are often convinced they are engaged in important work, sometimes nothing short of being on a ‘mission from God’. The work becomes an abiding obsession, a quest that goes well beyond mere employment. This intensely shared vision and sense of purpose endows cohesion and persistence.

### 5.2.2. Communicate shared vision to create optimism

**Purpose:** to communicate this shared vision to create optimism in members. This communication can take many forms in day-to-day practice but conveys an expectation of high standards.

**Outcomes:** As a result of the successful implementation of communicating shared vision to create optimism:

1. Leader and members have a unified vision of what is to be accomplished, ideally seen as an accomplished fact.

2. The leader instils in the team a strong commitment to the achievement of that vision, based on a sense of rightness and timeliness, such that they have sufficient resilience to overcome goal frustrating events.

3. A clear and unambiguous set of objectives (also known as goals) is recognized by the team.
Elaboration: An aspect of charisma. Inspirational motivation, optimism, individualized consideration and contingent reward all appear to optimise team performance by creating a positive affective climate.

5.2.3. Display integrity/good character and competence

Purpose: to act with integrity and honesty, to act consistently over time in pursuit of the shared vision, regardless of set-backs.

Outcomes: As a result of the successful implementation of displaying integrity/good character, empathy, openness to truth and competence:

1. The leader displays character traits including but not limited to guiding vision, passion, integrity, empathy, openness to truth and daring.
2. The leader displays competencies including but not limited to: technical competence, interpersonal skills, conceptual skills and judgment.
3. The leader remains principle-centred in the sense that his/her values are known to the team, and the team can rely on the leader acting consistently in accordance with those principles.

Elaboration: Principle-centred leadership creates a climate in which team members can rely on a leader to act according to guiding principle rather than exigent circumstances. Involves doing the ‘right thing’ when it is easier not to under the circumstances.

Such a leader leads by example, leads by having an open, enlightened mind, leads by remaining true to him/herself. Such a person is a natural leader, one who is respected and whose example is followed. The antithesis is the tyrant who is closed-minded and ignorant, who uses force to make people cooperate and who is full of base desires.

Such a leader acts from a sense of oneness with those being led. This sense of oneness is cultivated in a general sense by learning to recognise the interdependence and connectedness of the group members.

Such a leader avoids using unnecessary force to achieve ends, understanding that to do so creates a new set of problems.
5.2.4. Create trust

**Purpose**: to generate and sustain trust.

**Outcomes**: As a result of the successful implementation of creating trust:

1. The leader shall be perceived as trustworthy by the team, a state conditional on the leader behaving in a principle-centred way and displaying the good character and competencies outlined previously.

2. The leader engenders a sense of hope in the individual team members, as in the drive to realize the shared vision/objectives.

3. The leader engenders a sense of self-worth in the individual team members, based on a perceived competence to do what is required to achieve the shared vision/objectives.

**Elaboration**: The group has trust in itself and its leadership. This allows members to accept dissent and tolerate the turbulence of the group process.

Trust can be defined as confidence in someone or something. In terms of project groups we can make a distinguish between bilateral trust between individual group members (one-to-one trust) and general trust (one-to-all) in the project group.

5.2.5. Action-oriented

**Purpose**: to be inclined towards action, risk-taking, curiosity.

**Outcomes**: As a result of the successful implementation of being action-oriented:

1. The leader is generally inclined towards taking action once a situation has been considered and a plan developed.

2. The leader displays a willingness and an ability to overcome inertia and disincentives that reside in some situations that might paralyse others from taking action.

3. Action-oriented means taking action when necessary, but importantly it also means refraining from action when none is required – the ‘leave well-enough alone’ principle.
Elaboration: action-oriented leaders are able to overcome the inertia and disincentives that reside in situations that others might succumb to. Action-orientation is particularly relevant in goal-frustrating situations when others might give up.

Action-oriented implies taking action when necessary, and refraining from action when none is required – the ‘leave well-enough alone’ principle. In this way, a leader creates confidence in the group by being calm and in control.

5.2.6. Accepts responsibility

Purpose: to accept ultimate responsibility for events even if others appear blameworthy.

Outcomes: As a result of the successful implementation of accepting responsibility:

1. The leader recognizes the cause and event linkages that exist in situations, and accepts responsibility for causes when they are in fact due to the leaders actions or inaction.

2. The leader displays a willingness to deal effectively with the effects of their own actions.

3. Blaming behavior is avoided.

Elaboration: Requires the courage to accept the truth/reality of a situation, even when it is unpleasant. Effective leaders accept that the circumstances in which they find themselves are largely the result of their own previous actions. They do not blame others (Macaluso, 2003). They are able to see the linkages between cause and effect, how their behavior affects corporate vision and how their leadership can affect the profitability of the organisation. Effective leaders are proactive, rather than reactive, taking the initiative to improve matters (Macaluso, 2003).

5.2.7. Individualized consideration

Purpose: to have deep concern for the well-being of individual members. Provides mentoring.

Outcomes: As a result of the successful implementation of individualized consideration:
1. The leader recognizes and displays interest in each team member as individuals.

2. Individual team members have a sense that the leader knows them, understands them and has their interests in mind.

3. The leader, through their understanding of individual team member’s strengths and weaknesses, is able to unite them into an effective team.

**Elaboration:** Team members recognize that the leader to some extent knows them as an individual. The antithesis of this is a team member who feels that the leader regards them as expendable, as ‘cannon fodder’.

An aspect of original thinking is the ability to recognize the individual talents of team members, and unite them into a single enterprise.

### 5.2.8. Original thinking

**Purpose:** to stimulate members to think in original ways, emphasizing the triumph of reason over irrationality, and challenging established ways of thinking.

**Outcomes:** As a result of the successful implementation of original thinking:

1. The leader displays an ability to think outside of orthodox and accepted ways of thinking when approaching problem-solving.

2. The leader is less influenced by the opinions of others who may have a stake in orthodox thinking and who consequently endeavour to change or undermine the efforts of the leader in the realization of the shared vision/goals.

3. The leader creates an environment for the team to operate in which frees them from orthodox thinking.

**Elaboration:** creative thinking can lead to solutions that elude conventional thinking. Persistent problems often require new ways of thinking. Original thinkers are not so influenced by the opinions of those that say ‘it cannot be done’, they are more likely to think ‘we haven’t thought of a solution yet’.

It is to be free from the restraints of tradition - the ‘wisdom of the ages’ that can sometimes be a straightjacket for the mind. A leader who brings this approach to
leadership allows the team to function naturally, in proper response to the conditions in which it finds itself. A tradition-bound leader will base his decisions on precedent ‘what did my predecessors do in this situation’. These prefabricated responses lack insight and run a high risk of not being appropriate for the situation at hand.

5.2.9. Resilience

**Purpose**: to maintain an enthusiasm for goal realisation, regardless of set-backs.

**Outcomes**: As a result of the successful implementation of resilience:

1. The team is resilient in the face of goal-frustrating events.

2. Movement towards goal fulfilment is maintained. Should that movement be deflected in other directions by frustrating events, the direction of movement is corrected back towards goal-fulfilment.

**Elaboration**: leaders are more likely to develop resilience when their guiding vision (that they have communicated effectively to the group) is sufficiently strong to supersede the alternative situation that has been imposed on them, and which threatens the realization of the goal. It is having the integrity of character to remain true to the original goal in the face of adversity.

5.2.10. Conceptual ability

**Purpose**: to conceptualise abstractly in broad sense. In more narrow sense, has ability to understand technical issues at least at the conceptual level.

**Outcomes**: As a result of the successful implementation of conceptual ability:

1. The leader has a well-developed capacity for abstract conceptualization.

2. The leader uses this ability in conjunction with ‘original thinking’ (see above) to conceptualise appropriate solutions to problems that are not necessarily based on precedent.

**Elaboration**: Abstract conceptualization allows a leader to mentally manipulate abstractions in problem-solving, efficiency-enhancing ways. This ability is related to the ability to create a unifying vision for the project, which can be seen as a higher
level abstract conceptualization skill. The skill being discussed in this process relates more to how to make it happen.

5.2.11. Empathy

**Purpose:** to empathise, to see the world through member’s eyes.

**Outcomes:** As a result of the successful implementation of empathy:

1. The leader is able to understand situations from points of view other than their own. He/she sees the situation through the eyes of others, and imagines what it might be like if they (the leader) were in that person’s place.
2. The leader effectively anticipates likely consequences of actions involving other people through an understanding of their motives and circumstances.
3. A necessary attribute for ‘Individualised consideration’ (above)

**Elaboration:** Empathy is distinct from sympathy. Sympathy involves becoming emotionally attached to people and outcomes, whereas empathy is dispassionate, non-judgmental. An analogy from the medical domain is that of a doctor using empathy to accurately understand a patient’s condition/situation. The doctor cannot sympathise with the patient, unless they are to risk becoming overwhelmed by the suffering they encounter in the course of a day.

5.2.12. Judgement

**Purpose:** to exercise the ability to accurately and realistically assess people and situations,

**Outcomes:** As a result of the successful implementation of judgement:

1. The leader displays a realistic understanding of situations which allows appropriate action to be taken.

**Elaboration:** Good judgment is a fundamental ability that informs almost all of a leader’s activities. It is the foundation of appropriate action. Good judgment is conditional upon a rational, objective mind-set in which people, objects and events
are viewed realistically for what they are in any particular set of circumstances, rather than relying on stereotypes and prescribed understandings to guide action.

5.2.13. Self-worth & competence

**Purpose:** to make members feel valued, competent and effective in their role, so to avoid feelings of frustration, disillusionment, anger and betrayal.

**Outcomes:** As a result of the successful implementation of self-worth and competence:

1. The leader performs in a way that engenders a sense of self-worth and competence in team members by actively promoting such positive affect in members.

2. The leader engenders self-worth and competence by avoiding over-regulation (otherwise known as micro-management) of members which has the effect of conveying mistrust in the competence of members.

3. The leader engenders self-worth and competence in team members by minimising the perceived status distance between leader and member, in order to create a sense of identification with the members.

**Elaboration:** A key aspect of encouraging a sense of self-worth and competence in group members is to avoid over-regulation. By nature people do not react well to over-regulation. The human species has evolved in a chaotic environment where conditions vary from one day to the next and survival depends on swift adaptation to change.

Self-worth is encouraged when the leader minimises the perceived distance between their sense of their own position and the position of those they lead. By identifying with the group members the leader can better understand the psychological needs of the members, and so their decisions are more aligned with those needs. By extension, an effective leader might go so far as to practice humility as a way of engendering the trust and respect of the group members. The interests of the members are naturally promoted because they are the interests of the leader as well.

Therefore, effective leaders win the confidence of group members because the members sense the leader’s identification with them.
5.2.14. **Rewards desirable performance**

**Purpose:** to reward team behavior that works towards realization of goal (shared vision).

**Outcomes:** As a result of the successful implementation of rewarding desirable performance:

1. The leader specifically rewards team behavior that works towards goal realization, ideally in proportion with the contribution to goal realization.
2. The leader either does not reward, or actively discourages behavior that detracts from goal realization.

**Elaboration:** In behavioral psychology terms, this implies positive reinforcement for desirable behavior. A common mistake is to take desirable performance for granted, effectively ignoring it, while taking action to punish when undesirable performance occurs. While necessary to do the latter on occasion, it must be remembered that the leader’s attention is a reward in itself and adopting a reward for desirable performance approach shows significant benefits.

5.2.15. **Management-by-exception (passive)**

**Purpose:** to adopt a laissez-faire attitude until non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of passive management by exception:

1. The leader allows team members to perform their work without interference until and unless non-compliance with required performance occurs.

**Elaboration:** The ‘reward desirable performance’ process notwithstanding, under some circumstances, it is appropriate to operate on a management by exception basis. This laissez-faire, passive approach is appropriate when a member is expected to act independently, with a degree of autonomy. The member might be a sub-contractor who maintains a professional approach to his/her work and can be relied upon to perform professionally and to a high standard.
5.3. Integrated team leadership management factors

The integrated team leadership management factors is derived from the literature review section titled CMMI process areas, specific goals and practices related to IPPD.

5.3.1. Establish the project's work environment

**Purpose:** to establish the project's work environment (IPM+IPPD SP1.3) by creating an environment in which all virtual team members have access to and use (preferably broadband) two-way communications media.

**Outcomes:** As a result of the successful implementation of establishing the project's work environment:

1. Suitable communications media capable of delivering richly-textured messages between project team members is available on demand and as required.
2. Reliant on first outcome, team members are trained, capable and motivated to use said media.

**Elaboration:** Team members must be in a position to communicate with each other in ways that approximate normal face-to-face interactions. This implies that voice-only telephone and email are insufficient for this purpose. Video telephones and/or web-cam based audio-visual channels that deliver frame-rates that replicate natural movement and speech would be desirable.

5.3.2. Establish the project’s shared vision

**Purpose:** to establish the project’s shared vision (IPM+IPPD SP3.1) by understanding and communicating to team members the mission, goals, expectations and constraints of the project in a way that creates a sense of common purpose and enthusiasm.
Outcomes: As a result of the successful implementation of establishing the project’s shared vision:

1. Team members will implicitly understand the aims of the leader.
2. Team members will be unified in their efforts to achieve the leader’s vision.

Elaboration: When promulgating a shared vision, the following factors should be considered:

1. external stakeholder expectations and requirements
2. the aspirations and expectations of the project leader, team leaders, and team members
3. the project’s objectives
4. the conditions and outcomes the project will create
5. interfaces the project needs to maintain
6. the visions created by interfacing groups
7. the constraints imposed by outside authorities (e.g., environmental regulations)
8. project operation while working to achieve its objectives (both principles and behaviours)

5.3.3. Establish the integrated team structure

Purpose: to establish the integrated team structure (IPM+IPPD SP3.2) by considering the nature and scope of the project to arrive at an appropriate team structure (for example based on the product work breakdown structure). The team structure should be dynamic, able to adapt to emergent circumstances.

Outcomes: As a result of the successful implementation of establishing the integrated team structure:

1. An integrated team structure suited to the requirements of the project is established.
2. A suitable structure is one which makes allowance for product requirements, cost, schedule, risk, resource projections, business processes, the project’s defined process, and organizational guidelines.

**Elaboration:** Factors influencing appropriate team structure include product requirements, cost, schedule, risk, resource projections, business processes, the project’s defined process, and organizational guidelines are evaluated to establish the basis for defining integrated teams and their responsibilities, authorities, and interrelationships.

The Work Breakdown Structure (WBS) and derived product-oriented hierarchy may provide an appropriate team structure. More complex structuring occurs when the WBS is not product oriented, product risks are not uniform, and resources are constrained.

The integrated team structure is a dynamic entity that is adjusted to changes in people, requirements, and the nature of tasks, and to tackle many difficulties. For small projects, the integrated team structure can treat the whole project as an integrated team. The integrated team structure should be continuously monitored to detect malfunctions, mismanaged interfaces, and mismatches of the work to the staff.

Corrective action should be taken when performance does not meet expectations.

### 5.3.4. Allocate requirements to integrated teams

**Purpose:** to allocate requirements to integrated teams (IPM+IPPD SP3.3) by assigning requirements, responsibilities, tasks, and interfaces to teams in the integrated team structure.

**Outcomes:** As a result of the successful implementation of allocating requirements to integrated teams:

1. Before integrated teams are formed, requirements are allocated to the teams given the constraints of responsibilities, tasks and interfaces.

2. Integrated team sponsor(s) are allocated who then establish the team(s).

**Elaboration:** This allocation of requirements to integrated teams is done before any teams are formed to verify that the integrated team structure is workable and
covers all the necessary requirements, responsibilities, authorities, tasks, and interfaces. Once the structure is confirmed, integrated team sponsors are chosen to establish the individual teams in the structure.

5.3.5. Establish integrated teams

**Purpose**: to establish integrated teams (IPM+IPPD SP3.4) within the larger team structure (team leaders and members assigned, team charter established, resources allocated).

**Outcomes**: As a result of the successful implementation of establishing integrated teams:

1. Sponsors establish appropriately constituted (as in allocate requirements to teams) teams.
2. Team membership established (including appointment of team leader if appropriate).
3. Team charter created.
4. Resources allocated.

**Elaboration**: Integrated teams within the integrated team structure are established by the team sponsors. This process encompasses choosing team leaders and team members, and establishing the team charter for each integrated team based on the allocation of requirements. It also involves providing the resources required to accomplish the tasks assigned to the team.

5.3.6. Ensure collaboration among interfacing teams

**Purpose**: to ensure collaboration among interfacing teams (IPM+IPPD SP3.5) by creating an environment of collaboration, informed by the shared vision, facilitated by communications technology and brought together by the leader with the help of interface control working groups.

**Outcomes**: As a result of the successful implementation of ensuring collaboration among interfacing teams:
1. Environment for collaboration is established. Environment is facilitated by rich-texture communications technology.

2. Shared vision is promulgated by leader.

**Elaboration**: The success of an integrated team-based project is a function of how effectively and successfully the integrated teams collaborate with one another to achieve project objectives. This collaboration may be accomplished using interface control working groups.

### 5.3.7. Establish empowerment mechanisms

**Purpose**: to establish empowerment mechanisms (OPD+IPPD SP2.1) that allows team leaders and members to recognise clear channels of responsibility and authority. These mechanisms shall avoid situations where people assume too much or too little authority and when it is unclear who is responsible for making decisions.

**Outcomes**: As a result of the successful implementation of establishing empowerment mechanisms:

1. Clear channels of responsibility and authority are established that allow the leader to make decisions necessary for efficient team functioning.

2. Team members clearly understand their responsibilities.

3. Organizational guidelines that document these empowerment mechanisms are established.

**Elaboration**: Implementing IPPD introduces challenges to leadership because of the cultural changes required when people and integrated teams are empowered and decisions are driven to the lowest level appropriate. Effective and efficient communication mechanisms are critical to timely and sound decision making in the integrated work environment. Once an integrated team project structure is established and training is provided, mechanisms to handle empowerment, decision making, and issue resolution also need to be provided.
5.3.8. Establish rules and guidelines for integrated teams

**Purpose:** to establish rules and guidelines for integrated teams (OPD+IPPD SP2.2) by maintaining a clearly defined set of criteria for structuring and forming integrated teams. These operating rules and guidelines define how teams interact.

**Outcomes:** As a result of the successful implementation of establishing rules and guidelines for integrated teams:

1. Criteria for structuring integrated teams for optimal performance are established.
2. Operating conduct (how teams interact) is established.

**Elaboration:** Operating rules and guidelines for the integrated teams define and control how teams interact to accomplish objectives. These rules and guidelines also promote the effective leveraging of the teams’ efforts, high performance, and productivity. Integrated team members must understand the standards for work and participate according to those standards.

5.3.9. Balance team and home organization responsibilities

**Purpose:** to balance team and home organization responsibilities (OPD+IPPD SP2.3) by having clear guidelines for how members can balance their team and home organization responsibilities. A ‘home organization’ is the part of the organization to which team members are assigned when they are not on an integrated team.

**Outcomes:** As a result of the successful implementation of balancing team and home organization responsibilities:

1. Guidelines for balancing team and home organization responsibilities are established.

**Elaboration:** A ‘home organization’ is the part of the organization to which team members are assigned when they are not on an integrated team. A home organization may be called a ‘functional organization,’ ‘home base,’ ‘home office,’ or
Home organizations are often responsible for the career growth of their members (e.g., performance appraisals and training to maintain functional and discipline expertise).

In an IPPD environment, reporting procedures and rating systems assume that members’ responsibilities are focused on the integrated team, not on the home organization. However, the responsibility of integrated team members to their home organizations is also important, specifically for process implementation and improvement. Workloads and responsibilities should be balanced between projects and functions, and career growth and advancement. Organizational mechanisms should exist that support the home organization while aligning the workforce to meet business objectives in a teaming environment.

Sometimes teams persist beyond their productive life in organizations that do not have a home organization for the team members to return to after the integrated the team is dissolved. Therefore, there should be guidelines for disbanding the integrated teams and maintaining home organizations.

5.4. Leadership challenges in virtual environments (Bell & Kozlowski)

This material is derived from Bell and Kozlowski’s (2002) typology of leadership issues in virtual environments. As noted by the author’s their typology is an attempt to organise a complex phenomena in a way that is more meaningful and understandable. They note that typology is particularly useful when little work has yet to be done on understanding a broad phenomena that is characterised by diverse but related phenomenon. The typological approach would therefore seem appropriate as input material for a proposed process reference model that seeks to further organise and characterize the broad phenomena of leadership of virtual teams.

Bell and Kozlowski distinguish task complexity as a critical factor. They differentiate between complex and simple tasks and imply in several places that complex tasks will need to be performed by integrated teams (teams comprised of members with specialized expertise working together to achieve project outcomes). This distinction is well—suited to the development of a process reference model dealing
with leadership challenges within integrated teams operating in a virtual environment.

5.4.1. Recruit required expertise for virtual team

**Purpose:** To recruit specialized expertise sufficient to achieve the project objective(s), whether this expertise is available locally or in a geographically distant location.

**Outcomes:** As a result of the successful implementation of recruitment of required expertise for virtual team:

1. Suitably skilled virtual team members are recruited.
2. Complex projects may require an integrated team with which to achieve the project objective(s).

**Elaboration:** Virtual teams are usually comprised of geographically dispersed members, allowing for a broad base of potential expertise to be drawn upon when assembling a virtual team. This is particularly true when the task to be performed is a complex one.

5.4.2. Provide synchronous, information-rich channel(s) of communication

**Purpose:** To provide suitable technological mediation to enable communication between virtual team members. In simple projects, asynchronous communications may suffice. On more complex projects involving integrated teams, synchronous communications are essential to supplement the asynchronous.

**Outcomes:** As a result of the successful implementation of providing synchronous, information-rich channel(s) of communication:

1. Technological mediation is provided for all projects.
2. The minimum required for simple projects is audio-only synchronous communications such as telephone, and asynchronous communications such as email.
3. The minimum required for complex projects is the aforementioned plus synchronous, richly-textured communications such as videoconferencing so that the Quality of Service is an approximation of the richness of face-to-face communication is achieved.

**Elaboration:** Technological mediation is essential to bridge the gap created by geographical distance, in order to create a substitute for face-to-face communication between team members. Such mediation must be synchronous and richly-textured in the sense of being able to replicate the richness of face-to-face communication to an acceptable degree. Email and telephone is not sufficiently detailed with communicational nuance. Videoconferencing with a frame-rate of more than 15 frames per second (fps) would be a minimum.

### 5.4.3. Devolve leadership functions to team

**Purpose:** To create technologically mediated structures and routines that substitute for face-to-face contact. To distribute leadership functions to allow them to become more self-managing.

**Outcomes:** As a result of the successful implementation of devolving leadership functions to team:

1. Technologically mediated structures and routines that substitute for face-to-face contact are created.
2. Leadership functions are distributed to the virtual team.
3. The virtual team becomes self-managing as a result of this devolution of leadership functions.

**Elaboration:** The leader overcomes the difficulties of performing key leadership functions when not able to communicate face-to-face by creating technologically mediated structures and routines that substitute for face-to-face contact. In this way, leadership functions are distributed to the virtual team that is then able to become more self-managing as a result of this devolution of leadership functions.

### 5.4.4. Perform complex tasks in real-time

**Purpose:** To enable complex tasks to be performed in real-time.
**Outcomes**: As a result of the successful implementation of performing complex tasks in real-time:

1. Complex tasks are performed in real-time, particularly when workflow arrangements become more reciprocal and intensive.

2. Simple tasks may be performed in distributed time but still benefit from real-time operation.

**Elaboration**: Complex tasks become very difficult to perform when intensive, reciprocal interaction between virtual team members is required. The time-lag between action and response becomes impractical. Simpler tasks may be feasible to perform in distributed time where the workflow arrangements become less dynamic and more sequential.

### 5.4.5. Manage team boundaries

**Purpose**: To manage virtual team boundaries where functional, organizational and/or cultural boundaries are crossed, particularly where complex tasks are to be performed.

**Outcomes**: As a result of the successful implementation of managing team boundaries:

1. Team boundaries are less malleable/permeable when complex tasks are performed by virtual teams.

2. Team boundaries may be more malleable/permeable when simpler tasks are performed by virtual teams.

**Elaboration**: Managing team boundaries in a condition which allows complex tasks to be performed by integrated teams requires that the boundaries be in a condition that allows defined operating procedures and stable relationships to be maintained. This implies that the boundaries are less malleable over the course of the project lifecycle. Simpler tasks may be more tolerant where people move into and out of the team and where explicit operating procedures are less critical.
5.4.6. Establish and maintain stable team membership

**Purpose:** To establish and maintain stable virtual team composition, particularly when complex tasks are to be performed and the project is on-going.

**Outcomes:** As a result of the successful implementation of the establishment and maintenance of stable team membership:

1. Team membership is stable when complex tasks are performed by virtual teams in an on-going project.
2. Team membership may be less stable when simpler tasks are performed by virtual teams in projects with discrete lifecycles.

**Elaboration:** Complex tasks require more stable team membership to enable the virtual team to achieve the projects objective(s). Less complex tasks may be more tolerant to dynamic team membership.

5.4.7. Define roles and perform tasks synchronously

**Purpose:** To clearly define member roles where complex task performance requires (a) greater levels of expertise and specialization, and (b) synchronous workflow arrangements.

**Outcomes:** As a result of the successful implementation of defining roles and performing tasks synchronously:

1. Member roles are clearly defined, fixed and singular when complex tasks are to be performed, particularly when the work is to be performed synchronously.
2. Member roles may be less clearly defined, fixed and singular when simpler tasks are to be performed, particularly when the work is performed asynchronously.

**Elaboration:** While virtual team members may on occasion perform multiple roles, it becomes increasingly important that roles are clearly defined when the task complexity increases, and the work is done synchronously. Rigid role definition becomes less important when the tasks are simpler, particularly when the tasks can be performed asynchronously.
5.4.8. Establish performance management functions to compensate for temporal distribution

**Purpose:** To compensate for temporal distribution and the resulting degradation of performance management capability, the leader shall create explicit performance management functions to enable team members to self-manage their own performance.

**Outcomes:** As a result of the successful implementation of establishing performance management functions to compensate for temporal distribution:

1. Explicit performance management functions are established.
2. Said performance management functions allow team members to manage their own performance.
3. Said functions anticipate problems and provide clear guidance on how to adapt to changing environmental conditions.

**Elaboration:** Where temporal distribution degrades the quality of the information that a leader normally uses to carry out performance management, compensatory measures should be established that (a) allow team members to effectively manage their own performance, and (b) have an anticipatory element that helps team members to avoid potential problems and adapt to changing environmental conditions.

5.4.9. Establish team development practices, facilitated by rich-texture communications technology, in response to real-time requirement

**Purpose:** To allow real-time virtual team operations, the means shall exist for leaders to perform team development functions by using appropriate communication technology to facilitate team development experiences that promote team coherence.

**Outcomes:** As a result of the successful implementation of establishing team development practices, facilitated by rich-texture communications technology:
1. Appropriate communications technology is identified and implemented to facilitate team development activities.

2. Team coherence is facilitated by the use of said communication technology.

**Elaboration:** Team development activities that promote coherence are likely to be more important when the virtual team operates in real-time. Virtual team leaders need to be adept at identifying appropriate technology to facilitate the necessary degree of team coherence to achieve success.

### 5.4.10. Establish effective self-regulation functions across multiple boundaries

**Purpose:** To establish effective self-regulation functions where team members are across different functions, organizations and/or cultures.

**Outcomes:** As a result of the successful implementation of establishing effective self-regulation functions across multiple boundaries:

1. Effective self-regulation functions are established that take account of how these functions translate across diverse boundaries.

2. Contextual factors are considered carefully when carrying out performance management and appropriate allowances made.

3. Relevant factors (i.e. cultural differences) are identified and applied in relation to individual team members.

**Elaboration:** Where virtual teams cross multiple boundaries (in terms of culture, organization and specific job functions) it is important for leaders to carefully assess the nature of these boundaries and to determine how best to tailor performance management for individual team members given the nature of the differences.

### 5.4.11. Establish unique team culture where team spans multiple boundaries

**Purpose:** To establish a blended team culture across multiple boundaries that promotes mutual respect, trust and reciprocity among diverse team members.
Outcomes: As a result of the successful implementation of establishing unique team culture where team spans multiple boundaries:

1. Where virtual teams are across multiple boundaries (functional, organization, and/or cultural), an adaptive ‘third’ culture is established based on mutual respect, trust and reciprocity.

2. Team members are linked together and consider themselves team insiders.

3. Team interest is placed above self-interest.

4. Team cohesion is enhanced.

Elaboration: Teams that span diverse functional, organizational and/or cultural boundaries will have poor cohesion unless the leader works to establish a common culture that is a blend of each member’s individual culture. From this basis of common culture, team cohesion can be established and cultivated in a way that develops mutual respect, trust and reciprocity (mutual obligation).

5.4.12. Establish operating procedures to allow members to regulate their own performance

Purpose: To establish operating patterns early that allow team members to regulate their own performance, particularly in relation to discrete lifecycle projects.

Outcomes: As a result of the successful implementation of establishing operating procedures to allow members to regulate their own performance:

1. In the case of discrete lifecycle projects, effective self-management functions (goals, structures, norms) are established early in the project lifecycle to overcome the tendency for non-productive inertia to be overcome.

2. In continuous projects, self-management functions are established early also, yet given the on-going nature of such projects, the timing may be less critical than with discrete lifecycle projects.

Elaboration: In the same way as team members who have known each other for some time find it easier to work together, so too does a leader find it easier to lead when he/she has been doing so for some time and is familiar with the team members. In this situation, the leader is able to establish goals, structures and
norms that help to regulate performance. Deviation from these can generally be recognized.

On the other hand, with shorter-term, discrete lifecycle projects, it is more difficult to establish these regulating mechanisms since they tend to take time to develop. It is important for the leader to create these mechanisms early in the lifecycle rather than wait for them to develop.

5.4.13. Establish effective team development functions in discrete lifecycle projects

**Purpose:** In discrete lifecycle projects, to quickly establish team development functions that allow the team to become productive as soon as practically possible.

**Outcomes:** As a result of the successful implementation of establishing effective team development functions in discrete lifecycle projects:

1. Short-term or discrete lifecycle projects have the critical team development issues settled and implemented early to facilitate timely completion of project.

2. Longer-term or continuous projects have the critical team development issues settled and implemented early to facilitate the establishment of stable, long-term working relationships and complex workflow arrangements.

**Elaboration:** It is important for both short and long-term projects that the critical team development functions are established as early as possible. For short-term, discrete lifecycle projects, there is usually only time to focus on the most critical of functions, for example effective working relationships.

For long-term, continuous lifecycle projects, these functions are even more important in the sense that stable long-term working relationships are usually required, performing work of a complex nature that requires complex workflow arrangements. Such projects usually require reciprocal workflow arrangements in which integrated teams work collaboratively.
5.4.14. Manage role ambiguity and conflict where members hold multiple roles

**Purpose**: To minimise the effects of role ambiguity when members hold multiple roles within and across virtual teams.

**Outcomes**: As a result of the successful implementation of managing role ambiguity and conflict where members hold multiple roles:

1. Member roles are clearly understood when complex virtual teams have individual members who hold multiple roles.
2. Contingency plans exist for when a member is obliged to work on another team.
3. Time commitment to a particular team is clearly understood by each member.

**Elaboration**: When team members hold multiple roles within and across different teams, the leader’s performance management job becomes more difficult in the sense that role ambiguity and role conflict are likely to occur. The leader must make clear for each member exactly what their role is, in other words what the leader’s expectations are in terms of commitment of time and effort.

5.4.15. Establish effective team development functions where members hold multiple roles

**Purpose**: To perform effective team development functions where members hold multiple roles and move into and out of those roles.

**Outcomes**: As a result of the successful implementation of establishing effective team development functions where members hold multiple roles:

1. In complex projects where members hold multiple roles, those individual roles are clearly defined and understood.
2. In complex projects where members hold multiple roles, those role networks are clearly defined and understood by the members.
3. Where possible members with multiple roles have their role simplified/reduced to a single role in order to remove ambiguity and role conflict.

**Elaboration:** Team development functions become difficult and unwieldy when members have multiple roles. A coherent, well-ordered team is difficult to establish when people are flowing into and out of the team, particularly when those people are unclear about their role responsibilities. The objective is to establish a clearly defined role network that facilitates mutual understanding and interdependence. This is best achieved by simplifying member roles to one role per member.

### 5.5. Concluding remarks

The Process Reference Model (PRM) detailed in this chapter is the synthesis of the research question/objectives and the literature review. We now have a draft PRM ready for review by stakeholders.
6. Research event

This chapter elaborates on the research event, specifically the data collection and data analysis procedures. Data collection comprised a series of reviews involving participants. It does not discuss the larger research project in which the research questions and objectives were considered, literature reviewed etc, nor does it discuss the data analysis and findings write-up that followed data collection.

As such this chapter is a detailed description of the:

- Sampling strategy -- way in which participants were selected
- Project participants
- Design of field experiment instruments
- Stage review protocols
- Aggregation of data
- Justification of data collection method
- Limitations of field interviews
- Ethical considerations related to interviews
6.1. Selection of research participants

The research participants, as will be seen in this chapter, were selected on the basis of their capability to answer the research question and meet the research objectives (reiterate below):

Research question: What are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments?

Research objectives:

1. To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments.

2. Based on the identified qualities and characteristics, to develop a Process Reference Model (PRM) for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007.

3. To determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior.

4. To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior and/or Process Reference Models in the software engineering domain.

5. To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.

The research participants for Stage 1 and 2 reviews must have experience as a manager of virtual project team(s). The organisations in which the Stage 1 and 2 participants operate must be in the business of conducting virtual-team based IT development projects. Prospective Stage 1 & 2 participants were considered initially from the Australian industry contacts of the Software Quality Institute (SQI) at Griffith University. The SQI had for at least fifteen years before the research event been actively engaged in software development process improvement best practice transition in the Australian software engineering community. The SQI’s activities during
this time included industry training, capability appraisals and software engineering process group conferences. The SQI was therefore well-known and well-regarded by the software engineering (SE) community. It was from this basis that prospective research participants were approached.

Due to the nature of the SQI’s focus on model-based process improvement, the participants for the Stage 1 & 2 reviews were largely drawn from SE practitioners who had worked with and had an understanding of process models such as the Capability Maturity Model Integration (CMMI) and ISO/IEC 15504 (SPICE). Thus were the participants able to understand the basic purpose and nature of the Leadership PRM, the subject of this research project.

For the Stage 5 review, participants must be a recognized expert in process. The Stage 5 Expert Review participants were approached initially by the thesis advisor Associate Professor Terry Rout. The experts are acknowledged model-builders by the process research community (not by self-assessment). Once AProf Rout has obtained their consent to participate, the researcher took the lead with all correspondence. AProf Rout CC’ed on everything.

**Unit of analysis.** The unit of analysis is at the project level (software and systems development projects).

### 6.2. The participants

The Stage 1 & 2 participants cannot be identified by name, due to privacy requirements of the ethics committee and the commercial sensitivities of the participant’s organisation. The majority of participants are from competitive commercial organisations; so anything their employees say is covered by a ‘commercial-in-confidence’ privacy provision. All participants agreed to have the interview digitally recorded (using a Sony ICD-P530F recorder). The privacy of research participants and their organisation is also guaranteed by Griffith University’s Human Research Ethics Committee (HREC).

Half of the Stage 1 & 2 participants are Defence contractors operating in Australia, while one of the remaining participants are multinational IT organisations with a general commercial focus, also operating in Australia. Having a significant proportion of data deriving from a single sub-sector within the larger IT sector is not necessarily a
problem, since the data collection focuses on process matters that are common to any IT project (for example, does the project manager articulate a vision?) and not on any aspect related specifically to Defence projects. A benefit of solid representation from the Defence contracting sector, and indeed from the general commercial sector is that such organisations routinely conduct complex, virtual team based projects over long-durations; exactly the kind of project for which virtual team leadership competency is likely to be an issue, and a likely environment in which to find participants well-qualified to contribute useful input.

The software engineering consultant is a senior member of the SE community with decades of experience running complex projects. This participant has collaborated with the researcher on an earlier research project.

The medical software development participant is included since he operates a small but globally dispersed development project making full use of the available communications technology to facilitate team operations.

In keeping with Hevner’s guidelines for valid Design Research, the Stages outlined below are designed to satisfy the requirements of the following two specific guidelines:

**Guideline 3: Design Evaluation.** The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods.

**Guideline 5: Research Rigor.** Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artefact.

### 6.2.1. Stage 1 review

Stage 1 review performed on V0.1 PRM (draft that emerged from the literature review).

The industry sectors and dates of interview of the Stage 1 participants shown below:

1. IT hardware, software & services (general commercial)  
   Wed 18 July 2007
2. IT hardware, software & services (general commercial)  
   Mon 26 November 2007
3. IT hardware, software & services (Defence contractor)  
   Wed 6 February 2008
4. IT hardware, software & services (Defence contractor)
   Wed 13 February 2008

6.2.2. Stage 2 review

Stage 2 review performed on V0.2 PRM (the draft that emerged from Stage 1 review).

The industry sectors and dates of interview of the Stage 2 participants:

1. IT hardware, software & services (Defence contractor)
   Fri 4 July 2008

2. IT hardware, software & services (Defence contractor)
   Wed 16 July 2008

3. Software engineering consultancy & project management
   Mon 8 September 2008

4. Software development (medical)
   Fri 24 October 2008

Stage 2 review performed on V0.2 PRM (the draft that emerged from Stage 1 review).

6.2.3. Stage 3 review

Stage 3 review performed on V0.3 PRM (the draft that emerged from Stage 2 review).

Stage 3 review involved the researcher only (performing ISO/IEC 24774 compliance analysis).

6.2.4. Stage 4 review

Stage 4 review performed on V0.4 PRM (the draft that emerged from Stage 3 review).

Stage 4 review involved the researcher performing a Behavior Tree notation analysis after instruction from Prof Dromey, who later provided feedback on the draft analysis.

6.2.5. Stage 5 review

Stage 5 review performed on V0.5 PRM (the draft that emerged from Stage 4 review).
Stage 5 was an Expert Panel review involving the following participants. Note that ‘Experts’ in this project are publicly recognised, and there was no expectation of privacy for this category of participant.

1. Person 1 – Bill Curtis (author of People CMM)
2. Person 2 – Alec Dorling (leader of ISO/IEC 15504 / SPICE project)
3. Person 3 – Linda Ibrahim (leader of Enterprise SPICE project)
4. Person 4 – SuZ Garcia (member of IPD-CMM Integrated Product Development Capability Maturity Model development team)

6.2.6. Stage 6 review

Stage 6 review performed on V0.6 PRM (the draft that emerged from Stage 5 review).

Stage 6 review involved the researcher performing a Composition Tree notation analysis after being instructed on how to do so by Professor Geoff Dromey.

6.3. Data collection instruments

The data collection instruments comprised the following elements:

- **Information sheet & consent form.** Participants given, at the outset, an information sheet and consent form which seeks a person’s informed consent to participate in the research, having been fully apprised of the implications.

- **Interview Schedule (Stage 1 & 2 Review).** Version 0.1 and 0.2 PRM interview schedules are in the appendix. The term ‘schedule’ is used here in the sense of an ordered list. The table below is a representative sample of the schedule. Each process is expressed as a title, purpose, outcome(s) (as per ISO/IEC 15504-5), space to list instantiations of activities and artefacts, followed by informative material to contextualise the process. The purpose and outcomes are explained to the participants, who are then asked to cite, if possible, instantiations of the outcomes, thus providing the objective evidence needed to validate the PRM. The researcher enters the instantiations in the space provided under Activities & Artefacts.
Create and communicate a shared vision

**Purpose**: to perceive and communicate a guiding principle/idea that captures the imagination of members to create a shared vision and inspire them with the enthusiasm to realise that vision. An aspect of charisma.

**Outcomes**: as a result of the successful implementation of creating a shared vision:

The leader perceives and formulates a unified vision of what is to be accomplished, ideally seen as an accomplished fact.

Activities & Artefacts to support?

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Leader communicates shared unified vision with team, ideally seen as an accomplished fact.

Activities & Artefacts to support?

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Leader develops strong commitment to achieving vision, based on a sense of rightness and timeliness, such that they have sufficient resilience to overcome goal frustrating events.

Activities & Artefacts to support?

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The leader develops a clear and unambiguous set of objectives or goals that are concrete and achievable.

Activities & Artefacts to support?

---

Leader engenders hope/optimism towards achieving the objectives.

Activities & Artefacts to support?

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**Elaboration**: the shared vision is a clear and unambiguous expression of an envisioned future. It is the basis for a common understanding among stakeholders of the aspirations and governing ideals of the team in the context of that desired outcome. Conditional on being effectively communicated by the leader to the team, the shared vision grounds the team’s governing ideas and principles and allows for
appropriate objectives to be derived.

Creating and communicating a compelling vision of the future is an aspect of charisma; inspirational motivation, optimism, individualized consideration and contingent reward all appear to optimise team performance by creative a positive affective climate.

The team must grow to trust each other and the leadership. This allows members to accept dissent and tolerate the turbulence of the group process.

Trust can be defined as confidence in someone or something. In terms of project groups we can make a distinction between bilateral trust between individual group members (one-to-one trust) and general trust (one-to-all) in the project group.

Table 27: Indicative sample of stage 1 & 2 review interview schedule

- **Voice Recorder.** Interviews are recorded, with permission, using a digital recorder (Sony ICD-P530F). The resulting recording is converted to compact MP3 format and archived for later reference, if necessary.

### 6.4. Stage review protocols

Those stages requiring interaction with other individuals followed a prescribed protocol in each case, with no exceptions. The protocol is devised in part to satisfy the requirements of Human Research Ethics, but also to constitute what is considered acceptable behavior in the software engineering world, that is to say, clear, succinct, and respectful of both the participants’ busy schedule and domain knowledge. It is a pre-condition that participating in this project does not harm the pre-existing relationship with the Software Quality Institute.

For completeness, the procedures for the stage reviews that do not require interaction with participants are also included.

### 6.4.1. Stage 1 & 2 review interviews

Interview protocol followed this process:

1. Email requests sent to prospective participants.
2. On agreement by prospective participant, an offer is made by the researcher to travel to the participant’s place of work, or other convenient
location, at a time suitable to both parties. Participant is advised that the interview may last up to three hours, though not necessarily.

3. On arrival at the agreed meeting place, researcher gives the participant the information sheet and consent form. Participant is asked to read the information and complete the form. Any questions are answered fully in order that ‘informed consent’ is achieved.

4. Participant is asked for their consent for a digital recording of the interview to be made.

5. Participant is given a copy of the interview schedule, identical to the copy used by the researcher to record instantiations of outcomes (activities and artefacts).

6. Researcher introduces the draft process reference model (PRM) is the result of an extensive literature review of leadership practice. That the PRM will form the basis for a later process assessment model (PAM) to help project managers improve their leadership capability. The draft PRM is presented as a potentially useful tool for any IT development project manager, particularly those engaged in virtual and/or integrated team leadership.

7. Researcher reiterates that the purpose of the interview is to determine if activities and artefacts can be identified to substantiate the performance of each process outcome. It is further explained that a PRM such as the one under review must be validatable with activities and artefacts. If no such substantiation can be found, the outcome cannot remain in the PRM. So it is the purpose of the review to validate where possible the draft PRM.

8. Participant is asked to point out any aspects of the draft PRM that (a) do not make sense to them, or (b) seems incorrect. They are further encouraged to offer improvement suggestions as the walkthrough proceeds. Participant is told they will notice some duplication in these early drafts, and that these will be merged as the review cycles proceed and a rationale emerges.

9. Researcher and participant then walk through each process and outcome, discussing and clarifying where necessary, with results and feedback being recorded in the researcher’s copy of the interview schedule. The digital recording operates in the background as a fall-back reference if required.
10. On reaching the end of the draft PRM, the participant is thanked and their copy left with them for their own information and use on the understanding that it is a confidential work-in-progress.

11. Email sent the following day expressing the researcher’s gratitude for the time and effort put in by the participant (on average two hours).

6.4.2. Stage 3 review (ISO/IEC 24774 compliance)

The Stage three review involved only the researcher analysing and redrafting the V0.3 PRM for compliance with ISO/IEC 24774.

6.4.3. Stage 4 review (Dromey’s Behavior Tree notation analysis)

After two training sessions with Professor Geoff Dromey (at Griffith University’s Software Quality Institute), author of the Behavior Tree and Composition Tree methods for verifying software engineering requirements, the researcher reviewed the V0.4 PRM by applying the method. This involved analysing each outcome.

For example, in the V0.3 PRM:

*Outcome 1.1 Leader creates a shared vision of what is to be accomplished, ideally seen as an accomplished fact. Becomes:*

*Leader creates a shared vision of the goal(s) in the V0.4 PRM.*

This simplification was accomplished by constructing the table below according to Dromey’s method which identifies the essence of the outcome. The additional information contained in the V0.3 ORM Outcome is not lost. It is moved to the Informative section.

<table>
<thead>
<tr>
<th>1.1.1</th>
<th>LEADER (creates)</th>
</tr>
</thead>
<tbody>
<tr>
<td>what</td>
<td>SHARED VISION/</td>
</tr>
<tr>
<td>(of)</td>
<td>GOAL(S)</td>
</tr>
</tbody>
</table>

Table 28: Behavior Tree example (Dromey, 2007a).
6.4.4. **Stage 5 expert panel review**

Domain experts were approached by A/Prof Rout seeking their agreement to participate in an Expert Panel review of the V0.4 PRM.

Under the circumstances, four experts agreed to participate on the panel. They were sent an electronic package via email containing the following:

- Letter of Introduction to the Expert Panel
- Terms of Reference for the Review
- Ethics Information and Consent Form
- Draft (V0.4) PRM

The Terms of Reference read as follows:

**Feedback & Return**

*Please record your input into the PRM V0.4 Review Document and return to D.Tuffley@griffith.edu.au, preferably within 14 days. Please make your comments directly into this document. Your input will form the basis of the fifth and final review, leading ultimately to its release as V1.0. Any matters requiring further clarification can be dealt with by phone at your convenience.*

**Objectives**

*The objectives of the expert review are to:*

**Identify omissions and weaknesses.**

*From an expert perspective, omissions and weaknesses may exist (preceding four reviews notwithstanding).*

**Suggestions for improvement.**

*Identify ways in which the efficacy of the model might be improved, given the broader aim of producing a practical tool for project managers engaged in the often difficult process of managing complex, virtual teams.*

**Consent form and non-disclosure agreement**

*Please sign (electronically) the combined consent form and non-disclosure agreement on the following pages.*
The consent form is required by Griffith University’s Human Research Ethics Committee. It is a standard form that protects your privacy and interests, as prescribed by Australian Federal legislation.

The non-disclosure component seeks your agreement to not disclose the content of the Leadership PRM to a third party without the consent of the Principal Investigator.

6.4.5. Stage 6 review (Dromey’s Composition Tree notation analysis)

The sixth and final review cycle applies Composition Tree notation analysis to identify a system vocabulary of terms used in the PRM to determine whether duplications, ambiguities and synonyms are being used. The purpose of the analysis is to achieve consistency in terminology.

6.5. Aggregation of data

Where data aggregation is required, a tabular approach is used. The data collected in each review stage is tabulated against each process outcome. Any transition from one draft version to the next (i.e. V0.1 to 0.2) is explained in an adjacent table cell in order to achieve full traceability. The goal is to make no change unless said change is tracked and a reason given for the change. In this way, traceability is achieved. It also provides a rationale for future researchers who may wish to apply this Design Research approach to process model development.

Stage 1 review uses an averaging algorithm (see below) to arrive at a consolidated Fully, Largely, Partially or Not at all rating for each outcome. This method allows an outcome to be validated or not.

The average calculation is based on the following:

- IF Site Rating = ‘F’, then a weighting of 100 is assigned
- IF Site Rating = ‘L’, then a weighting of 66.67 is assigned,
- IF Site Rating = ‘P’, then a weighting of 33.33 is assigned
- IF Site Rating = ‘N’ then a weighting of 0 is assigned
• Average for the four sites is then calculated and shown in the Avg% column

• Excel Spreadsheet formula =IF(B4='F',100,IF(B4='L',66.67,IF(B4='P',33.33,0)))

Median is calculated based on the following:

• IF Average Percentage < 16 then a rating of N is assigned

• IF Average Percentage < 51 then a rating of P is assigned

• IF Average Percentage < 86 then a rating of L is assigned

• IF Average Percentage < 100 then a rating of F is assigned

• Median Rating value is shown in the Median Value column

• Excel Spreadsheet formula =IF(J4<16,'N',IF(J4<51,'P',IF(J4<86,'L','F')))

**Stage 2** review. Version 0.1 merging of processes to become Version 0.2 uses the rationale outlined below:

• Processes that have a median rating of Fully or Largely have arguably been validated and may proceed to Version 0.2 PRM

• Processes that have a median rating of Partially or Not At All may still arguably deserve a place in Version 0.2 PRM but require further review to clarify whether they are valid but difficult or impossible to validate, in which case they may be merged in with another process that is logically able to accommodate it.

• All processes included in V0.1 PRM are theoretically valid, based on the literature review. The challenge with some is how to express them in a way that can be validated. Merging them with other, validated processes, then subjecting them to a second review using the same procedure as with V0.1 PRM is arguably a valid way to accomplish this.

• Based on the rationale outlined in the previous point, any process with a median rating of N or P will be merged with another process that has already been validated.

• A rating of F or L notwithstanding, processes that are similar in nature may be merged in the interests of conciseness and simplicity. The PRM needs to be expressed simply while avoiding over-simplification.
Rationale for Stage 2 Data Collection. All stages of the project are informed by Hevner’s (2004, 2007) general principles and guidelines for valid Design Research. Relevant to Stage 2, the principles to be considered include being cognizant of the Design Cycle component of Hevner’s (2007) three cycle view of DR (Relevance & Rigor being the other two cycles). The Design Cycle focuses on iterations between artefact construction, evaluation and feedback. This effectively generates design alternatives and allows these alternatives to be evaluated (derived from rigour cycle) against the requirements (derived from relevance cycle) until a satisfactory design is achieved. These design alternatives must be evaluated from multiple perspectives if they are to satisfy the interests of multiple stakeholders. This implies taking a fresh look at the designed artefact, rather than the same look a second time.

Also, Guideline 6 (of 7) from Hevner’s (2004) Guidelines for conducting Design-Science research states; The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment. ‘Available means’ that satisfy ‘laws in the problem environment’ could reasonably be interpreted to mean making the evaluation techniques consistent with the environment in which the artefact will be used, understandable by the persons operating in that environment and who are the intended users of the artefact. This strongly implies asking the respondents what they think about the artefact as a prospective tool, and be asked to communicate this feedback. This is in contrast to Stage 1, where the respondents were asked to indicate the existence of validating artefacts to support the PRM practices.

In Stage 2, the spirit of this process might therefore best be served by evaluating the design that emerged from Stage 1 in a different way from that which was used in Stage 1. In Stage 2, instead of asking respondents to validate every practice with specific examples of activities and/artefacts as done in Stage 1, respondents are asked to review every practice and indicate those that do not apply or are not understandable to integrated-virtual teams (in their experience), and to express their opinion of the practices. Thus, Stage 2 proceeds on an exception basis.

A possible alternative approach would be to perform the same validation/evaluation process in both Stages 1 and 2. This would have the advantage of consistency, but the disadvantage that it does not consider the respondent’s subjective impressions about how the model functions as an artefact in a user’s environment. It only considers whether the process purpose and outcomes can be validated by the
existence of artefacts and performance of activities. Also, if Stage 1 has been performed comprehensively, using the same approach is unlikely to reveal much new data.

After extended consideration, the proposed course of action is to evaluate the design that emerged from Stage 1 in a way that utilises a different perspective from that used in stage 1.

The following rationale is offered:


- **Strength of the literature review.** The literature review identifies the leadership factors from the software engineering, psychology and management literatures. It is therefore broad-based and comprehensive. All of the factors present in the V0.1 PRM are corroborated in the academic literature and in some cases from multiple instances in the literature. The strong presence of these leadership factors in the literature justifies their inclusion in V0.1 PRM and to some extent validates their place in the PRM.

- **Stage 1 review** identifies the presence or otherwise of artefacts and/or activities that serve to validate the presence of practices in V0.1 PRM, as specified by the requirements for PRM’s in ISO/IEC 15504. Stage 1 identifies that most practices could be fully or largely validated by the presence of activities and/or artefacts. Some could only be partially validated or not at all. On questioning, respondents indicated that the practices in question are outside of the scope of operations of the respondent. Significantly, none of the unvalidated practices were beyond the understanding of the Stage 1 respondents, who said they could understand the need for such practices where the circumstances exist. Significantly therefore, there is nothing in V0.1 PRM that seems out of place to the four respondents. The consistency of these responses suggests that the four Stage 1 data-sets are sufficient. It also strongly indicates the need to incorporate (rather than discard) the non-validated practices into other validated practices of a related nature, as and where they could logically fit.

- **Stage 2 review** can therefore proceed on the assumption that the practices have been verified (from literature review) and validated (from Stage 1
review). The revisions and consolidations made as a result of the Stage 1
review are then the subject of the Stage 2 review in which respondents look
at all of the practices of the V0.2 PRM with instructions to identify any
exceptions, i.e. practices that do not appear to belong. This approach looks
at the V0.2 PRM from a different perspective relative to the first review and
is therefore perhaps more likely to reveal exceptions.

Stage 3 (ISO/IEC 24774 compliance), Stage 4 (Behavior Tree notation analysis)
and Stage 6 (Composition Tree notation analysis) do not require data aggregation.

Stage 5 (Expert Panel review) like Stage 1 and 2 uses a tabular approach to data
aggregation. The detailed feedback and comments from the expert reviewers are
shown in a table against each specific outcome. Any transitions from one draft
version to the next (i.e. V0.4 to 0.5) are explicated in an adjacent table cell in order
to achieve full traceability. As before, the goal is to make no change unless the
change is tracked and a reason given for the change. Traceability is achieved, and
also a rationale for future researchers who may wish to apply this Design Research
approach to process model development.

6.6. Justification of data collection method

The data collection method is founded upon the orthodox Design Research approach
outlined by Hevner (2004, 2007), Vaishnavi and Kuechler (2007). This approach is
rigorously applied in this project. It is arguably orthodox and therefore a safe method to
use for a PhD project.

Iterative data collection stages, each of which examines the developing process model
from a different angle, accumulates a body of data that is intended to be
comprehensive, at least within the scope of a PhD level project that must be
constrained within certain manageable limits, and not allowed to grow to
unmanageable proportions.

Arguably the Fully, Largely, Partially, Not at all (FLPN) rating scale in data collection
Stage 1, and the percentage value allocated to each, is an appropriate method for
assessing validational compliance.
6.7. How much data is enough?

The concept of ‘theoretical saturation’ is useful in determining when enough data has been collected from which valid findings might be drawn. Theoretical saturation derives principally from the Grounded Theory research method, but might arguably be generalised to Design Research. The rigor of Grounded Research offers a degree of assurance when applied to Design Research.

Glaser and Strauss (1967) describe theoretical saturation and its application in deciding when to stop sampling data in the following terms:

... no additional data are being found whereby the (researcher) can develop properties of the category. As he sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated ... when one category is saturated, nothing remains but to go on to new groups for data on other categories, and attempt to saturate these categories also.

Martin and Turner (1986) suggest that by the time three or four sets of data have been analysed, the majority of useful concepts will have been discovered. For this reason, review stages 1 and 2 of this project each involve four interviews.

Arguably therefore, when the results of the data collection trials yield a high degree of consistency, then theoretical saturation has been reached and we know how much data is enough.

6.8. Limitations of participant interviews

Limitations of the participant interviews and how the risk of these limitations was mitigated are identified as follows:

- **Time constraints.** Interviewees are busy project managers for whom two to three hours is a long time to spend away from the tasks at hand in a busy day, thus the risk is that not enough time is spent on the (stage 1 and 2) review. This risk was mitigated by clearly setting expectations beforehand, and reiterating at the beginning of the interview about the scope of work to be covered. Each
participant was asked if this is likely to be problem, and agreement reached on what would be covered and the time required.

- **Interruptions.** Interviewees are likely to be interrupted if interview is conducted in their office. Where possible, interviews were conducted in a conference room, or at an agreed off-site location such as a coffee shop.

- **Missed information.** The researcher runs the risk of not capturing all of the interviewee’s comments and feedback. To mitigate, the researcher concentrated on capturing the most important points, as seemed appropriate at the time, then clarifying any ambiguities by listening to the appropriate portion of the digital recording later. This could be done by noting the time at the place where information overload occurred which allowed the appropriate place in the recording to be later found.

- **Commercial in Confidence considerations.** The interviewees all worked for organisation’s that carefully guard their sensitive information (whether this is commercial or Defence-related). The risk is that interviewees felt so constrained by these considerations that they could not provide sufficient data to the interviewer for the purposes of this project. The risk was mitigated by constraining all discussion to the general aspects of project management and engaging in no project-specific discussion. Interviewees were also assured that nothing that was said in interviews would be attributable in any way to any organisation.

- **Scarcity of suitable interviewees.** Finding a sufficient number of willing and suitably qualified interviewees presented some challenges. The risk is that insufficient interviewees would be found. To mitigate, the interviewee selection process extended over a year, with the aid of professional networking to find interviewees (eight in total).

- **Travel/logistics expense.** Interviewees were located in three Australian States (Queensland, New South Wales, Victoria), necessitating the expense of air-travel and overnight accommodation, plus time away from University teaching. The expenses were paid from the researcher’s consultancy account with funds earned from teaching Introduction to CMMI training courses. With sufficient notice, alternate teaching arrangements could be made with the approval of the Head of School.
6.9. Ethical considerations related to interviews

The ethical considerations related to the interviews were carefully considered, guidelines developed as seen above and rigorously applied. These include preserving the privacy of each interviewee, treating the interviewee with due dignity and respect, and observing the relevant code of professional conduct applicable to university researchers and software engineering professionals.

Griffith University's Human Research Ethics Committee requires exhaustive documentation on proposed approach before permission is given to undertake any research:

This certificate confirms that protocol 'Effective leadership factors for integrated teams operating in virtual environments' (GU Protocol Number ICT/15/06/HREC) has ethical clearance from the Griffith University Human Research Ethics Committee (HREC) and has been issued with authorisation to be commenced.
7. Data analysis

This chapter analyses the results of the data collected from the sources described in Chapter 6. The data was collected from the six review stages between July 2007 and May 2009.

This chapter shows how the collected and analysed data relates to and supports the achievement of the research question and objectives (reiterated below for reference).

**Research question:** What are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments?

**Research objectives:**

1. To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments.

2. Based on the identified qualities and characteristics, to develop a Process Reference Model (PRM) for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007.

3. To determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior.

4. To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior and/or Process Reference Models in the software engineering domain.

5. To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.

In order to achieve the objectives, the PRM will undergo five reviews, each from a different angle, which is consistent with Hevner’s (2004) Design Research guideline that *the utility, quality, and efficacy of a designed artefact must be rigorously demonstrated via well-executed evaluation methods.*
Hevner (2004) states that the evaluation of a designed IT artefact requires the definition of appropriate metrics and the gathering and analysis of appropriate data. IT artefacts can be evaluated in terms of functionality, completeness, consistency, accuracy, performance, reliability, usability, fit with the organization, and other relevant quality attributes. As argued in the research method chapter, the four-level measurement framework derived from (though not identical to) ISO/IEC 15504 is an appropriate metrics approach to use in this project (justification follows below).

7.1. Measurement framework

After careful considerable the four-level measurement framework derived from ISO/IEC 15504-2:2003 (N, P, L, F) is adapted to analyse the data. This measurement framework was the outcome of extensive deliberation by the SPICE Project team in the 1990's. The team considered a wide range of possibilities from a simple binary scale at one end of the scale of possibilities through to a percentage score at the other. Ultimately the SPICE Project Working Group decided on the N,P,L,F scale as the most appropriate when dealing with data of the kind found in SPICE Assessments.

Jung (2003) evaluates the reliability of empirical measurement in ISO/IEC 15504–based process assessment. In discussing the critical issue of the reliability of assessment results, he concludes ‘our findings indicate that the current four-category rating scale gives higher internal consistency of process capability measures than a two- or a three-category rating scale.’

It is acknowledged that assigning a measure involves an element of subjectivity. Random measurement error will play a role in the process. It is therefore necessary to estimate the amount of error. In relation to this, Jung (2003) observes that where repeated measurement yields consistent results, the higher is the reliability of the measuring procedure.

Given that in this project the same person asks the same questions to successive data collection sites, the presence of consistent results would arguably indicate a high degree of reliability. This may be deduced from Jung’s (2003) contention that ‘consistency is affected by ambiguities in wording and inconsistencies in the interpretation by assessors’. Since the researcher developed the process reference model and the interview questions, as well as conducted the interviews with a high
degree of consistency of approach, it may be argued that reasonable steps have been
taken to minimise or eliminate the causes of inconsistencies.

The measurement framework (adapted from ISO/IEC 15504-2:2003) is described as
shown below. It is used to express the degree to which the process characteristics in
the Leadership PRM could be substantiated.

- **F - Fully substantiated** (>85 % to 100 % achievement). There is evidence of a
  complete and systematic approach to, and full achievement of, the defined
  attribute in the assessed process. No significant weaknesses related to this
  attribute exist in the assessed process.

- **L - Largely substantiated** (>50 % to 85% achievement). There is evidence of
  a systematic approach to, and significant achievement of, the defined attribute
  in the assessed process. Some weakness related to this attribute may exist in
  the assessed process.

- **P - Partially substantiated** (>15 % to 50 % achievement). There is some
  evidence of an approach to, and some achievement of, the defined attribute in
  the assessed process. Some aspects of achievement of the attribute may be
  unpredictable.

- **N - Not substantiated** (0 to 15 % achievement). There is little or no evidence
  of achievement of the defined attribute in the assessed process.

**Limitations.** It should be noted that the measurement framework has the following
limitations:

- There is a limit to what can be done in a statistical sense with a four point scale

- The nature of the scale does not permit the expression of averages; it does
  however allow for the expression of median values.

- It is emphasised that the FLPN framework is *not used* to express a percentage
  on a continuous percentage scale, despite the presence of percentage values
  that indicate transition points between elements of the scale. These transition
  points are indicative only.
7.2. Data analysis approach: summary

Full data set too large to show in full; moved to appendix.
Given the large volume of data derived from the six review stages, it is not possible within the upper limit of a PhD thesis word count (100,000 words) to present the full data set in this Chapter, though this was the original intention. Since full traceability of changes from one draft version to the next is provided a great deal of data and associated rationale/action statements were generated. To solve this problem, a representative set of data is included in this chapter, with the full data set provided in the Appendices.

In justification, were the full data set to be included in the body of the thesis, the total word count would be around 180,000 words, with 100,000 maximum allowable under Griffith University’s rules for PhD theses.

Representative data samples in this chapter.
For the reasons cited above, it is therefore necessary to show only a representative sample of data analysis for each review stage. The representative data presented in this chapter is a fully indicative sub-set of the data analysis process for each review stage.

Data analysis is performed in six stages:

1. Initial data gathering & review
2. Second data gathering & review
3. ISO/IEC 15504-2 / ISO/IEC 24774 review (verifying that the PRM conforms to the requirements of ISO/IEC 15504-2 and ISO/IEC 24774 which is detailed guidance on structuring process descriptions in a way that meets the requirements of ISO/IEC 15504-2.
4. Behavior Tree notation analysis review
5. Expert panel review
6. Composition Tree notation analysis review
7.2.1. Stage 1: First data gathering & review (V0.1 to V0.2 PRM)

Version 0.1 is subject to four data gathering iterations. The results are analysed by:

- Applying the four-level measurement framework which will identify broadly which processes can be eliminated through insufficient substantiation (Not substantiated), which can unconditionally remain (Full) and which require further investigation (Largely or Partially):
  1. **Outcomes Fully substantiated** (>85 % to 100 % achievement). These can be considered validated for the purposes of this exercise.
  2. **Outcomes Largely substantiated** (>50 % to 85 % achievement). These require further investigation to rule them either in or out.
  3. **Outcomes Partially substantiated** (>15 % to 50 % achievement). These require further investigation to rule them either in or out.
  4. **Outcomes Not substantiated** (0 % to 15 % achievement). These are potentially excluded where the nature of the process renders it impossible to substantiate (0%), or require further validation to rule them either in or out (>0% <15%).

- Having refined the model by applying the process described in the previous step, the PRM will be consolidated by:
  - Rationalising similar or related processes to achieve a more streamlined and practical expression of the underlying principles. The rationalisation is governed by logic and practicality. ‘Would it make sense to the practitioner trying to apply this model?’, ‘What is the most concise way this can be expressed without compromising meaning?’
  - There is considerable scope in the draft PRM for this; greater detail was deliberately included in V0.1 so that feedback from interviewees could be gained before rationalisation.
  - This approach is arguably appropriate since it is reasonable to take detail out as the PRM evolves than it is to put detail in as it evolves, detail that has not been scrutinised and discussed by the interviewees.
Full traceability on how this refinement was arrived at is provided.

- The end point of Stage 1: initial data gathering and review is the transition from V0.1 to V0.2 of the PRM. It is ready for Stage 2.

### 7.2.2. Stage 2: Second data gathering & review (V0.2 to V0.3 PRM)

V0.2 of the PRM is subject to a further four interviews to confirm the efficacy of the validated processes, examined from a different angle.

The four point measurement scale will not be applied since only those processes that passed the first stage will be present in the second stage, so the four point measurement scale is arguably inappropriate.

Further rationalisation occurs from the second review. Full traceability on how this was arrived at is provided.

The end point of Stage 2: Second data gathering and review is the transition from V0.2 to V0.3 of the PRM. It is ready for Stage 3 review.

### 7.2.3. Stage 3: ISO/IEC 15504-2 / ISO/IEC 24774 review (V0.3 to V0.4 PRM)

Stage 3 review verifies conformance to these two standards. The ISO/IEC 15504-2 / ISO/IEC 24774 review verifies that the PRM conforms with the requirements of ISO/IEC 15504-2 and ISO/IEC 24774 which is detailed guidance on structuring process descriptions in a way that meets the requirements of ISO/IEC 15504-2.

For reference,

- **ISO/IEC 15504-2** is titled *Information technology -- Process assessment -- Part 2: Performing an assessment*. The purpose of this standard/part is to define the requirements for performing process assessment as a basis for use in process improvement and capability determination.

- **ISO/IEC 24774 (2007)** is titled *Software and systems engineering -- Life cycle management -- Guidelines for process description*. The purpose of this
standard is to foster uniformity in the way processes are described in the software and systems engineering domains.

The end point of Stage 3: ISO/IEC 15504-2 / ISO/IEC 24774 review is the transition from V0.3 to V0.4 of the PRM. It is ready for Stage 4 review.

7.2.4. Stage 4: Behavior tree review (V0.4 to V0.5 PRM)

Dromey’s (2007a) Behavior Tree notation analysis is performed on the V0.3 PRM to determine the presence of logical inconsistencies and the correction thereof.

The end point of Stage 4: Behavior Tree notation analysis review is the transition from V0.4 to V0.5 of the PRM. It is ready for Stage 5 review.

7.2.5. Stage 5: Expert panel review (V0.5 to V0.6 PRM)

Version 0.5 of the PRM is subjected to review by a panel of experts drawn from academia and industry. Feedback and comments will be consolidated and changes made to the PRM accordingly. Full traceability on how this was arrived at is provided.

The end point of Stage 5: Expert panel review is the transition from V0.5 to V0.6 of the PRM.

7.2.6. Stage 6: Composition tree review (V0.6 to V1.0 PRM)

Dromey’s (2007a) Composition Tree notation analysis is performed on the V0.6 PRM to determine the system vocabulary and the presence of duplications, double meanings and ambiguity, and the correction thereof.

The end point of Stage 6: Composition Tree notation analysis review is the transition from V0.6 to V1.0 of the PRM.
7.3. Stage 1: First data gathering & review (V0.1 to V0.2 PRM)

7.3.1. Table characteristics

The table below presents the results of the validation interviews at the four research sites.

Each interview was with a current project manager of at least one integrated virtual team. All four of the organizations within which these project managers operated are well-known commercial IT organizations with a global base of operations.

The measurement framework (adapted from ISO/IEC 15504-2:2003) is described. It is used to express the degree to which the process characteristics in the Leadership PRM could be substantiated.

- **F - Fully substantiated** (>85 % to 100 % achievement). There is evidence of a complete and systematic approach to, and full achievement of, the defined attribute in the assessed process. No significant weaknesses related to this attribute exist in the assessed process.

- **L - Largely substantiated** (>50 % to 85% achievement). There is evidence of a systematic approach to and significant achievement of, the defined attribute in the assessed process. Some weakness related to this attribute may exist in the assessed process.

- **P - Partially substantiated** (>15 % to 50 % achievement). There is some evidence of an approach to and some achievement of, the defined attribute in the assessed process. Some aspects of achievement of the attribute may be unpredictable.

- **N - Not substantiated** (0 to 15 % achievement). There is little or no evidence of achievement of the defined attribute in the assessed process.
7.3.2. Definition of measurement

In the context of software engineering and model-based process improvement, and therefore in the context of this project, measurement is defined as the ‘process of linking abstract concepts to empirical indicants’ (Jung, 2003). The abstract concepts cannot be measured or even observed directly, so must be estimated using so-called empirical indicants that may include indicators, items, scales or variables (Jung, 2003).

The reliability of the measurements is reliant on the degree of repeatability and consistency of the empirical measurements. The amount of random error is inversely proportional to the reliability of the measurement instrument. The more consistent the results derived from a repeated measurement (in this case four), the higher will be the reliability of the measuring procedure (Jung, 2003).

*Table next page.*
### 7.3.3. Version 0.1 results and ratings

The table below is a representative summary of interview results and ratings. This initiates the first review stage of the project in which the draft PRM (V0.1) is evaluated for validity, and opportunities identified for the refinement of the PRM into V0.2.

*See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.*

<table>
<thead>
<tr>
<th>Process</th>
<th>Site 1</th>
<th>Attribute Satisfactory</th>
<th>Site 2</th>
<th>Attribute Satisfactory</th>
<th>Site 3</th>
<th>Attribute Satisfactory</th>
<th>Site 4</th>
<th>Attribute Satisfactory</th>
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<tbody>
<tr>
<td>1 Generic Leadership Factors</td>
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<tr>
<td>1.1 Create a Shared Vision</td>
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<tr>
<td>1.1.1 Leader formulates a unified vision</td>
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<td>F</td>
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<tr>
<td>Team Charter (Vision enunciated) Workshop</td>
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<tr>
<td>1.1.2 Leader develops strong commitment to achieving vision</td>
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<td>N</td>
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<td>F</td>
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<td>Vision statement is documented and communicated by management</td>
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<td>Vision statement reinforced Team buy-in</td>
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<tr>
<td>1.1.3 Leader develops clear objectives</td>
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<td>F</td>
<td></td>
<td>N</td>
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<td>F</td>
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<td>F</td>
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<tr>
<td>Objectives Team goals</td>
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<td>Project plan clearly states objectives</td>
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<td>1.2 Communicate shared vision to create optimism</td>
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<tr>
<td>1.2.1 Team has unified vision</td>
<td></td>
<td>F</td>
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<td>F</td>
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<td>L</td>
<td></td>
<td>F</td>
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<tr>
<td>Vision statement Roadmap</td>
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<td>Yearly kick-off Quarterly review</td>
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<td>Team briefing</td>
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<td></td>
<td>Regular project meetings goals restated</td>
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</tbody>
</table>
### 1.2.2 Leader instils commitment to vision
- Site 1: N
- Site 2: N
- Site 3: Yes through briefings
- Site 4: Regular meetings

### 1.2.3 Leader develops clear objectives
- Site 1: Objectives created
- Site 2: Objectives clearly communicated
- Site 3: Project plan
- Site 4: Project plan

### 1.3 Display integrity & competence

#### 1.3.1 Leader displays vision, passion, integrity, empathy openness to truth, daring
- Site 1: Feedback from team
- Site 2: Communicate the good with the bad
- Site 3: Yes openness to team input, willingness to respond
- Site 4: Integrity is cornerstone of trust bond with members

#### 1.3.2 Leader displays technical competence, interpersonal skills, conceptual skills and good judgment
- Site 1: Work products, Performance reviews
- Site 2: Demonstrated by results
- Site 3: Not enough to be competent, must appear competent in day-to-day interactions
- Site 4: General competence needed to gain respect of team

#### 1.3.3 Leader displays principle-centred behavior (behaves consistently)
- Site 1: Statement of organizational and individual values and behaviors
- Site 2: Sticking to the vision. Mandated by code of practice.
- Site 3: Consistent behavior to create confidence and trust
- Site 4: Company code of ethics

### 1.4 Create Trust

#### 1.4.1 Leader is perceived as trustworthy
- Site 1: Keeping confidences is reliable
- Site 2: Previously demonstrated results
- Site 3: Trustworthiness earned through reputation
- Site 4: Integrity important. Mean what say, say what mean

#### 1.4.2 Leader engenders hope towards achievement of goals
- Site 1: Lead by example, Display confidence to goals are achievable
- Site 2: Hope for the company
- Site 3: Positive reinforcement
- Site 4: Keep people on track with pep-talks

#### 1.4.3 Leader engenders sense of self-worth in team
- Site 1: Delegation, Rewards, Recognition
- Site 2: Pat on back, positive feedback
- Site 3: Positive feedback where deserved
- Site 4: Team activities

### 1.5 Action-oriented
<table>
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<tr>
<th>Process</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
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</thead>
<tbody>
<tr>
<td>1.5.1 Leader takes action once decision is made</td>
<td>Turnaround time on issues raised by team members</td>
<td>Action plans in relation to objectives</td>
<td>Decisive action</td>
<td>Decision made once issues clarified. Stick to decisions even if unpopular (integrity)</td>
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<tr>
<td></td>
<td>Focus on outcomes and decision-making</td>
<td>Absence of buck passing</td>
<td>Timely action essence of good management</td>
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<tr>
<td>1.5.2 Leader overcomes inertia and blockages that might otherwise paralyse</td>
<td>Weekly reviews can identify areas where progress is slow/stalled</td>
<td>Remind about vision</td>
<td>Project momentum maintained through project monitoring and control + corrective action</td>
<td>Yes</td>
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<td></td>
<td>Explore in one-on-one or coaching sessions</td>
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<tr>
<td>1.5.3 Leader knows when to refrain from action when appropriate</td>
<td>Choice made when to leave alone</td>
<td>Hard to validate, but done as matter of experience</td>
<td>Experience</td>
<td>Yes</td>
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<td>1.6 Accepts responsibility</td>
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<tr>
<td>1.6.1 Leader sees causal links and accepts responsibility</td>
<td>Recognition that this is performed, but difficult to validate.</td>
<td>Recognition that this is performed, but difficult to validate.</td>
<td>Causal analysis and resolution</td>
<td>Validation problematic</td>
</tr>
<tr>
<td>1.6.2 Leader willing to deal with the consequences of their actions</td>
<td>Take ownership and follow-through</td>
<td>Honest recognition of cause and effect</td>
<td>Cause and effect analysis, corrective action</td>
<td>Yes in general</td>
</tr>
<tr>
<td>1.6.3 Leader avoids blaming others</td>
<td>No blaming behavior can be found</td>
<td>Absence of blaming behavior</td>
<td>Blame non-productive. Done in private if necessary</td>
<td>Blame-game makes enemies, incurs resentment</td>
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<td>1.7 Individualized consideration</td>
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<tr>
<td>1.7.1 Leader treats each member as an individual</td>
<td>One-on-one Team building Remembering birthdays Asking about non-work activities</td>
<td>Career development Maintain their position through opportunities to grow Mentoring</td>
<td>Get to know team members as people, not as units of production</td>
<td>Team members made to feel valued part of team / organisation</td>
</tr>
</tbody>
</table>

Chapter 7: Data analysis

Doctor of Philosophy Thesis, David Tuffley, Griffith University, 2009
<table>
<thead>
<tr>
<th>Process</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.7.2 Team members have sense that leader knows them, understands them, has their interests in mind.</td>
<td>Regular one-on-one coaching sessions F</td>
<td>Work-life balance mechanisms (ie telecommuting) Leader mentors team members F</td>
<td>On-going relationship building Mentoring F</td>
<td>Staff development Cultivating talent Correcting deficiencies F</td>
</tr>
<tr>
<td>1.7.3 Leader uses their in-depth knowledge of individuals to unite them into an effective team</td>
<td>Understanding characteristics of team members Individual strengths Communication styles F</td>
<td>Build on individual strengths L</td>
<td>Tailor communication based on knowledge of team member to achieve best results/cooperation L</td>
<td>Ongoing ‘getting to know’ L</td>
</tr>
<tr>
<td><strong>1.8 Original thinking</strong></td>
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<tr>
<td>1.8.1 Leader thinks outside of the orthodoxy when solving problems</td>
<td>Recognition that this is important, but difficult to validate P</td>
<td>Related to 1.5.1 Action-oriented Risk-taking Situational balance Subject to safety critical concerns L</td>
<td>Yes, difficult to validate P</td>
<td>Yes, difficult to validate P</td>
</tr>
<tr>
<td>1.8.2 Leader is not unduly affected when orthodox pressure is applied</td>
<td></td>
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<tr>
<td>1.8.3 Leader creates environment in which members can think in unorthodox ways</td>
<td>Brainstorming L</td>
<td>Provide a guiding principle F</td>
<td>Create space in which good work is done, shield from outside influence L</td>
<td>Provide resources, support, open-mindedness by leader L</td>
</tr>
<tr>
<td><strong>1.9 Resilience</strong></td>
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<tr>
<td>1.9.1 Team is resilient in face of goal-frustrating events</td>
<td>Goals and objectives revised on on-going basis as situation evolves Team attendance at meetings F</td>
<td>Persistence Keep to the goals F</td>
<td>Adopt resilience as a policy towards knock-backs F</td>
<td>Make adjustments to project plan to remain on-target. Priorities change, the world changes, must be flexible F</td>
</tr>
<tr>
<td>1.9.2 Movement towards goal-fulfilment is maintained</td>
<td>Weekly review of achievements F</td>
<td>Project monitoring and control F</td>
<td>Monitor against project plan Team meetings weekly F</td>
<td>Track progress against project plan F</td>
</tr>
<tr>
<td>Process</td>
<td>Site 1</td>
<td>Site 2</td>
<td>Site 3</td>
<td>Site 4</td>
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<tr>
<td><strong>1.10 Conceptual ability</strong></td>
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<tr>
<td>1.10.1 Leader has well-developed ability for abstract conceptualization</td>
<td>Development of roadmap and vision document</td>
<td>Recognition that this is important, but difficult to validate.</td>
<td>Yes, but difficult to prove beyond displaying high capability generally</td>
<td>Would not last in the job without this ability</td>
</tr>
<tr>
<td>1.10.2 Leader uses this ability combined with original thinking to conceptualize appropriate solutions</td>
<td>Produces effective strategic solutions</td>
<td>Recognition that this is important, but difficult to validate.</td>
<td>Advanced problem – solving skills an essential to project management</td>
<td>Yes, to some extent.</td>
</tr>
<tr>
<td><strong>1.11 Empathy</strong></td>
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</tr>
<tr>
<td>1.11.1 Leader is able to see situations through the eyes of others</td>
<td>Ask for their perspective during one-on-one discussions</td>
<td>Relates to individualized consideration</td>
<td>Essential to good management, would not be a good manager if could not see through member’s understanding</td>
<td>Ongoing communication with team members. Ability to understand other povs</td>
</tr>
<tr>
<td>1.11.2 Leader is able to foresee issues based on their empathic understanding of others</td>
<td>Communication plan Change management</td>
<td>Proceeding from previous point</td>
<td>Extrapolation on previous point</td>
<td>Uses empathic understanding to predict/extrapolate</td>
</tr>
<tr>
<td><strong>1.12 Judgment</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.12.1 Leader displays realistic understanding of situations</td>
<td>Results of decisions made</td>
<td>Track record to indicate whether someone can be trusted to do the job</td>
<td>Record speaks for itself</td>
<td>Judged according to results</td>
</tr>
<tr>
<td><strong>1.13 Self-worth &amp; competence</strong></td>
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<tr>
<td>1.13.1 Leader promotes sense of self-worth and competence in team members</td>
<td>Positive feedback</td>
<td>An aspect of individualized consideration Management style</td>
<td>Individualised consideration applicable here</td>
<td>Team morale maintained through regular team-building</td>
</tr>
<tr>
<td>1.13.2 Leader avoids micro-management as way of engendering self-worth in team</td>
<td>Evaluation of risk (Question is how to strike the right balance (how does one know when one is micromanaging?))</td>
<td>Management style to engender autonomy in team members</td>
<td>Hands-off management. Displays trust in team members to get the job done</td>
<td>Choose the right people to begin with, give them the tools they need, stand back and let them get on with it</td>
</tr>
</tbody>
</table>
1.13.3 Leader engenders self-worth by avoiding perceived status differences between leader and members

<table>
<thead>
<tr>
<th>Process</th>
<th>Site 1</th>
<th>Attribute Satisfaction</th>
<th>Site 2</th>
<th>Attribute Satisfaction</th>
<th>Site 3</th>
<th>Attribute Satisfaction</th>
<th>Site 4</th>
<th>Attribute Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.13.3 Leader engages team members, c.f. vice versa. Role of leader to remove roadblocks &amp; smooth the way</td>
<td>F</td>
<td></td>
<td>Egalitarian leadership not a feature of this organisation</td>
<td>N</td>
<td>To some extent try to minimise perceived status differences</td>
<td>P</td>
<td>Leader must be perceived as being approachable, not aloof</td>
<td>L</td>
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</tbody>
</table>

1.14 Rewards desirable performance

<table>
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<tr>
<th>Process</th>
<th>Site 1</th>
<th>Attribute Satisfaction</th>
<th>Site 2</th>
<th>Attribute Satisfaction</th>
<th>Site 3</th>
<th>Attribute Satisfaction</th>
<th>Site 4</th>
<th>Attribute Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.14.1 Leader rewards specific goal-oriented behavior</td>
<td>SNAP rewards system. Supports training &amp; development opportunities</td>
<td>F</td>
<td>Team members rewarded with recognition for desirable behavior. Rewards should not be solely on basis of length-of-service</td>
<td>F</td>
<td>Rewards, bonus, other benefits</td>
<td>F</td>
<td>Recognition, bonus</td>
<td>F</td>
</tr>
<tr>
<td>1.14.2 Leader does not reward behavior that does not lead to goal fulfillment</td>
<td>Immediate feedback on poor performance Creates confidence when ‘doing the right thing’.</td>
<td>F</td>
<td>Is not common sense to reward undesirable behavior</td>
<td>L</td>
<td>Mistakes are corrected, not rewarded.</td>
<td>L</td>
<td>Team member knows to persist until job is done right. Undesirable effort is not rewarded</td>
<td>L</td>
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</table>

1.15 Management by exception

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<tr>
<th>Process</th>
<th>Site 1</th>
<th>Attribute Satisfaction</th>
<th>Site 2</th>
<th>Attribute Satisfaction</th>
<th>Site 3</th>
<th>Attribute Satisfaction</th>
<th>Site 4</th>
<th>Attribute Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.15.1 Leader allows team to work without undue interference</td>
<td>Aspect of not being a micro-manager</td>
<td>L</td>
<td>Give space to do work</td>
<td>L</td>
<td>‘Interference’ is not appropriate. Reasonable oversight is ok</td>
<td>L</td>
<td>Laissez-faire management not a feature of this org, but reasonable space is given</td>
<td>L</td>
</tr>
</tbody>
</table>

Table 29: Stage 1 (Version 0.1 PRM) representative interview summary and measurement results
7.3.4. Consolidation of Version 0.1 ratings

This section shows a summary of consolidated ratings in which a median value for each process is derived from the individual ratings for each of the four interviews. *SO/IEC 15504:2003 does not prescribe a method for aggregating instantiation data. The SEI's Standard CMMI Appraisal Method for Process Improvement (SEI, 2001) does contain an aggregation prescription; however this calls for significant judgment on the part of Appraisal Team members. As an empirically-based project, a more objective approach to aggregation was deemed appropriate; therefore an aggregation method that divides the instantiation data equally in the way shown below is arguably the most appropriate way. A two-step process is applied.*

**Step 1:** Assign a normative value to each instantiation of Fully, Largely, Partially or Not At All. To arrive at a median value across the four samples, a *weighting* is applied to each rating. The weighting allows for the data from the four sites to be aggregated and a median value derived from which a Fully, Largely, Partially or Not At All overall rating for an Outcome can be established.

- IF Site Rating = 'F', then a weighting of 100 is assigned
- IF Site Rating = 'L', then a weighting of 66.67 is assigned,
- IF Site Rating = 'P', then a weighting of 33.33 is assigned
- IF Site Rating = 'N' then a weighting of 0 is assigned
- Average for the four sites is then calculated and shown in the Avg% column

*Excel Spreadsheet formula =IF(B4='F',100,IF(B4='L',66.67,IF(B4='P',33.33,0)))*

**Step 2:** The Median is calculated based on the following:

- IF Average Percentage < 16 then a rating of N is assigned
- IF Average Percentage < 51 then a rating of P is assigned
- IF Average Percentage < 86 then a rating of L is assigned
- IF Average Percentage < 100 then a rating of F is assigned
Median Rating value is shown in the Median Value column.

Excel Spreadsheet formula =IF(J4<16,'N',IF(J4<51,'P',IF(J4<86,'L','F')))

See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.

<table>
<thead>
<tr>
<th>Site</th>
<th>Site 1</th>
<th>Site 2</th>
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<th>Site 4</th>
<th>S1 %</th>
<th>S2 %</th>
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<th>S4 %</th>
<th>Avg %</th>
<th>Median Value</th>
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<td>Site 1</td>
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<td>S3 %</td>
<td>S4 %</td>
<td>Avg %</td>
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<tr>
<td>1.3.2 Leader displays technical competence, interpersonal skills, conceptual skills and good judgment</td>
<td>L</td>
<td>L</td>
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<td>L</td>
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<td>1.3.3 Leader displays principle-centred behavior (behaves consistently)</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>L</td>
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<td>100</td>
<td>100</td>
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<td><strong>1.4 Create Trust</strong></td>
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<tr>
<td>1.4.1 Leader is perceived as trustworthy</td>
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<td>L</td>
<td>F</td>
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<tr>
<td>1.4.2 Leader engenders hope towards achievement of goals</td>
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<td>F</td>
<td>L</td>
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<td>91.7</td>
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<tr>
<td>1.4.3 Leader engenders sense of self-worth in team</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>L</td>
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<td><strong>1.5 Action-oriented</strong></td>
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<tr>
<td>1.5.1 Leader takes action once decision is made</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>F</td>
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<td>100</td>
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<tr>
<td>1.5.2 Leader overcomes inertia and blockages that might otherwise paralyse</td>
<td>L</td>
<td>P</td>
<td>L</td>
<td>P</td>
<td>66.7</td>
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<tr>
<td>1.5.3 Leader knows when to refrain from action when appropriate</td>
<td>L</td>
<td>P</td>
<td>P</td>
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<td>66.7</td>
<td>33.3</td>
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<td><strong>1.6 Accepts responsibility</strong></td>
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<tr>
<td>1.6.1 Leader sees causal links and accepts responsibility</td>
<td>P</td>
<td>P</td>
<td>P</td>
<td>P</td>
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<td>33.3</td>
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<td>1.6.2 Leader willing to deal with the consequences of their actions</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>P</td>
<td>66.7</td>
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<td>66.7</td>
<td>33.3</td>
<td>58.3</td>
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<td>1.6.3 Leader avoids blaming others</td>
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<td><strong>1.7 Individualized consideration</strong></td>
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<tr>
<td>1.7.1 Leader treats each member as an individual</td>
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<tr>
<td>1.7.2 Team members have sense that leader knows them, understands them, has their interests in mind.</td>
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<td>F</td>
<td>F</td>
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<tr>
<td>1.7.3 Leader uses their in-depth knowledge of individuals to unite them into an effective team</td>
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<td>L</td>
<td>L</td>
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<td><strong>1.8 Original thinking</strong></td>
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<td>1.8.1 Leader thinks outside of the orthodoxy when solving problems</td>
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<td>1.8.2 Leader is not unduly affected when orthodox pressure is applied</td>
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<tr>
<td>1.8.3 Leader creates environment in which members can think in unorthodox ways</td>
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<td><strong>1.9 Resilience</strong></td>
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<td>1.9.1 Team is resilient in face of goal-frustrating events</td>
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<td>1.9.2 Movement towards goal-fulfilment is maintained</td>
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<td>1.10.1 Leader has well-developed ability for abstract conceptualization</td>
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<td>Leader uses this ability combined with original thinking to conceptualize appropriate solutions</td>
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1.11 Empathy

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<th>Leader is able to see situations through the eyes of others</th>
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<tr>
<th>1.11.2</th>
<th>Leader is able to foresee issues based on their empathic understanding of others</th>
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<tr>
<td>Site 1</td>
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1.12 Judgment

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<th>1.12.1</th>
<th>Leader displays realistic understanding of situations</th>
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<td>Avg %</td>
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1.13 Self-worth & competence

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<tr>
<th>1.13.1</th>
<th>Leader promotes sense of self-worth and competence in team members</th>
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<td>Site 2</td>
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<table>
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<tr>
<th>1.13.2</th>
<th>Leader avoids micro-management as way of engendering self-worth in team</th>
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<tbody>
<tr>
<td>Site 1</td>
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<tr>
<th>1.13.3</th>
<th>Leader engenders self-worth by avoiding perceived status differences between leader and members</th>
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<tr>
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<td>Avg %</td>
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1.14 Rewards desirable performance

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<th>Leader rewards specific goal-oriented behavior</th>
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<table>
<thead>
<tr>
<th>1.14.2</th>
<th>Leader does not reward behavior that does not lead to goal fulfilment</th>
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<tr>
<td>Avg %</td>
<td>66.7</td>
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</table>
Table 30: Representative consolidated Version 0.1 ratings

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<thead>
<tr>
<th></th>
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<th>Site 2</th>
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<th>S1 %</th>
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<th>Avg %</th>
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<tbody>
<tr>
<td>1.15 Management by exception</td>
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<tr>
<td>1.15.1 Leader allows team to work without undue interference</td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
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<td>66.7</td>
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</table>
7.3.5. Version 0.1 merging of processes to become Version 0.2

The table below transitions Version 0.1 PRM to 0.2. It does so using the following rationale:

- Processes outcomes that have a median rating of Fully or Largely have arguably been validated and may proceed to V0.2 PRM.
- Processes that have a median rating of Partially or Not At All may (a total of 19, as seen in table below) still arguably deserve a place in Version 0.2 PRM but require further review to clarify whether they are valid but difficult or impossible to validate, in which case they may be merged in with another process that is logically able to accommodate it.
- All processes included in V0.1 PRM are theoretically valid, based on the literature review. The challenge with some is how to express them in a way that can be validated. Merging them with other, validated processes, then subjecting them to a second review is arguably a valid way to accomplish this.
- Based on the rationale outlined in the previous point, any process with a median rating of N or P will be merged with another process that has already been validated.
- A rating of F or L notwithstanding, processes that are similar in nature may be merged in the interests of conciseness and simplicity. The PRM needs to be simply expressed without being oversimplified.

See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.

<table>
<thead>
<tr>
<th>Version 0.1 PRM</th>
<th>Transition</th>
<th>Avg %</th>
<th>Median Value</th>
<th>Version 0.2 PRM</th>
<th>Rationale for Change</th>
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<tbody>
<tr>
<td>1 Generic Leadership Factors</td>
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<td>1 Generic Leadership Factors</td>
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<tr>
<td>1.1 Create a Shared Vision</td>
<td></td>
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<td>1.1 Create &amp; Communicate a Shared Vision</td>
<td>V0.1 Process Outcomes 1.2 &amp; 1.4 integrated with 1.1 because they concern shared vision and commitment to objectives. A more logical concise expression is gained.</td>
</tr>
<tr>
<td>1.1.1 Leader formulates a unified vision</td>
<td>Becomes V0.2 Process Outcome 1.1.1</td>
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<td>1.1.1 Leader formulates a unified vision</td>
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<tr>
<td>Version 0.1 PRM</td>
<td>Transition</td>
<td>Avg %</td>
<td>Median Value</td>
<td>Version 0.2 PRM</td>
<td>Rationale for Change</td>
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<td>1.1.2 Leader develops strong commitment to achieving vision</td>
<td>Becomes V0.2 Process Outcome 1.1.3</td>
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<td>1.1.2 Leader communicates unified vision to team</td>
<td>V0.1 Process Outcome 1.2.1 fits logically following after leader formulating shared vision</td>
</tr>
<tr>
<td>1.1.3 Leader develops clear objectives</td>
<td>Becomes V0.2 Process Outcome 1.1.4</td>
<td>75</td>
<td>L</td>
<td>1.1.3 Leader develops strong commitment to achieving vision</td>
<td>V0.1 Process Outcome 1.1.2 moves down one space to become V0.2 Process Outcome 1.1.3. Incorporates V0.1 Process Outcome 1.2.2 which was rated Partial.</td>
</tr>
<tr>
<td>1.2 Communicate shared vision to create optimism</td>
<td>Integrate 1.2 with 1.1 (see rationale in V0.2)</td>
<td></td>
<td></td>
<td>1.1.4 Leader develops clear objectives</td>
<td>V0.1 Process Outcome 1.1.3 moves down one space to become V0.2 Process Outcome 1.1.4</td>
</tr>
<tr>
<td>1.2.1 Team has unified vision</td>
<td>Insert to become V0.2 Process Outcome 1.1.2</td>
<td>91.7</td>
<td>F</td>
<td>1.1.5 Leader engenders hope towards achievement of objectives</td>
<td>V0.1 Process Outcome 1.4.2 fits logically in this series of processes. Creating a sense of enthusiasm for goal fulfilment</td>
</tr>
<tr>
<td>1.2.2 Leader instils commitment to vision</td>
<td>Integrate with V0.1 Process Outcome 1.1.2 These are very similar processes This is a low 'Partial' that participants had difficulty with the word ‘instil’ how do you validate the act? Easier to validate the results of the act, hence integrate with V0.1 Process Outcome 1.1.2 to become V0.2 Process Outcome 1.1.3</td>
<td>16.7</td>
<td>P</td>
<td></td>
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</tr>
<tr>
<td>1.2.3 Leader develops clear objectives</td>
<td>Integrate with V0.1 Process Outcome 1.1.3 to become V0.2 Process Outcome 1.1.4</td>
<td>100</td>
<td>F</td>
<td>1.2 Display integrity &amp; competence</td>
<td></td>
</tr>
<tr>
<td>1.3 Display integrity &amp; competence</td>
<td></td>
<td></td>
<td></td>
<td>1.2.1 Leader displays trustworthiness, vision, passion, integrity, empathy openness to truth, daring</td>
<td>V0.1 Process Outcome 1.4.1 fits logically here as trust and integrity go hand in hand. Bold word indicates changed title</td>
</tr>
<tr>
<td>1.3.1 Leader displays vision, passion, integrity, empathy openness to truth, daring</td>
<td>Becomes V0.2 Process Outcome 1.2.1</td>
<td>83.3</td>
<td>L</td>
<td>1.2.2 Leader displays technical competence, interpersonal skills, conceptual skills and good judgment</td>
<td></td>
</tr>
<tr>
<td>1.3.2 Leader displays technical competence, interpersonal skills, conceptual skills and good judgment</td>
<td>Becomes V0.2 Process Outcome 1.2.2</td>
<td>75</td>
<td>L</td>
<td>1.2.3 Leader displays principle-centred behavior (behaves consistently)</td>
<td></td>
</tr>
<tr>
<td>Version 0.1 PRM</td>
<td>Transition</td>
<td>Avg %</td>
<td>Median Value</td>
<td>Version 0.2 PRM</td>
<td>Rationale for Change</td>
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</tr>
<tr>
<td>1.3.3 Leader displays principle-centred behavior (behaves consistently)</td>
<td>Becomes V0.2 Process Outcome 1.2.31</td>
<td>91.7</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.4 Create Trust</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Integrate V0.1 Process Outcome 1.9 Resilience here for better logical fit.</td>
</tr>
<tr>
<td>1.4.1 Leader is perceived as trustworthy</td>
<td>Integrate with V0.1 Process Outcome 1.3.1 which deals with compatible/similar character traits. Hence integrate with V0.1 Process Outcome 1.3.1 to become V0.2 Process Outcome 1.2.1</td>
<td>83.3</td>
<td>L</td>
<td>1.3.1 Leader takes decisive action when appropriate</td>
<td>V0.1 Process Outcome 1.5.2 and 1.5.3 fits logically here as overcoming inertia and taking action are closely related concepts. Bold word indicates changed title. Both of these received Partial ratings.</td>
</tr>
<tr>
<td>1.4.2 Leader engenders hope towards achievement of goals</td>
<td>Move to become V0.2 Process Outcome 1.1.5 as it fits logically in the sequence there</td>
<td>91.7</td>
<td>F</td>
<td>1.3.2 Team is resilient in face of goal-frustrating events</td>
<td>V0.1 Process Outcome 1.9.1 and 1.9.2 are integrated (closely related concepts) and moved here to follow ‘taking decisive action’ since resilience logically follows acting decisively (problems encountered)</td>
</tr>
<tr>
<td>1.4.3 Leader engenders sense of self-worth in team</td>
<td>Integrate with V0.1 Process Outcome 1.1.2 which deals with gaining commitment to goals; part of this is conditional on a sense of team member self-worth. Hence integrate with V0.1 Process Outcome 1.1.2 to become V0.2 Process Outcome 1.1.3</td>
<td>91.7</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.5 Action-oriented</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Integrates V0.1 Process Outcome 1.10 Conceptual ability, 1.8 Original thinking, and 1.12 Judgment, all of which are aspects of intelligence.</td>
</tr>
<tr>
<td>1.5.1 Leader takes action once decision is made</td>
<td>Becomes V0.2 Process Outcome 1.3.1</td>
<td>100</td>
<td>F</td>
<td>1.4.1 Leader creates environment in which unorthodox thinking is encouraged and shielded from external influences</td>
<td>V0.1 Process Outcome 1.8.1 and 1.8.2 were combined (both Partial) with 1.8.3 to cover the whole concept of original thinking in a conducive environment. Bold word indicates changed title</td>
</tr>
<tr>
<td>Version 0.1 PRM</td>
<td>Transition</td>
<td>Avg %</td>
<td>Median Value</td>
<td>Version 0.2 PRM</td>
<td>Rationale for Change</td>
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</tr>
<tr>
<td>1.5.2 Leader overcomes inertia and blockages that might otherwise paralyse</td>
<td>Integrate with V0.1 Process Outcome 1.5.1 because they follow closely each other in nature they can be easily combined in one. Hence integrate with V0.1 Process Outcome 1.5.1 to become V0.2 Process Outcome 1.3.1</td>
<td>50</td>
<td>P</td>
<td>1.4.2 <strong>Leader uses original thinking and abstract conceptualization to solve problems</strong></td>
<td>V0.1 Process Outcome 1.10.1 and 1.10.2 (Partial) are integrated to cover general topic of abstract conceptual ability. Bold word indicates changed title</td>
</tr>
<tr>
<td>1.5.3 Leader knows when to refrain from action when appropriate</td>
<td>Integrate with V0.1 Process Outcome 1.5.1 because they follow closely each other in nature they can be easily combined in one. Hence integrate with V0.1 Process Outcome 1.5.1 to become V0.2 Process Outcome 1.3.1</td>
<td>41.7</td>
<td>P</td>
<td>1.4.3 <strong>Leader displays realistic understanding of situations enabling appropriate action</strong></td>
<td>V0.1 Process Outcome 1.21.1 moved here to strengthen the overall topic of Intelligence. Bold word indicates changed title</td>
</tr>
<tr>
<td><strong>1.6 Accepts responsibility</strong></td>
<td></td>
<td></td>
<td></td>
<td>1.4.4 <strong>Leader sees cause and effect relationships and takes responsibility without resorting to blame</strong></td>
<td>V0.1 Process Outcome 1.6.1, 1.6.2 and 1.6.3 are integrated to give comprehensive coverage to the issue of perceiving links between cause and effect. Bold word indicates changed title</td>
</tr>
<tr>
<td>1.6.1 Leader sees causal links and accepts responsibility</td>
<td>Integrate V0.1 Process Outcome 1.6.1 with 1.6.2 as both deals with cause/effect.</td>
<td>33.3</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6.2 Leader willing to deal with the consequences of their actions</td>
<td>V0.1 Process Outcome 1.6.2 is strengthened by the addition of 1.6.1 and 1.6.3 to create a comprehensive process for dealing with cause and effect. Moved over to become V0.2 Process Outcome 1.4.3</td>
<td>58.3</td>
<td>L</td>
<td><strong>1.5 Individualized consideration</strong></td>
<td>V0.1 Process Outcome 1.7.1 and 1.7.2 integrated; knowing and treating as individual closely related. Bold indicates new wording.</td>
</tr>
<tr>
<td>1.6.3 Leader avoids blaming others</td>
<td>Integrate V0.1 Process Outcome 1.6.3 with 1.6.2 as blame is often a refusal to take responsibility.</td>
<td>66.7</td>
<td>L</td>
<td><strong>1.5.1 Leader knows and values team members as individuals</strong></td>
<td>V0.1 Process Outcome 1.7.1 and 1.7.2 integrated; knowing and treating as individual closely related. Bold indicates new wording.</td>
</tr>
<tr>
<td><strong>1.7 Individualized consideration</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.5.2 Leader uses their in-depth knowledge of individuals to unite them into an effective team</strong></td>
<td>V0.1 Process Outcome 1.7.1 and 1.7.2 integrated; knowing and treating as individual closely related. Bold indicates new wording.</td>
</tr>
<tr>
<td>Version 0.1 PRM</td>
<td>Transition</td>
<td>Avg %</td>
<td>Median Value</td>
<td>Version 0.2 PRM</td>
<td>Rationale for Change</td>
</tr>
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</tr>
<tr>
<td>1.7.1 Leader treats each member as an individual</td>
<td>Becomes V0.2 Process Outcome 1.5.1</td>
<td>100</td>
<td>F</td>
<td>1.5.3 Leader understands situations from other’s point of view and anticipates their actions</td>
<td>V0.1 Process Outcome 1.11.1 and 1.11.2 integrated to form a more complete statement of ‘empathy’. Bold indicates new wording.</td>
</tr>
<tr>
<td>1.7.2 Team members have sense that leader knows them, understands them, has their interests in mind.</td>
<td>Integrate V0.1 Process Outcome 1.7.2 with 1.7.1; recognizing people as individuals and treating them as such are closely related</td>
<td>100</td>
<td>F</td>
<td>1.5.4 Leader rewards behavior to the extent that it achieves goals</td>
<td>V0.1 Process Outcome 1.14.1 and 1.14.2 integrated to create a single continuum of reward, from max reward to zero reward for undesirable behavior. Bold indicates new wording.</td>
</tr>
<tr>
<td>1.7.3 Leader uses their in-depth knowledge of individuals to unite them into an effective team</td>
<td>Becomes V0.2 Process Outcome 1.5.2</td>
<td>75</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.8 Original thinking</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1.6 Management by exception</strong></td>
<td></td>
</tr>
<tr>
<td>1.8.1 Leader thinks outside of the orthodoxy when solving problems</td>
<td>Integrate V0.1 Process Outcome 1.8.1 with 1.8.3 as unorthodox thinking is a feature of the conducive environment specified in 1.8.3</td>
<td>41.7</td>
<td>P</td>
<td>1.6.1 Leader allows team to work without undue interference</td>
<td></td>
</tr>
<tr>
<td>1.8.2 Leader is not unduly affected when orthodox pressure is applied</td>
<td>Integrate V0.1 Process Outcome 1.8.2 with 1.8.3 as it is also a feature of the conducive environment specified in 1.8.3</td>
<td>33.3</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.8.3 Leader creates environment in which members can think in unorthodox ways</td>
<td>V0.1 Process Outcome 1.8.3 is strengthened by integrating 1.8.1 and 1.8.2 and moved over to become V0.2 Process Outcome 1.4.1</td>
<td>75</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.9 Resilience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.9.1 Team is resilient in face of goal-frustrating events</td>
<td>Move to V0.2 Process Outcome 1.3.2 as resilience and action-orientation can be logically paired.</td>
<td>100</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.9.2 Movement towards goal-fulfilment is maintained</td>
<td>Integrate with V0.1 1.9.1 since movement towards goal is an aspect of resilience.</td>
<td>100</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.10 Conceptual ability</strong></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Doctor of Philosophy Thesis, David Tuffley, Griffith University, 2009
<table>
<thead>
<tr>
<th>Version 0.1 PRM</th>
<th>Transition</th>
<th>Avg %</th>
<th>Median Value</th>
<th>Version 0.2 PRM</th>
<th>Rationale for Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.10.1 Leader has well-developed ability for abstract conceptualization</td>
<td>V0.1 Process Outcome is strengthened by integrating 1.10.2 and moved over to become V0.2 Process Outcome 1.4.2</td>
<td>58.3</td>
<td>L</td>
<td>50</td>
<td>P</td>
</tr>
<tr>
<td>1.10.2 Leader uses this ability combined with original thinking to conceptualize appropriate solutions</td>
<td>Integrate V0.1 Process Outcome 1.10.2 with 1.10.1 to cover general topic of abstract conceptual ability, since difficult to validate</td>
<td>50</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.11 Empathy</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.11.1 Leader is able to see situations through the eyes of others</td>
<td>Integrate V0.1 Process Outcome 1.11.1 and 1.11.2, both closely related aspects of empathy Becomes V0.2 Process Outcome 1.5.3</td>
<td>83.3</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.11.2 Leader is able to foresee issues based on their empathic understanding of others</td>
<td>Integrate V0.1 Process Outcome 1.11.2 and 1.11.1, both closely related aspects of empathy Becomes V0.2 Process Outcome 1.5.3</td>
<td>75</td>
<td>L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12 Judgment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12.1 Leader displays realistic understanding of situations</td>
<td>Move over to become V0.2 Process Outcome 1.4.3 – Judgment is an aspect of intelligence</td>
<td>91.7</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.13 Self-worth &amp; competence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.13.1 Leader promotes sense of self-worth and competence in team members</td>
<td>Merge with new 1.2 Integrity</td>
<td>91.7</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.13.2 Leader avoids micro-management as way of engendering self-worth in team</td>
<td>Merge with new 1.2 Integrity</td>
<td>91.7</td>
<td>F</td>
<td></td>
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</tr>
<tr>
<td>Version 0.1 PRM</td>
<td>Transition</td>
<td>Avg %</td>
<td>Median Value</td>
<td>Version 0.2 PRM</td>
<td>Rationale for Change</td>
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</tr>
<tr>
<td>1.13.3 Leader engenders self-worth by avoiding perceived status differences between leader and members</td>
<td>Merge with new 1.2 Integrity. Combine with 1.2.1.1 Leader displays vision, passion, integrity, empathy openness to truth, daring, treats equally</td>
<td>50</td>
<td>P</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.14 Rewards desirable performance</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.14.1 Leader rewards specific goal-oriented behavior</td>
<td>Integrate V0.1 1.14.1 and 1.14.2 to say reward to the extent behavior achieves goals. Implies punishment as lack of +ve reinforcement</td>
<td>100</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.14.2 Leader does not reward behavior that does not lead to goal fulfilment</td>
<td>Integrate V0.1 1.14.1 and 1.14.2 to say reward to the extent behavior achieves goals. (see previous point)</td>
<td>83.3</td>
<td>L</td>
<td></td>
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<tr>
<td><strong>1.15 Management by exception</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.15.1 Leader allows team to work without undue interference</td>
<td>Becomes V0.2 Process Outcome 1.6</td>
<td>66.7</td>
<td>L</td>
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</tr>
</tbody>
</table>

Table 31: Version 0.1 representative merging of processes to become Version 0.2
7.4. **Stage 2: Second data gathering & review (V0.2 PRM)**

The PRM V0.2 emerges from the Stage 1 data analysis process described in the previous sections.

### 7.4.1. Rationale for Stage 2 data collection

All stages of the project are informed by Hevner’s (2004, 2007) general principles and guidelines for valid Design Research. Relevant to Stage 2, the principles to be considered include being cognizant of the Design Cycle component of Hevner’s (2007) three cycle view of DR (Relevance & Rigor being the other two cycles). The Design Cycle focuses on iterations between artefact construction, evaluation and feedback. This effectively generates design alternatives and allows these alternatives to be evaluated (derived from rigour cycle) against the requirements (derived from relevance cycle) until a satisfactory design is achieved. These design alternatives must be evaluated from multiple perspectives if they are to satisfy the interests of multiple stakeholders. This implies taking a fresh look at the designed artefact, rather than the same look a second time.

Also, Guideline 6 (of 7) from Hevner’s (2004) Guidelines for conducting Design-Science research states; *The search for an effective artefact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.* ‘Available means’ that satisfy ‘laws in the problem environment’ could reasonably be interpreted to mean making the evaluation techniques consistent with the environment in which the artefact will be used, understandable by the persons operating in that environment and who are the intended users of the artefact. This strongly implies asking the respondents what they think about the artefact as a prospective tool, and be asked to communicate this feedback. This is in contrast to Stage 1, where the respondents were asked to indicate the existence of validating artefacts to support the PRM practices.

In Stage 2, the spirit of this process might therefore best be served by evaluating the design that emerged from Stage 1 in a different way from that which was used in Stage
1. In Stage 2, instead of asking respondents to validate every practice with specific examples of activities and/or artefacts as done in Stage 1, respondents are asked to review every practice and indicate those that do not apply or are not understandable to integrated-virtual teams (in their experience), and to express their opinion of the practices. Thus, Stage 2 proceeds on an exception basis.

A possible alternative approach would be to perform the same validation/evaluation process in both Stages 1 and 2. This would have the advantage of consistency, but has the disadvantage that it does not consider the respondent’s subjective impressions about how the model functions as an artefact in a user’s environment. It only considers whether the process purpose and outcomes can be validated by the existence of artefacts and performance of activities. Also, if Stage 1 has been performed comprehensively, using the same approach is unlikely to reveal much new data.

On consideration, the proposed course of action is to evaluate the design that emerged from Stage 1 in a way that utilises a different perspective from that used in stage 1.

The following rationale is offered:

- **Consistent with Hevner’s (2007) three cycle view, and Seven Guidelines for valid Design-Science research (2004).**

- **Strength of the literature review.** The literature review identifies the leadership factors from the software engineering, psychology and management literatures. It is therefore broad-based and comprehensive. All of the factors present in the V0.1 PRM are corroborated in the academic literature and in some cases from multiple instances in the literature. The strong presence of these leadership factors in the literature justifies their inclusion in V0.1 PRM and to some extent validates their place in the PRM.

- **Stage 1 review** identifies the presence or otherwise of artefacts and/or activities that serve to validate the presence of practices in V0.1 PRM, as specified by the requirements for PRM's in ISO/IEC 15504. Stage 1 identifies that most practices could be fully or largely validated by the presence of activities and/or artefacts. Some could only be partially validated or not at all. On questioning, respondents indicated that the practices in question are outside of the scope of operations of the respondent. Significantly, none of the unvalidated practices were beyond the understanding of the Stage 1 respondents, who said they could understand the need for such practices where the circumstances exist.
Significantly therefore, there is nothing in V0.1 PRM that seems out of place to the four respondents. The consistency of these responses suggests that the four Stage 1 data-sets are sufficient. It also strongly indicates the need to incorporate (rather than discard) the non-validated practices into other validated practices of a related nature, as and where they could logically fit.

- **Stage 2** review can therefore proceed on the assumption that the practices have been verified (from literature review) and validated (from Stage 1 review). The revisions and consolidations made as a result of the Stage 1 review are then the subject of the Stage 2 review in which respondents look at all of the practices of the V0.2 PRM with instructions to identify any exceptions, i.e. practices that do not appear to belong. This approach looks at the V0.2 PRM from a different perspective relative to the first review and is therefore perhaps more likely to reveal exceptions.

### 7.4.2. Stage 2 (Version 0.2 PRM) interview summary results

Stage 2 review participants were given a copy of the V0.2 PRM and asked to read each practice. They were asked to identify any practice that did not make sense, seemed incorrect or that they outright disagreed with. This was done in accordance with the rationale outlined in the previous section and decided upon before Stage 2 data collection began.

Each data collection interview proceeded in the same manner. Participants would ask for clarification on particular practices. Discussion around various practices would also ensue.

**Summary of results:**

- Significantly, no participant rejected any practice.
- All practices were seen to be reasonable, at least under some circumstances.
- Some practices were not clear as represented in the model. Explanation was needed.
- Feedback and comments on specific practices were collected and is represented in the table below.
Feedback from each participant is collated below.

See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.

<table>
<thead>
<tr>
<th>Version 0.2 PRM</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
<th>Site 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1 Generic Leadership Factors</strong></td>
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<tr>
<td>1.1 Create &amp; Communicate a Shared Vision</td>
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</tr>
<tr>
<td>1.1.1 Leader formulates a unified vision</td>
<td>@ team briefings</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>1.1.2 Leader communicates unified vision to team</td>
<td>Three stages</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.3 Leader develops strong commitment to achieving vision</td>
<td>Internal vs external</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.4 Leader develops clear objectives</td>
<td>Goals may need to change</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1.5 Leader engenders hope towards achievement of objectives</td>
<td>Should be self-belief not hope</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.2 Display integrity &amp; competence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.1 Leader displays trustworthiness, vision, passion, integrity, empathy openness to truth, daring</td>
<td>Consistent framework for assessing projects</td>
<td>‘ambitious’ instead of ‘daring’</td>
<td>Include ‘committed’</td>
<td></td>
</tr>
<tr>
<td>1.2.2 Leader displays technical competence, interpersonal skills, conceptual skills and good judgment</td>
<td>Up-line reporting</td>
<td>Technical competence essential</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2.3 Leader displays principle-centred behavior (behaves consistently)</td>
<td>More visibility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.3 Action-orientation &amp; resilience</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.1 Leader takes decisive action when appropriate</td>
<td>Must be good risk assessor</td>
<td>Act when necessary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3.2 Team is resilient in face of goal-frustrating events</td>
<td>balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.4 Intelligence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.1 Leader creates environment in which unorthodox thinking is encouraged and shielded from external influences</td>
<td>Access to knowledge base</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.2 Leader uses original thinking and abstract conceptualization to solve problems</td>
<td></td>
<td>Good judgment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.3 Leader displays realistic understanding of situations enabling appropriate action</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4.4 Leader sees cause and effect relationships and takes responsibility without resorting to blame</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>1.5 Individualized consideration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5.1 Leader knows and values team members as individuals</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5.2 Leader uses their in-depth knowledge of individuals to unite them into an effective team</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 32: Stage 2 (Version 0.2 PRM) representative interview summary results

To reiterate, V0.2 review produced no substantive changes to the draft PRM, so there is no before/after column in the above table. As outlined in the rationale, the stage 2 review takes the validated processes from V0.1 and subjects them to scrutiny from practitioners who are asked to look for problems, aspects that don’t seem right from their point of view. This approach is consistent with Hevner’s (2007) guidelines to performing valid Design Research by testing the artefact from different directions.

Summary of results:

- Significantly, no participant rejected any practice.
- All practices were seen to be reasonable, at least under some circumstances.
- Some practices were not clear as represented in the model. Explanation was needed.
- Feedback and comments on specific practices were collected and is represented in the table below.

### 7.5. Stage 3: ISO/IEC 15504-2 / ISO/IEC 24774 review (V0.2 to V0.32 PRM)

Stage 3 review involves two sub-stages:

1. **V0.2 to V0.31.** The ISO/IEC 15504-2 / ISO/IEC 24774 review that applies the requirements prescribed in those standards to the V0.2 PRM as it has come forward from the stage 1 review (note no changes were made to the PRM in the
stage 2 review due to it being a ‘reality check’ review by practitioner participants who found nothing that needed changing)

2. **V0.31 to V0.32.** After the ISO/IEC 15504-2 / ISO/IEC 24774 review, the resulting V0.31 PRM was found to be disorganised due to the merging of processes. V0.31 did not flow logically from one process to the next. So V0.31 is subjected to a reorganisation to become V0.32. It is debatable whether these two sub-stages qualify to be two separate review stages in their own right. Arguably, since the content remains the same, only reordered, it should remain two parts of a single review stage.

### 7.5.1. Stage 3 (V0.31 PRM) ISO/IEC 15504-2 / ISO/IEC 24774 review results

The table below details the transition from V0.2 PRM, as it emerged from the Stage 2 review, into V0.31 PRM. The ‘1’ in V0.31 indicates that this version will undergo a reordering of the processes to achieve a more logical flow, becoming V0.32 as it does so. This transition is shown in the table that follows the table below.

*See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.*

<table>
<thead>
<tr>
<th>V0.2 PRM</th>
<th>V0.31 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Generic leadership personality factors</td>
<td>1. Generic team leadership factors</td>
<td>Reword to be consistent with Virtual &amp; Integrated team leadership factors</td>
</tr>
<tr>
<td><strong>Purpose:</strong> to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).</td>
<td><strong>Purpose:</strong> to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).</td>
<td></td>
</tr>
<tr>
<td><strong>Outcomes:</strong> as a result of the successful implementation of Generic leadership personality factors the degree to which a leader embodies such factors and is able to practice them may be identified.</td>
<td><strong>Outcomes:</strong> as a result of the successful implementation of Generic leadership personality factors the degree to which a leader embodies such factors and is able to practice them may be identified.</td>
<td></td>
</tr>
<tr>
<td><strong>Elaboration:</strong> generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams.</td>
<td><strong>Informative Notes:</strong> generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams.</td>
<td>‘Elaboration’ replaced with ‘Informative Notes’</td>
</tr>
<tr>
<td>1.1 Create and communicate a shared vision</td>
<td>1.1 Shared vision</td>
<td>Remove ‘create and communicate’ as per ISO 24774 guidelines that Titles be noun phrases</td>
</tr>
</tbody>
</table>
### Purpose

**V0.2 PRM**

*To perceive and communicate a guiding principle/idea that captures the imagination of members to create a shared vision and inspire them with the enthusiasm to realise that vision.* An aspect of charisma.

**V0.31 PRM**

*To create and communicate a shared vision in ways that inspires people to realise that vision.*

**Action**

Simplify by creating statement of single purpose rather than aggregation of marginally-related outcomes

---

### Outcomes

**V0.2 PRM**

*As a result of the successful implementation of creating a shared vision:*

1. The leader perceives and formulates a unified vision of what is to be accomplished, ideally seen as an accomplished fact.

2. Leader communicates shared unified vision with team, ideally seen as an accomplished fact.

3. Leader develops strong commitment to achieving vision, based on a sense of rightness and timeliness, such that they have sufficient resilience to overcome goal frustrating events.

4. The leader develops a clear and unambiguous set of objectives or goals that are concrete and achievable.

5. Leader engenders hope/optimism towards achieving the objectives.

**V0.31 PRM**

*As a result of the successful implementation of creating and communicating a shared vision in ways that inspires people to realise that vision:*

1. Leader creates a shared vision of what is to be accomplished, ideally seen as an accomplished fact.

2. Leader clearly communicates the shared vision with team, ideally seen as an accomplished fact.

3. Leader facilitates strong commitment in team to achieving the shared vision, encouraging resilience in the face of goal frustrating events.

4. Leader develops a concrete and achievable set of goals that support achievement of the shared vision.

5. Leader engenders optimism towards achieving the stated goals.

**Action**

Amend to be consistent with Purpose

---

### Elaboration

**V0.2 PRM**

*The shared vision is a clear and unambiguous expression of an envisioned future.*

(remainder removed to save space. See Appendix)

**V0.31 PRM**

*The shared vision is a clear and unambiguous expression of an envisioned future.*

(remainder removed to save space. See Appendix)

**Action**

‘Elaboration’ replaced with ‘Informative Notes’

---

### 1.2 Display integrity and competence

**Purpose**

To act with integrity and honesty, to act consistently over time in pursuit of the shared vision, and promote a sense of self-worth in team members.

**Outcomes**

*As a result of the successful implementation of displaying integrity/good character, empathy, openness to truth and competence:*

**V0.2 PRM**

1. Display integrity/good character, empathy, openness to truth and competence.

2. Engender hope/optimism towards achieving the objectives.

3. Foster an environment of trust and mutual respect.

4. Promote a sense of self-worth in team members.

5. Communicate effectively with team members.

**V0.31 PRM**

1. Display integrity/good character, empathy, openness to truth and competence.

2. Engender hope/optimism towards achieving the objectives.

3. Foster an environment of trust and mutual respect.

4. Promote a sense of self-worth in team members.

5. Communicate effectively with team members.

**Action**

Simplify by creating statement of single purpose rather than aggregation of related outcomes

---

### 1.2 Integrity and competence

**Purpose**

To consistently act with integrity and competence over time in pursuit of the shared vision.

**Outcomes**

*As a result of the successful implementation of consistently acting with integrity and competence over time in pursuit of the shared vision:*

**V0.2 PRM**

1. Act with integrity/good character, empathy, openness to truth and competence.

2. Engender hope/optimism towards achieving the objectives.

3. Foster an environment of trust and mutual respect.

4. Promote a sense of self-worth in team members.

5. Communicate effectively with team members.

**V0.31 PRM**

1. Act with integrity/good character, empathy, openness to truth and competence.

2. Engender hope/optimism towards achieving the objectives.

3. Foster an environment of trust and mutual respect.

4. Promote a sense of self-worth in team members.

5. Communicate effectively with team members.

**Action**

Amend to be consistent with Purpose

---

**Informative Notes**

*The shared vision is a clear and unambiguous expression of an envisioned future.*

(remainder removed to save space. See Appendix)

**Action**

‘Informative Notes’ replaced with ‘Elaboration’

---

**1.2 Display integrity and competence**

**Purpose**

To act with integrity and honesty, to act consistently over time in pursuit of the shared vision, and promote a sense of self-worth in team members.

**Outcomes**

*As a result of the successful implementation of displaying integrity/good character, empathy, openness to truth and competence:*

1. Display integrity/good character, empathy, openness to truth and competence.

2. Engender hope/optimism towards achieving the objectives.

3. Foster an environment of trust and mutual respect.

4. Promote a sense of self-worth in team members.

5. Communicate effectively with team members.

**Action**

Simplify by creating statement of single purpose rather than aggregation of related outcomes

---

**1.2 Integrity and competence**

**Purpose**

To consistently act with integrity and competence over time in pursuit of the shared vision.

**Outcomes**

*As a result of the successful implementation of consistently acting with integrity and competence over time in pursuit of the shared vision:*

1. Act with integrity/good character, empathy, openness to truth and competence.

2. Engender hope/optimism towards achieving the objectives.

3. Foster an environment of trust and mutual respect.

4. Promote a sense of self-worth in team members.

5. Communicate effectively with team members.

**Action**

Amend to be consistent with Purpose

---

---

Doctor of Philosophy Thesis, David Tuffley, Griffith University, 2009
### Chapter 7: Data analysis

<table>
<thead>
<tr>
<th>V0.2 PRM</th>
<th>V0.31 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The leader displays character traits including but not limited to trustworthiness, guiding vision, passion, integrity, empathy, openness to truth and daring.</td>
<td>1. Leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle.</td>
<td>The seven traits can be condensed into two, or removed (empathy passion, daring are dealt with elsewhere)</td>
</tr>
<tr>
<td>2. The leader displays competencies including but not limited to: technical competence, interpersonal skills, conceptual skills and judgment.</td>
<td>2. Leader consistently displays competence, characterised by technical, interpersonal, conceptual and reasoning skills.</td>
<td>Reward to preserve consistency with Outcome 1</td>
</tr>
<tr>
<td>3. The leader remains principle-centred in the sense that his/her values are known to the team, and the team can rely on the leader acting consistently in accordance with those principles.</td>
<td>Merge with Outcome 1 above – 'Integrity' and 'Principle-centeredness' are largely synonymous, therefore Outcome 3 is redundant.</td>
<td></td>
</tr>
</tbody>
</table>

**Elaboration:** Principle-centred leadership creates a climate in which team members can rely on a leader to act according to guiding principle

(Remainder removed to save space. See Appendix).

**Informative Notes:** Principle-centred leadership creates a climate in which team members can rely on a leader to act according to guiding principle

(Remainder removed to save space. See Appendix).

<table>
<thead>
<tr>
<th>1.3 Action-orientation and resilience</th>
<th>1.3 Action-orientation and resilience</th>
<th>No change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose:</strong> to be inclined towards action, risk-taking, curiosity.</td>
<td><strong>Purpose:</strong> to be inclined towards action and resilience.</td>
<td>Remove risk-taking &amp; curiosity and include resilience, to be consistent with title</td>
</tr>
<tr>
<td><strong>Outcomes:</strong> As a result of the successful implementation of being action-oriented:</td>
<td><strong>Outcomes:</strong> As a result of the successful implementation of being action-oriented and resilient:</td>
<td>Amend to be consistent with Purpose</td>
</tr>
<tr>
<td>1. The leader takes decisive and appropriate action consistent with goals.</td>
<td>1. Leader is inclined towards taking decisive action when appropriate (when a situation has been considered and a plan developed).</td>
<td>Reward for conciseness and include mention of alignment with goals</td>
</tr>
<tr>
<td>2. The leader and team are resilient in the face of goal-frustrating events.</td>
<td>2. Leader and team are resilient in the face of goal-frustrating events.</td>
<td></td>
</tr>
</tbody>
</table>

**Elaboration:** action-oriented leaders are able to overcome the inertia and disincentives that reside in situations that others might succumb to.

(Remainder removed to save space. See Appendix).

**Informative Notes:** action-oriented leaders are able to overcome the inertia and disincentives that reside in situations that others might succumb to.

(Remainder removed to save space. See Appendix).

<table>
<thead>
<tr>
<th>1.4 Intelligence</th>
<th>1.4 Intelligence</th>
<th>No change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose:</strong> to employ the cognitive ability to conceptualise abstractly, stimulate team members to think in original ways, and exercise the ability to accurately and realistically assess people and situations, particularly in relation to perceiving cause and effect relationships.</td>
<td><strong>Purpose:</strong> to apply appropriate cognitive resources in the achievement of goals.</td>
<td>Simplify by creating statement of single purpose rather than aggregation of related outcomes</td>
</tr>
</tbody>
</table>

Doctor of Philosophy Thesis, David Tuffley, Griffith University, 2009
<table>
<thead>
<tr>
<th>V0.2 PRM</th>
<th>V0.31 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcomes</strong>: As a result of the successful implementation of intelligence:</td>
<td><strong>Outcomes</strong>: As a result of the successful application of appropriate cognitive resources:</td>
<td>Amend to be consistent with Purpose</td>
</tr>
<tr>
<td>1. The leader creates an environment in which unorthodox thinking is encouraged, in which the team is sheltered from undue external influence.</td>
<td>1. Leader creates a team environment in which original thinking is encouraged.</td>
<td>Remove ‘undue external influence’ mention as this is implied already, plus is not relevant in all situations. Add mention of ‘team’</td>
</tr>
<tr>
<td>2. The leader uses original thinking and abstract conceptualization to solve problems.</td>
<td>2. Leader and team are not bound by concrete thinking only, applying abstract conceptualisation to develop solutions.</td>
<td>Broaden to include ‘team’. Make clear that abstract thinking should supplement not replace concrete.</td>
</tr>
<tr>
<td>3. The leader displays a realistic understanding of situations, which enables appropriate action to be taken.</td>
<td>3. Leader displays a realistic understanding of situations, which enables appropriate action to be taken.</td>
<td>No change (except removal of initial ‘The’)</td>
</tr>
<tr>
<td>4. The leader sees cause and effect relationships and takes responsibility for the effects they cause without blaming others.</td>
<td>4. Leader takes responsibility for outcomes by consciously generating the causes that support goal achieving outcomes.</td>
<td>Clarify the nature of responsibility for creating goal-achieving outcomes.</td>
</tr>
</tbody>
</table>

**Elaboration**: Abstract conceptualization allows a leader to mentally manipulate abstractions in problem-solving, efficiency-enhancing ways. 
(remainder removed to save space. See Appendix) 

**Informative Notes**: Abstract conceptualization allows a leader to mentally manipulate abstractions in problem-solving, efficiency-enhancing ways. 
(Remainder removed to save space. See Appendix) 

'Elaboration' replaced with 'Informative Notes'

---

**1.5 Individualized consideration**

**Purpose**: to have deep concern for the well-being of individual members, rewarding behavior that contributes to goal realization, and generally practice the ability to see the world through individual team-member’s eyes. 

**Outcomes**: As a result of the successful implementation of individualized consideration: 

<table>
<thead>
<tr>
<th>V0.2 PRM</th>
<th>V0.31 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The leader knows and values team members as individuals.</td>
<td>1. Leader understands and values team members as complete human beings.</td>
<td>Amend to be consistent with Purpose</td>
</tr>
<tr>
<td>2. The leader, through their understanding of individual team members strengths and weaknesses, is able to unite them into an effective team.</td>
<td>2. Leader unites the individual team members into an effective team.</td>
<td>Simplify to emphasise the essential aspects of united and effective</td>
</tr>
<tr>
<td>3. The leader understands situations from others’ point of view and anticipates their action.</td>
<td>3. Leader is empathic.</td>
<td>Simplify to emphasise essential aspect of empathy</td>
</tr>
</tbody>
</table>

**Purpose**: to manifest deep concern for individual team-members as complete human beings.

**Outcomes**: As a result of the successful implementation of concern for individual team-members as complete human beings: 

**Amend to be consistent with Purpose**
4. The leader rewards behavior to the extent that it achieves goals.

**Elaboration:** Team members recognize that the leaders to some extent know them as an individual.

(Remainder removed to save space. See Appendix)

**Informative Notes:** Team members recognize that the leaders to some extent know them as an individual.

(Remainder removed to save space. See Appendix)

---

1.6 **Management-by-exception (passive)**

**Purpose:** to adopt a laissez-faire attitude until non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of passive management by exception:

1. The leader allows team members to perform their work without interference until and unless non-compliance with required performance occurs.

**Elaboration:** The ‘reward desirable performance’ process notwithstanding, under some circumstances, it is appropriate to operate on a management by exception basis.

(Remainder removed to save space. See Appendix)

**Informative Notes:** The ‘reward desirable performance’ process notwithstanding, under some circumstances, it is appropriate to operate on a management by exception basis.

(Remainder removed to save space. See Appendix)

Table 33: Stage 3 (Version 0.31 PRM) representative ISO/IEC 15504-2 / ISO/IEC 24774 review analysis results

### 7.5.2. Stage 3 (Version 0.31 to V0.32 reordering of processes)

**V0.31 to V0.32.** As mentioned above, the V0.31 PRM was found to be somewhat disorganised due to the merging of processes. V0.31 did not flow logically from one process to the next. So V0.31 is subjected to a reorganisation to become V0.32 using the basic criteria of what order made the most sense from a practitioner point of view.

So it is debatable whether these two sub-stages qualify to be two separate review stages in their own right. Arguably, since the content remains the same, only reordered, it should remain two parts of a single review stage.
The following table therefore takes the results of the above conformance analysis and presents them in a re-ordered sequence, specifically Section 3, Virtual teams, has been re-ordered to be a more logical sequence.

*The content has not changed.*

*See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.*

<table>
<thead>
<tr>
<th>V0.32 PRM</th>
</tr>
</thead>
</table>

## 1. Generic team leadership factors

**Purpose:** to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).

**Outcomes:** as a result of the successful implementation of Generic leadership personality factors the degree to which a leader embodies such factors and is able to practice them may be identified.

**Informative Notes:** generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams.

### 1.1 Shared vision

**Purpose:** to create and communicate a shared vision in ways that inspires people to realise that vision.

**Outcomes:** as a result of the successful implementation of creating and communicating a shared vision in ways that inspires people to realise that vision:

1. Leader *creates* a shared vision of what is to be accomplished, ideally seen as an accomplished fact.
2. Leader clearly *communicates* the shared vision with team, ideally seen as an accomplished fact.
3. Leader facilitates strong commitment in team to achieving the shared vision, encouraging resilience in the face of goal frustrating events.
4. Leader develops a concrete and achievable set of goals that support achievement of the shared vision.
5. Leader engenders optimism towards achieving the stated goals.

**Informative Notes:** the shared vision is a clear and unambiguous expression of an envisioned future. It is the basis for a common understanding among stakeholders of the aspirations and governing ideals of the team in the context of that desired outcome.
1.2 Integrity and competence

**Purpose**: to consistently act with integrity and competence over time in pursuit of the shared vision.

**Outcomes**: as a result of the successful implementation of consistently acting with integrity and competence over time in pursuit of the shared vision:

1. Leader consistently displays *integrity*, characterised by openness to truth, trustworthiness, and adherence to principle.

2. Leader consistently displays *competence*, characterised by technical, interpersonal, conceptual and reasoning skills.

*Informative Notes*: Principle-centred leadership creates a climate in which team members can rely on a leader to act according to guiding principle rather than exigent circumstances. Involves doing the ‘right thing’ all of the time, even when it is easier not to under the circumstances.

1.3 Action-orientation and resilience

**Purpose**: to be inclined towards action and resilience.

**Outcomes**: As a result of the successful implementation of being action-oriented and resilient:

1. Leader takes decisive and appropriate action consistent with goals.

2. Leader and team are resilient in the face of goal-frustrating events.

*Informative Notes*: action-oriented leaders are able to overcome the inertia and disincentives that reside in situations that others might succumb to. Action-orientation is particularly relevant in goal-frustrating situations when others might give up.

1.4 Intelligence

**Purpose**: to apply appropriate cognitive resources in the achievement of goals.

**Outcomes**: As a result of the successful application of appropriate cognitive resources:

1. Leader creates a team environment in which original thinking is encouraged.

2. Leader and team are not bound by concrete thinking only, applying abstract conceptualisation to develop solutions.
3. Leader displays a realistic understanding of situations, which enables appropriate action to be taken.

4. Leader takes responsibility for outcomes by consciously generating the causes that support goal achieving outcomes.

**Informative Notes:** Abstract conceptualization allows a leader to mentally manipulate abstractions in problem-solving, efficiency-enhancing ways. This ability is related to the ability to create a unifying vision for the project, which can be seen as a higher level abstract conceptualization skill. The skill being discussed in this process relates more to how to make it happen.

(Remainder removed to save space. See Appendix).

### 1.5 Individualized consideration

**Purpose:** to manifest deep concern for individual team-members as complete human beings.

**Outcomes:** As a result of the successful implementation of concern for individual team-members as complete human beings:

1. Leader understands and values team members as individuals.

2. Leader unites the individual team members into an effective team.

3. Leader is empathic.

4. Leader practices positive reinforcement by rewarding goal achieving behavior.

**Informative Notes:** Team members recognize that the leaders to some extent knows them as an individual. The antithesis of this is a team member who feels that the leader regards them as mere units of production, expendable.

(Remainder removed to save space. See Appendix)

### 1.6 Management-by-exception (passive)

**Purpose:** to adopt a laissez-faire attitude until non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of passive management by exception:

1. Leader allows team members to perform their work without interference until and unless non-compliance with required performance occurs.

**Informative Notes:** The ‘reward desirable performance’ process notwithstanding, under some circumstances, it is appropriate to operate on a management by exception basis.

(Remainder removed to save space. See Appendix)
V0.32 PRM

* Note: it is intended that processes with single outcomes be ultimately incorporated into other processes.

Table 34: Stage 3.2 (representative reordering of processes for logic and clarity)
7.6. Stage 4: Behavior tree notation review (V0.32 to V0.4 PRM)

The table below is a Behavior Tree notation analysis performed on the V0.32 PRM to identify errors, omissions and duplications in the draft PRM. The behavior tree approach is based on the systematic application, with associated formal notation, of the principle of comprehensive factual description of an event known as the Five W’s (and one H).

Note that the Behavior Tree method was developed to validate software system requirements. Its application to a PRM is not specifically prescribed, so a significant degree of interpretive latitude exists as to how it is best applied in this project. The application seen below uses it to good effect on a process by process, outcome by outcome basis. As will be seen, it identifies numerous improvements. Arguably, this represents a valid, if unprecedented application of Behavior Tree notation to the validation of PRMs, as shall be discussed in the Findings chapter. It should also be noted that Behavior Tree is not a central element of the Design Research process as originally planned. Its addition to the DR approach in this project was considered worthwhile as an exploratory exercise given the potential benefits of using this formal method to the validation of PRMs and Models of Organisational Behavior more generally.

Defects are identified when the notation is applied, beginning with the main entity (leader in most cases), a verb that describes what the entity does (eg. develops, or verifies, or provides etc), and followed by the specific what, or who or when etc as makes sense for each outcome in order to build up a complete unit of sense. This process goes beyond simple editing however. When applied rigorously to the process model, a high-degree of consistency and clarity of expression is achieved. Even with competent editors, other process models (eg. OOSPICE and CMMI) do not achieve this level of consistency and clarity.

See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.
### 1. Generic team leadership factors

**Purpose:** to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).

**Outcomes:** as a result of the successful implementation of Generic leadership personality factors the degree to which a leader embodies such factors and is able to practice them may be identified.

**Informative Notes:** generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. (Remainder removed to save space. See Appendix)

#### 1.1 Shared vision

**Purpose:** to create and communicate a shared vision in ways that inspires people to realise that vision.

**Purpose:** to create and communicate a shared vision in ways that inspires people to realise that vision.
### Outcomes: as a result of the successful implementation of creating and communicating a shared vision in ways that inspires people to realise that vision:

<table>
<thead>
<tr>
<th>V0.32 PRM</th>
<th>Behavior Tree notation analysis</th>
<th>V0.4 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Leader creates a shared vision of what is to be accomplished, ideally seen as an accomplished fact.</td>
<td>1.1.1 LEADER [creates]</td>
<td>1. Leader creates a shared vision of the goal(s).</td>
<td>Goal(s) not 'what is to be accomplished'</td>
</tr>
<tr>
<td>what</td>
<td>SHARED VISION/</td>
<td>Remove qualification (ideally seen as an accomplished fact) to Informative Material</td>
<td></td>
</tr>
<tr>
<td>what (of)</td>
<td>GOAL(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Leader clearly communicates the shared vision with team, ideally seen as an accomplished fact.</td>
<td>1.1.2 LEADER [communicates]</td>
<td>2. Leader communicates the shared vision of the goal(s) with the team.</td>
<td>Goal(s) included</td>
</tr>
<tr>
<td>what</td>
<td>SHARED VISION/</td>
<td>Remove qualification altogether - redundant</td>
<td></td>
</tr>
<tr>
<td>/ what (of)</td>
<td>GOAL(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ who (with)</td>
<td>TEAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Leader facilitates strong commitment in team to achieving the shared vision, encouraging resilience in the face of goal frustrating events.</td>
<td>1.1.3 LEADER [gains]</td>
<td>3. Leader gains commitment from team to achieve the goal(s).</td>
<td>Create a new outcome about resilience (it should be a stand-alone outcome rather than a qualification of the commitment to goals outcome.</td>
</tr>
<tr>
<td>what</td>
<td>COMMITMENT /</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ who (with)</td>
<td>TEAM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/ what (of)</td>
<td>GOAL(S)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V0.32 PRM</td>
<td>Behavior Tree notation analysis</td>
<td>V0.4 PRM</td>
<td>Action</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>4. New outcome in V0.4</td>
<td>1.1.4 LEADER [encourages] what RESILIENCE / / what (in) TEAM / when GOAL-FRUSTRATING EVENTS</td>
<td>4. Leader encourages resilience in team when goal-frustrating events occur.</td>
<td>New outcome focusing on the important issue of resilience in the face of goal-frustrating events</td>
</tr>
<tr>
<td>5. Leader develops a concrete and achievable set of goals that support achievement of the shared vision.</td>
<td>1.1.5 LEADER [develops] what PRACTICAL OBJECTIVE(S) [achieve] (to) GOAL(S)</td>
<td>5. Leader develops practical objective(s) to achieve the goal(s).</td>
<td>Practical objectives support the achievement of the goal(s). Change ‘shared vision’ to ‘goals’ because the objectives derive directly from the goals.</td>
</tr>
<tr>
<td>6. Leader engenders optimism towards achieving the stated goals.</td>
<td>1.1.6 LEADER [generates] what OPTIMISM [achieve] (to) STATED OBJECTIVE(S)</td>
<td>6. Leader generates optimism towards achieving the stated objectives.</td>
<td>Change to ‘optimism towards achieving objectives’ not ‘goals’ since we have descended to this lower, more concrete level of objectives</td>
</tr>
</tbody>
</table>
### 1.2 Integrity & competence

**Purpose:** to consistently act with integrity and competence over time in pursuit of the shared vision.

**Outcomes:** as a result of the successful implementation of consistently acting with integrity and competence over time in pursuit of the shared vision:

1. Leader behaves with integrity.

<table>
<thead>
<tr>
<th>1.2.1</th>
<th>LEADER [behaves]</th>
</tr>
</thead>
<tbody>
<tr>
<td>how (with)</td>
<td>INTEGRITY</td>
</tr>
</tbody>
</table>

Remove qualifiers to the informative section
<table>
<thead>
<tr>
<th>2. Leader consistently displays competence, characterised by technical, interpersonal, conceptual and reasoning skills.</th>
<th>1.2.2</th>
<th>LEADER [behaves]</th>
<th>2. Leader behaves with competence.</th>
</tr>
</thead>
<tbody>
<tr>
<td>how</td>
<td>COMPETENCE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes**: Principle-centred leadership creates a climate in which team members can rely on a leader to act according to guiding principle.

(Remainder removed to save space. See Appendix).

<table>
<thead>
<tr>
<th><strong>1.3 Action-orientation and resilience</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong>: to be inclined towards action and resilience.</td>
</tr>
<tr>
<td><strong>Outcomes</strong>: As a result of the successful implementation of being action-oriented and resilient:</td>
</tr>
<tr>
<td>1. Leader takes decisive and appropriate action consistent with goals.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.3.1</th>
<th>LEADER [decisive]</th>
</tr>
</thead>
<tbody>
<tr>
<td>how</td>
<td>PURSUE</td>
</tr>
<tr>
<td>what (with)</td>
<td>OBJECTIVE(S)</td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – the leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle.

(Remainder removed to save space. See Appendix)

<table>
<thead>
<tr>
<th><strong>1.3 Action-orientation &amp; resilience</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong>: to be inclined towards action and resilience.</td>
</tr>
<tr>
<td><strong>Outcomes</strong>: As a result of the successful implementation of being action-oriented and resilient:</td>
</tr>
<tr>
<td>1. Leader is decisive in pursuit of objective(s).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.3.1</th>
<th>LEADER [decisive]</th>
</tr>
</thead>
<tbody>
<tr>
<td>how</td>
<td>PURSUE</td>
</tr>
<tr>
<td>what (with)</td>
<td>OBJECTIVE(S)</td>
</tr>
</tbody>
</table>

Remove qualifiers to the informative section

Change goal to ‘objective’ as the more concrete.
<table>
<thead>
<tr>
<th>V0.32 PRM</th>
<th>Behavior Tree notation analysis</th>
<th>V0.4 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Leader and team are resilient in the face of goal-frustrating events.</td>
<td>1.3.2 LEADER [resilient]</td>
<td>2. Leader is resilient when goal-frustrating events happen.</td>
<td>Remove qualifiers to the informative section. This outcome refers to the leader, whereas outcome 1.1.4 refers to resilience in team. This outcome is an adjunct to the quality of decisiveness.</td>
</tr>
<tr>
<td>when GOAL-FRUSTRATING EVENTS</td>
<td>what OCCUR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes**: action-oriented leaders are able to overcome the inertia and disincentives that reside in situations that others might succumb to.

(Remainder removed to save space. See Appendix)

**1.4 Intelligence**

**Purpose**: to apply appropriate cognitive resources in the achievement of goals.

**Outcomes**: As a result of the successful application of appropriate cognitive resources:

- 1. Leader creates a team environment in which original thinking is encouraged.

<table>
<thead>
<tr>
<th>1.4.1</th>
<th>LEADER [engenders]</th>
<th>1. Leader engenders original thinking in team members.</th>
<th>Rephrase for clarity with emphasis on ‘original thinking’ in ‘team members’ rather than ‘environment’.</th>
</tr>
</thead>
<tbody>
<tr>
<td>what</td>
<td>ORIGINAL THINKING</td>
<td>TEAM MEMBERS</td>
<td></td>
</tr>
<tr>
<td>(in) who</td>
<td>TEAM MEMBERS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Outcome 1** – the leader consistently displays the ability to think and act decisively in pursuit of objective(s).

(Remainder removed to save space. See Appendix)
<table>
<thead>
<tr>
<th>Behavior Tree notation analysis</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Leader and team are not bound by concrete thinking only, applying abstract conceptualisation to develop solutions.</td>
<td>Merge with 1.4.1</td>
</tr>
<tr>
<td>3. Leader displays a realistic understanding of situations, which enables appropriate action to be taken.</td>
<td>2. Leader understands situations realistically.</td>
</tr>
<tr>
<td>4. Leader takes responsibility for outcomes by consciously generating the causes that support goal achieving outcomes.</td>
<td>3. Leader generates the cause(s) of objective-achieving outcomes.</td>
</tr>
</tbody>
</table>

**Informative Notes:** Abstract conceptualization allows a leader to mentally manipulate abstractions in problem-solving, efficiency-enhancing ways.

(Remainder removed to save space. See Appendix)

**1.5 Individualized consideration**

**Informative Notes**

Outcome 1 – the leader displays a realistic understanding of situations, enabling appropriate action to be taken.

(Remainder removed to save space. See Appendix)

**1.5 Individualized consideration**
<table>
<thead>
<tr>
<th>V0.32 PRM</th>
<th>Behavior Tree notation analysis</th>
<th>V0.4 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose</strong>: to manifest deep concern for individual team-members as complete human beings.</td>
<td></td>
<td><strong>Purpose</strong>: to manifest deep concern for individual team-members as complete human beings.</td>
<td></td>
</tr>
<tr>
<td><strong>Outcomes</strong>: As a result of the successful implementation of concern for individual team-members as complete human beings:</td>
<td></td>
<td><strong>Outcomes</strong>: As a result of the successful implementation of concern for individual team-members as complete human beings:</td>
<td></td>
</tr>
<tr>
<td>1. Leader understands and values team members as individuals.</td>
<td>1.5.1 <strong>LEADER</strong> [values] who TEAM MEMBERS what INDIVIDUAL</td>
<td>1. Leader values each team member as an individual.</td>
<td></td>
</tr>
<tr>
<td>2. Leader unites the individual team members into an effective team.</td>
<td>1.5.2 <strong>LEADER</strong> [unites] who TEAM MEMBERS / (into) what EFFECTIVE TEAM</td>
<td>2. Leader unites the individual team members into an effective team.</td>
<td>No change</td>
</tr>
<tr>
<td>3. Leader is empathic.</td>
<td>1.5.3 <strong>LEADER</strong> [is] what EMPATHIC</td>
<td>3. Leader is empathic.</td>
<td>No change</td>
</tr>
<tr>
<td>4. Leader practices positive reinforcement by rewarding goal achieving behavior.</td>
<td>1.5.4 <strong>LEADER</strong> [rewards] what OBJECTIVE-ACHIEVING BEH / (with) POSITIVE REINFORCEMENT</td>
<td>4. Leader rewards objective-achieving behavior with positive reinforcement.</td>
<td>Rephrase to put emphasis on the rewarding of goal-achieving behavior rather than the positive reinforcement aspect</td>
</tr>
</tbody>
</table>

Rephrase to emphasise the 'value' dimension. 'Understand' is redundant in this context since a team-member cannot be valued unless they are also understood.

No change
### Behavior Tree notation analysis

#### 1.6 Management-by-exception (passive)

**Purpose:** to adopt a laissez-faire attitude until and unless non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of passive management by exception:

1. Leader allows team members to perform their work without interference until and unless non-compliance with required performance occurs.

<table>
<thead>
<tr>
<th>1.6.1</th>
<th>LEADER [allows]</th>
</tr>
</thead>
<tbody>
<tr>
<td>who</td>
<td>TEAM-MEMBERS [act]</td>
</tr>
<tr>
<td>how</td>
<td>INDEPENDENTLY</td>
</tr>
<tr>
<td>when</td>
<td>OBJ-ACHIEVING BEH</td>
</tr>
<tr>
<td>what</td>
<td>CONTINUES</td>
</tr>
</tbody>
</table>

---

### Action

#### Informative Notes

**Team members** recognize that the leaders to some extent knows them as an individual. The antithesis of this is a team member who feels that the leader regards them as mere units of production, expendable.

(Reminder removed to save space. See Appendix)

**Outcome 1** – the leader manifests an understanding of team members within a mind-set of respect. This leads to a valuing of the member as an individual. On perceiving this mind-set in the leader, the member’s commitment is reinforced.

(Reminder removed to save space. See Appendix)

**1.6 Management-by-exception**

**Purpose:** to adopt a laissez-faire attitude until and unless non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of passive management by exception:

1. Leader allows team members to act independently while objective-achieving behavior continues.

Remove ‘(passive)’ as redundant.

Add ‘and unless’ to make more accurate.

Rephrase to simplify and clarify that team members have independence as long as they are doing the job expected.
<table>
<thead>
<tr>
<th>V0.32 PRM</th>
<th>Behavior Tree notation analysis</th>
<th>V0.4 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6.2</td>
<td>LEADER [corrects]</td>
<td>2.</td>
<td>Leader corrects team-member’s behavior when non-objective-achieving behavior occurs</td>
</tr>
<tr>
<td>who</td>
<td>TEAM-MEMBERS</td>
<td></td>
<td>New Outcome which distinguish between what happens when non-objective achieving behavior occurs, and when objective-achieving behavior occurs</td>
</tr>
<tr>
<td>what</td>
<td>BEHAVIOR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>when</td>
<td>NON-OBJ-ACHIEVING BEHAV</td>
<td></td>
<td></td>
</tr>
<tr>
<td>what</td>
<td>OCCURS</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes:** The ‘reward desirable performance’ process notwithstanding, under some circumstances, it is appropriate to operate on a management by exception basis. (Remainder removed to save space. See Appendix)

**Informative Notes**
Outcome 1 – when the team is doing their job the leader leaves them alone. In effect, the leader does not give the impression of being a ‘micro-manager’. (Remainder removed to save space. See Appendix)

Table 35: Stage4 representative behavior tree review (Dromey, 2007a)
7.7. **Stage 5: Expert panel review (V0.4 to V0.5 PRM)**

7.7.1. **Stage 5 (V0.4 to V0.5A) Expert Panel review comments**

The input from the Expert Panel calls for a restructuring of the PRM, evolving the original three independent category architecture (generic, integrated, virtual) to become a single generic category with two supplementary categories depending on the generic category. Therefore, given the presence of a major change plus many small changes, for the sake of clarity and transparency, the Expert Panel revisions will be done in two steps; Step A implements the many small changes as seen in the table below, with Step B, the major restructure, shown in the table that follows this one.

*See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.*

<table>
<thead>
<tr>
<th>V0.4 PRM</th>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Generic team leadership factors</strong></td>
<td><strong>1. Generic team leadership factors</strong></td>
<td><strong>Purpose:</strong> The purpose of the generic team leadership factors is to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).</td>
<td><strong>Purpose:</strong> The purpose of the generic team leadership factors is to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).</td>
<td></td>
</tr>
<tr>
<td>V0.4 PRM</td>
<td>Re Expert 1</td>
<td>Re Expert 2</td>
<td>V0.5A PRM</td>
<td>Rationale</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>-------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>Outcomes</strong>: As a result of the successful implementation of Generic leadership personality factors the degree to which a leader embodies such factors and is able to practice them may be identified.</td>
<td>Suggest delete ‘personality’ as it is later discussed as ‘skills’, which is something different, and also is not part of the category title.</td>
<td>There is no place for personality factors in a process reference model. Fifty years of personality research has shown that a person’s personality traits are unstable across situations. ISO standards must absolutely stay away from ‘personality’ if they are to have credibility. You are much safer treating these as ‘leadership behaviors’ or ‘leadership processes’.</td>
<td><strong>Outcomes</strong>: As a result of the successful implementation of Generic leadership processes the degree to which a leader embodies such processes and is able to practice them may be identified.</td>
<td>Re Expert 1&amp;2: Remove ‘personality’ and replace with ‘processes’ to be consistent with software engineering terminology, and not stray into the social psychology domain.</td>
</tr>
</tbody>
</table>

**Informative Notes**: generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams.  

(Remainder removed to save space. See Appendix)
### 1.1 Shared vision

**Purpose:** The purpose of the shared vision process is to create and communicate a shared vision in ways that inspires people to realise that vision.

**Outcomes:** As a result of the successful implementation of creating and communicating a shared vision in ways that inspires people to realise that vision:

---

**1.1 Shared vision**

This concept was considered mushy and almost embarrassing in early versions of CMMI. Unless you provide a very clear definition of what constitutes a shared vision, it tends toward the 'cumbyyah' interpretation.

**Rationale**

Re Expert 2: No change; shared vision is cited extensively in the management literature and is commonly agreed to be of central importance. No alternative term seems appropriate.

**Re Expert 1:**

GLOBAL COMMENT: ISO 24774 format is to state the process here (and in all other outcome introductions through the document)

**Outcomes:** As a result of the successful implementation of shared vision process:

---

Re Expert 1: As per ISO 24774 Section 3.4 (b). The list of outcomes associated with a process shall be prefaced by the text, 'As a result of successful implementation of this process:’
<table>
<thead>
<tr>
<th>V0.4 PRM</th>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Leader creates a shared vision of the goal(s).</td>
<td><strong>GLOBAL COMMENT:</strong> 24744 requires declarative present tense for outcomes. To conform, all outcomes should be rephrased as in this example provided. <strong>GLOBAL COMMENT:</strong> In addition, responsibility for performing the process is in CL2, and should be excluded. Thus, don’t say ‘who’, just say ‘what’ (delete ‘leader’ from all)</td>
<td>This is a very top-down version of developing shared goals and will be rejected by the agile crowd that believes the entire team or at least it senior representatives should be involved in creating ‘the shared vision’, otherwise it may never be shared. You need to provide for both top-down and bottom-up goal-building. ‘Leader ensures the development of...’ or some such construction.</td>
<td>1. A shared vision of the goal(s) is created.</td>
<td><strong>Re Expert 1:</strong> As per ISO 24774 Section 3.4 (c) An outcome shall be phrased as a declarative sentence using a verb in the present tense. Typically, the verb is ‘is’ or ‘are’ although others may be used when appropriate. <strong>Re Expert 2:</strong> Removing ‘Leader’ from outcome removes the top-down implication and suggests an inclusive approach.</td>
</tr>
<tr>
<td>2. Leader communicates the shared vision of the goal(s) with the team.</td>
<td><strong>Same problem as ‘1’.</strong></td>
<td>2. A shared vision of the goal(s) is communicated to the team.</td>
<td>As per ISO 24774 Section 3.4 (c)</td>
<td><strong>Re Expert 2:</strong> Same remedy</td>
</tr>
<tr>
<td>V0.4 PRM</td>
<td>Re Expert 1</td>
<td>Re Expert 2</td>
<td>V0.5A PRM</td>
<td>Rationale</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------</td>
<td>-------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>3. Leader gains commitment from team to achieve the goal(s).</td>
<td><em>What if there are people who disagree? I have seen too many teams in which the person who refused to accept the 'shared vision' was proven right in the end. Be wary that this leadership factor doesn’t force people to drink the Kool-aid. Ensure that you have mechanisms for dealing with diverse views in the team and occasional revision</em></td>
<td>3. Commitment by team to achieving the goal(s) is gained.</td>
<td>As per ISO 24774 Section 3.4 (c) Re Expert 2: ‘Shared vision’ has by now been translated into practical ‘objectives’ as to what will be achieved. Arguably, team members who do not commit to the objectives are of questionable value to the team.</td>
<td></td>
</tr>
<tr>
<td>4. Leader encourages resilience in team when goal-frustrating events occur.</td>
<td>4. Resilience by team to goal-frustrating events is encouraged.</td>
<td>As per ISO 24774 Section 3.4 (c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Leader develops practical objective(s) to achieve the goal(s).</td>
<td>5. Practical objective(s) for goal(s) achievement are developed.</td>
<td>As per ISO 24774 Section 3.4 (c)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Leader generates optimism towards achieving the stated objectives.</td>
<td><em>Mushy</em></td>
<td>6. Positive expectation for achieving objective(s) is encouraged.</td>
<td>As per ISO 24774 Section 3.4 (c). Re Expert 2: ‘Optimism’ changed to more neutral ‘positive expectation’.</td>
<td></td>
</tr>
<tr>
<td>V0.4 PRM</td>
<td>Re Expert 1</td>
<td>Re Expert 2</td>
<td>V0.5A PRM</td>
<td>Rationale</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
<td>-------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>Informative Notes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outcome 1 -- the shared vision of the goal should ideally be seen as an accomplished fact. The goals will still be abstract at this point. The goal(s) become concrete when translated into objective(s).</td>
<td>The paragraphs on trust do not seem relevant to the outcomes described, which pertain to shared vision ... suggest delete</td>
<td>Outcome 1 -- the shared vision of the goal should ideally be seen as an accomplished fact. I'm not sure what is being implied here, but it doesn't sound right. Many people may not be willing to commit to the goal until they see how it translated into clear objectives. The goals will still be abstract at this point. The goal(s) become concrete when translated into objective(s).</td>
<td><strong>Informative Notes</strong></td>
<td>Re Expert 1: Deleted as suggested</td>
</tr>
<tr>
<td>(Remainder removed to save space. See Appendix)</td>
<td></td>
<td></td>
<td>Re Expert 1: 'mushy'; the informative material complements the hard factual nature of the outcome statements by expressing the same message in more human terms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Factor 1 (and several others in this list) was not mentioned before? So ... how is this summary? Suggest delete this or tie more directly to the process outcomes.</td>
<td></td>
<td><strong>Re Expert 1</strong>: 'mushy'; the informative material complements the hard factual nature of the outcome statements by expressing the same message in more human terms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>Re Expert 2</strong>: Outcome 4 Informative Note is reworded to say 'demonstrates resilience in the face of goal-frustrating events'.</td>
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<tr>
<td><strong>Outcome 1</strong> – the shared vision of the goal should ideally be seen as an accomplished fact.</td>
<td></td>
<td></td>
<td><strong>Outcome 1</strong> – the shared vision of the goal should ideally be seen as an accomplished fact. I'm not sure what is being implied here, but it doesn't sound right. Many people may not be willing to commit to the goal until they see how it translated into clear objectives. The goals will still be abstract at this point. The goal(s) become concrete when translated into objective(s).</td>
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<td>Outcome 2 – the shared vision should be communicated in a way that creates enthusiasm and optimism among the team.</td>
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<td></td>
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<td></td>
<td><strong>Outcome 2</strong> – the shared vision should be communicated in a way that creates enthusiasm and optimism among the team.</td>
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<td>Outcome 3 – the way in which the shared vision of the abstract goal(s) is communicated should generate strong commitment to the achievement of the goal(s).</td>
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<td></td>
<td><strong>Outcome 3</strong> – the way in which the shared vision of the abstract goal(s) is communicated should generate strong commitment to the achievement of the goal(s).</td>
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<td></td>
<td>Outcome 4 – the leader demonstrates resilience in the face of goal-frustrating events.</td>
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<td><strong>Outcome 4</strong> – the leader demonstrates resilience in the face of goal-frustrating events.</td>
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<td>Outcome 5 – from the shared vision and subsequent goals, a set of practically-worded objectives are developed that give the team a concrete set of outcomes to achieve.</td>
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<td><strong>Outcome 5</strong> – from the shared vision and subsequent goals, a set of practically-worded objectives are developed that give the team a concrete set of outcomes to achieve.</td>
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<td>Outcome 6 – having developed concretely-</td>
<td><strong>Outcome 6</strong> – having developed concretely-</td>
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<td>worded objectives, the leader generates in the team an optimistic mind-set and outlook to wards the achievement of the</td>
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<td>worded objectives, the leader generates in the team an optimistic mind-set and outlook towards the achievement of the</td>
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<td></td>
<td></td>
<td></td>
<td>goal(s).</td>
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</tbody>
</table>
### 1.2 Integrity & competence

Integrity is an attribute of behavior, not behavior itself. It belongs in codes of ethics, not in process models. How would you ever appraise this without going through a process much like that of a court. How do you deal with situations where moral values conflict. Was Franklin D. Roosevelt acting with ‘integrity’ when he deceived the American people about the extent to which he was helping the British resist the Germans before America entered the Second World War?

| Purpose: The purpose of the integrity and competence process is to consistently act with integrity and competence over time in pursuit of the shared vision. |
| Purpose: The purpose of the integrity and competence process is to consistently act with integrity and competence over time in pursuit of the shared vision. |

| Outcomes: As a result of the successful implementation of consistently acting with integrity and competence over time in pursuit of the shared vision: |
| Outcomes: As a result of the successful implementation of the integrity and competence process: |

As per ISO 24774 Section 3.4 (b).
<table>
<thead>
<tr>
<th>V0.4 PRM</th>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Leader behaves with integrity.</td>
<td>1. Integrity is consistently practiced.</td>
<td>As per ISO 24774 Section 3.4 (c).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Leader behaves with competence.</td>
<td>2. Competence is consistently exhibited.</td>
<td>As per ISO 24774 Section 3.4 (c).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V0.4 PRM</td>
<td>Re Expert 1</td>
<td>Re Expert 2</td>
<td>V0.5A PRM</td>
<td>Rationale</td>
</tr>
<tr>
<td>----------</td>
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<td>-------------</td>
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</tr>
<tr>
<td><strong>Informative Notes</strong></td>
<td>Outcome 1 – the leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle. Was Churchill acting with integrity when with advance knowledge of the impending massacre he allowed thousands of Britons to be slaughtered in the German mass bombing of Coventry? Or was he right to allow it to happen to keep secret that England had deciphered the Germans’ secret code? Which principle should he adhere to? Will I trust him again?</td>
<td><strong>Informative Notes</strong></td>
<td>Outcome 1 – the leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle.</td>
<td>Re Expert 1: Delete para on self-worth as suggested</td>
</tr>
<tr>
<td></td>
<td><strong>Outcome 2 – the leader manifests competence, characterised by technical and interpersonal skills, and advanced conceptual and reasoning skills.</strong> How on earth do you measure this. Must a process appraiser have a competence scale and tests of cognitive abilities in order to determine whether this outcome has been satisfied? Must a leader be competent in all areas? Do the stakeholders want advanced conceptual skills? Are there enough such leaders to go around?</td>
<td><strong>Outcome 2</strong> – the leader manifests competence, characterised by technical and interpersonal skills, and advanced conceptual and reasoning skills.</td>
<td><strong>Rationale</strong></td>
<td>Re Expert 2: Trustworthiness and adherence to principle is nonetheless the desirable behavior, despite some leaders being placed in situations where aspects of their behavior could be said to be less than trustworthy in relation to some stakeholders.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Re Expert 2: assessment might be problematic, but for the process reference model, it is sufficient to say there is evidence in the form of activities and artefacts that this is being performed.</td>
<td></td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Re Expert 2: the literature asserts strongly that these qualities of integrity etc are important for leadership. A way must be found to include such factors in a PRM rather than be removed and put into the ‘too hard’ basket.</td>
</tr>
</tbody>
</table>
## 1.3 Action-orientation & resilience

**Purpose:** The purpose of the action and resilience process is to be inclined towards action and resilience.

**Outcomes:** As a result of the successful implementation of being action-oriented and resilient:

1. Leader is decisive in pursuit of objective(s).

**Re Expert 1:**

**Outcomes:** As a result of the successful implementation of the action-orientation and resilience process:

1. Objective-achieving behavior is decisively pursued.

**Re Expert 2:**

**Outcomes:** As a result of the successful implementation of the action-orientation and resilience process:

1. Objective-achieving behavior is decisively pursued.

---

**1.3 Action-orientation & resilience**

**Purpose:** The purpose of the action and resilience process is to be inclined towards action and resilience.

**Outcomes:** As a result of the successful implementation of being action-oriented and resilient:

1. Leader is decisive in pursuit of objective(s).

**Re Expert 2:**

Objective evidence of resilience can nonetheless be identified, based on Stage 1 and 2 data collection. The literature cites resilience as a key quality of a leader. Arguably it belongs in this PRM, despite the difficulties in defining capability levels in relation to it.

---

**V0.4 PRM** | **Re Expert 1** | **Re Expert 2** | **V0.5A PRM** | **Rationale**
--- | --- | --- | --- | ---

1.3 Action-orientation & resilience

**Purpose:** The purpose of the action and resilience process is to be inclined towards action and resilience.

**Outcomes:** As a result of the successful implementation of being action-oriented and resilient:

1. Leader is decisive in pursuit of objective(s).

---

**V0.5A PRM** | **Rationale**
--- | ---

Re Expert 2: Objective evidence of resilience can nonetheless be identified, based on Stage 1 and 2 data collection. The literature cites resilience as a key quality of a leader. Arguably it belongs in this PRM, despite the difficulties in defining capability levels in relation to it.
<table>
<thead>
<tr>
<th>V0.4 PRM</th>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Leader is resilient when goal-frustrating events happen.</td>
<td></td>
<td></td>
<td>2. Objective-frustrating events are met with resilience.</td>
<td>As per ISO 24774 Section 3.4 (c).</td>
</tr>
</tbody>
</table>

Outcome 3 – the leader evaluates situations to determine when it is time to stop pursuing the current objectives.

3. Viability of continuing pursuit of current objective(s) is evaluated.

Re Expert 2 suggests adding this new outcome to limit wasted time and effort on hopeless causes.

**Informative Notes**

Outcome 1 – the leader consistently displays the ability to think and act decisively in pursuit of objective(s).

(Remainder removed to save space. See Appendix)

**1.4 Intelligence**

**Purpose:** The purpose of the intelligence process is to apply appropriate cognitive resources in the achievement of goals.

**Outcomes:** As a result of the successful application of appropriate cognitive resources:

As per ISO 24774 Section 3.4 (b).
### V0.4 PRM
1. Leader engenders original thinking in team members.

<table>
<thead>
<tr>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leader engenders original thinking in team members. Who assesses whether it is ‘original’? Hasn’t this been one of the barriers to reuse—everyone wants to believe their work is ‘original’. How many people on a team are capable of truly ‘original’ thinking?</td>
<td>1. Original thinking in team-members is facilitated.</td>
<td>As per ISO 24774 Section 3.4 (c). Re Expert 2: Objective evidence of original thinking can nonetheless be identified, based on Stage 1 and 2 data collection. The literature also cites resilience as a key quality of a leader. Arguably it belongs in this PRM, despite the difficulties in defining capability levels in relation to it. Additional clarification in Informative Material added to address the issue.</td>
<td></td>
</tr>
</tbody>
</table>

### V0.4 PRM
2. Leader understands situations realistically.

1. Situations are realistically understood.

<table>
<thead>
<tr>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leader understands situations realistically. How do you assess this? Whose reality is the criteria? Is this appropriate for a process model?</td>
<td>2. Situations are realistically understood.</td>
<td>As per ISO 24774 Section 3.4 (c). Re Expert 2: Additional clarification in Informative Material added to address the issue. ‘Realistic’ in this sense depends on objective-achievement.</td>
<td></td>
</tr>
</tbody>
</table>
### V0.4 PRM

3. Leader generates the cause(s) of objective-achieving outcomes.

### Re Expert 1

*Leader >> generates the cause(s) of objective-achieving outcomes <<. What does this mean in ordinary English?*

### Re Expert 2

3. Cause(s) of objective-achieving outcomes are generated.

### V0.5A PRM

### Rationale

As per ISO 24774 Section 3.4 (c).

*Re Expert 2: Additional clarification in Informative Material added to address the issue. ‘Objective achieving outcomes’ refers to generating the right conditions for objectives to be achieved.*
<table>
<thead>
<tr>
<th>V0.4 PRM</th>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Informative Notes</strong></td>
<td><strong>Outcome 1 – the leader displays a realistic understanding of situations, enabling appropriate action to be taken.</strong> (Remainder removed to save space. See Appendix)</td>
<td><strong>Notes on outcomes 1 and 2 look the same?</strong></td>
<td><strong>How do you assess this? Whose reality is the criteria?</strong></td>
<td><strong>Informative Notes</strong></td>
</tr>
<tr>
<td><strong>Notes on outcomes 1 and 2 look the same?</strong></td>
<td><strong>Still not sure what this entails? Generating what causes?</strong></td>
<td><strong>How do you assess this? Whose reality is the criteria?</strong></td>
<td><strong>Still not sure what this entails? Generating what causes?</strong></td>
<td><strong>Re Expert 1: Rewrite Outcome one informative material</strong></td>
</tr>
<tr>
<td><strong>Suggest that a good leader however does not simply ignore lessons learned and collected knowledge.</strong></td>
<td><strong>Re Expert 1: Rewrite Outcome one informative material</strong></td>
<td><strong>Re Expert 2: Assessment of Capability Levels may be problematic beyond level 1. Objective evidence of original thinking has been observed in stages 1 and 2 data collection, therefore this arguably belongs in the PRM.</strong></td>
<td><strong>Re Expert 1: Rewrite Outcome one informative material</strong></td>
<td><strong>Re Expert 2: Assessment of Capability Levels may be problematic beyond level 1. Objective evidence of original thinking has been observed in stages 1 and 2 data collection, therefore this arguably belongs in the PRM.</strong></td>
</tr>
</tbody>
</table>
1.5 *Individualized consideration*

**Purpose:** The purpose of the individualized consideration process is to manifest deep concern for individual team-members as complete human beings.

**Purpose:** The purpose of the individualized consideration process is to convey to team-members their value as individuals.

**Outcomes:** As a result of the successful implementation of concern for individual team-members as complete human beings:

**Outcomes:** As a result of the successful implementation of the individualized consideration process:

---

V0.4 PRM  Re Expert 1  Re Expert 2  V0.5A PRM  Rationale

Re Expert 2: the literature emphatically states that team-members respond well to individualised consideration, and poorly to the opposite, being treated as expendable units of production.

Have reworded the Purpose statement to the perception that this is about ‘motherhood’. Leadership is fundamentally about people perceiving they are valued as people not managed as things – calling this ‘motherhood’ discounts the importance of this point.

As per ISO 24774 Section 3.4 (b).
<table>
<thead>
<tr>
<th>V0.4 PRM</th>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Leader values each team member as an</td>
<td></td>
<td></td>
<td>1. Individual team-members are valued.</td>
<td>As per ISO 24774 Section 3.4 (c).</td>
</tr>
<tr>
<td>individual.</td>
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<tr>
<td>2. Leader unites the individual team</td>
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<td>2. Individual team-members are unified into</td>
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<td>members into an effective team.</td>
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<td></td>
<td>team.</td>
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<tr>
<td>3. Leader is empathic. Empathetic (not</td>
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<td>3. Empathy towards individual team-members</td>
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<tr>
<td>empathic)</td>
<td></td>
<td></td>
<td>is practiced.</td>
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<tr>
<td>4. Leader rewards objective-achieving</td>
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<td></td>
<td>4. Objective-achieving team behavior is</td>
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<td>behavior with positive reinforcement.</td>
<td></td>
<td></td>
<td>rewarded.</td>
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</tbody>
</table>

**Informative Notes**
Outcome 1 – the leader manifests an understanding of team-members within a mind-set of respect. This leads to a valuing of the member as an individual. On perceiving this mind-set in the leader, the member’s commitment is reinforced.

(remainder removed to save space. See Appendix)
### 1.6 Management-by-exception

**Purpose:** The purpose of the management-by-exception process is to adopt a laissez-faire attitude until and unless non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of passive management by exception:

---

**Re Expert 1:**

Purpose: The purpose of the management-by-exception process is to adopt a laissez-faire attitude until and unless non-compliance of standards has occurred. ‘Laissez-faire’ is the wrong term to use to describe outcomes 1 & 2, and has a bad reputation in the leadership literature. ‘Empowered’ is a better word to use.

Outcomes: As a result of the successful implementation of the management by exception process:

---

**Re Expert 2:**

Re Expert 2: reword to remove ‘laissez-faire’ and replace with ‘empower’. The word ‘empower’ has become something of a cliché yet it probably works better than the French expression in this context.

---

**1.6 Management-by-exception**

**Purpose:** The purpose of the management-by-exception process is to empower team-members to act independently until and unless non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of the management by exception process:

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**V0.5A PRM**

As per ISO 24774 Section 3.4 (b).
<table>
<thead>
<tr>
<th>V0.4 PRM</th>
<th>Re Expert 1</th>
<th>Re Expert 2</th>
<th>V0.5A PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Leader allows team-members to act independently while objective-achieving behavior continues.</td>
<td>Leader allows team-members to act independently while objective-achieving behavior continues. So the leader should not engage in coaching so long as the behavior is 'objective-achieving' even though it may be inefficient?</td>
<td>1. Independent team behavior that is objective-achieving is encouraged.</td>
<td>As per ISO 24774 Section 3.4 (c). Re Expert 1: Reframe outcome to emphasise the encouragement of independent behavior rather than toleration. Re Expert 2: add clarification to informative notes to include coaching.</td>
<td></td>
</tr>
<tr>
<td>V0.4 PRM</td>
<td>Re Expert 1</td>
<td>Re Expert 2</td>
<td>V0.5A PRM</td>
<td>Rationale</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
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<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Informative Notes</strong></td>
<td>Outcome 1 – when the team is doing their job the leader leaves them alone. In effect, the leader does not give the impression of being a ‘micro-manager’. <em>(Remainder removed to save space. See Appendix)</em></td>
<td>‘Leaving them alone’ can be interpreted as ignoring them. Paying attention/coaching/discussing progress is not the same as micro-managing.</td>
<td><strong>Informative Notes</strong></td>
<td>Outcome 1 – when the team is doing their job the leader leaves them alone. In effect, the leader does not give the impression of being a ‘micro-manager’. If the team is inexperienced, coaching of specific skills towards objective(s) achievement is warranted. The leader should evaluate the potential negative impact of such coaching before performing. <em>(Remainder removed to save space. See Appendix)</em></td>
</tr>
<tr>
<td></td>
<td>Suggest it might be useful to discuss distinctions between ‘leaders’ and ‘managers’ somewhere in this document</td>
<td></td>
<td></td>
<td>Re Expert 1: Have included discussion of distinction between manager and leader in the Generic factors intro section.</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>Re Expert 2: Have included ‘If the team is inexperienced, coaching of specific skills towards objective(s) achievement is warranted. The leader should evaluate the potential negative impact of such coaching before performing.’</td>
</tr>
<tr>
<td>V0.4 PRM</td>
<td>Re Expert 1</td>
<td>Re Expert 2</td>
<td>V0.5A PRM</td>
<td>Rationale</td>
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<tr>
<td><strong>1.7 Team development &amp; coherence</strong></td>
<td>So integrated teams don’t need team development and coherence functions? Again, these are Generic issues which need elaboration for different types of teams.</td>
<td>Purpose: The purpose of the team development and coherence process is to establish team development functions to promote productivity and coherence.</td>
<td>Re Expert 2: have moved this process to generic from virtual, as suggested.</td>
<td>Moved here from virtual section because it is generic</td>
</tr>
<tr>
<td><strong>Outcomes</strong></td>
<td>As a result of the successful implementation of the team development and coherence process:</td>
<td>As per ISO 24774 Section 3.4 (b).</td>
<td>As per ISO 24774 Section 3.4 (c).</td>
<td></td>
</tr>
<tr>
<td>1. Development practices for team coherence are established.</td>
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<tr>
<td>2. Outcome deleted as redundant</td>
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<td>Once the outcomes had been reworded in accordance with 24774, it became clear the two outcomes were too similar to remain separate</td>
</tr>
<tr>
<td>Leader uses team development practices to promote team coherence</td>
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</tr>
<tr>
<td>V0.4 PRM</td>
<td>Re Expert 1</td>
<td>Re Expert 2</td>
<td>V0.5A PRM</td>
<td>Rationale</td>
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<td>----------</td>
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</tr>
<tr>
<td></td>
<td>Good luck in India with 30% voluntary turnover. This can be beyond the leader's capability or span of influence, especially if salary or career opportunity is involved. Again, stability is an important issue on all types of teams, and therefore is a Generic category issue. What percent can turnover before it is considered unstable? This process category does not help since it offers no insight into practices that ameliorate the causes of team turnover.</td>
<td>3. Stable team membership is maintained.</td>
<td>As per ISO 24774 Section 3.4 (c). Re Expert 1: former 3.7 Virtual team membership stability process has been combined with the team coherence process and moved here to the generic section. Insufficient difference to remain a separate process from the coherence. Re Expert 2: to the extent the leader is able to achieve through inspirational leadership, members can be persuaded to stay. Watts Humphrey in his TSP literature review mentions instances of project staff returning to a former employer at lower pay because a good leadership. Re Expert 2: insufficient information to determine a percentage figure at this time. A matter for further investigation. Re Expert 2: arguably a process model should not concern itself with the ‘how’ of amelioration strategies.</td>
<td></td>
</tr>
</tbody>
</table>
### Stage 5 (V0.5A to V0.5B) reordering of processes for clarity

The input from the Expert Panel calls for a restructuring of the PRM, evolving the original three independent category architecture (generic, integrated, virtual) to become a single generic category with two supplementary categories depending on the generic category.

Therefore, given the presence of a major change plus many small changes, the Expert Panel revisions will be done in two steps; Step A implements the many small changes as seen in the previous table, with Step B, the major restructure, shown in the table below. Both Experts made the point repeatedly in their analysis feedback that the categories should be merged. The column to the right shows the gist of their comments, as given in their summing up.

See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.
V0.5B PRM

Note: V0.5A PRM is NOT shown in a line-by-line relationship with V0.5B PRM because the restructure is too radical for this to be practical.

Rationale

Re Expert 1: Please better distinguish between integrated and virtual teams OR I'd suggest just dropping that distinction for better usability of your work.

Re Expert 2: Many of leadership factors underlying Integrated Teams or Virtual Teams are really Generic issues that are relevant to most teams regardless of whether they are virtual or integrated. Accordingly the model factors in the Generic Category and then shows how they are specialized for integrated or virtual teams. In essence there needs to be some reanalysis of the process categories and synthesis of practices to get the abstractions underlying the model right.

1. Generic team leadership factors

Purpose: The purpose of the generic team leadership factors is to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).

Outcomes: As a result of the successful implementation of Generic leadership processes the degree to which a leader embodies such processes and is able to practice them may be identified.

Informative Notes: generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams.

(Reminder removed to save space. See Appendix)
1.1 Shared vision

**Purpose:** The purpose of the shared vision process is to create and communicate a shared vision in ways that inspires people to realise that vision.

**Outcomes:** As a result of the successful implementation of shared vision process:

1. A shared vision of the goal(s) is created.
2. A shared vision of the goal(s) is communicated to the team.
3. Commitment by team to achieving the goal(s) is gained.
4. Resilience by team to goal-frustrating events is encouraged.
5. Practical objective(s) for goal(s) achievement are developed.
6. Positive expectation for achieving objective(s) is encouraged.

**Informative Notes**

Outcome 1 -- the shared vision of the goal is seen as achievable. The goals will still be abstract at this point. The goal(s) become concrete when translated into objective(s).

(Remainder removed to save space. See Appendix)

1.2 Integrity & competence

**Purpose:** The purpose of the integrity and competence process is to consistently act with integrity and competence over time in pursuit of the shared vision.

**Outcomes:** As a result of the successful implementation of the integrity and competence process:

1. Integrity is consistently practiced.
2. Competence is consistently exhibited.
### V0.5B PRM

<table>
<thead>
<tr>
<th>Rationale</th>
</tr>
</thead>
</table>

#### Informative Notes

**Outcome 1** – the leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle.

*(Remainder removed to save space. See Appendix)*

#### 1.3 Action-orientation & resilience

**Purpose:** The purpose of the action and resilience process is to be inclined towards action and resilience.

**Outcomes:** As a result of the successful implementation of the action-orientation and resilience process:

1. Objective-achieving behavior is decisively pursued.
2. Objective-frustrating events is met with resilience.
3. Viability of continuing pursuit of current objective(s) is evaluated.

---

#### Informative Notes

**Outcome 1** – the leader consistently displays the ability to think and act decisively in pursuit of objective(s).

*(Remainder removed to save space. See Appendix)*

#### 1.4 Intelligence

**Purpose:** The purpose of the intelligence process is to apply appropriate cognitive resources in the achievement of goals.

**Outcomes:** As a result of the successful implementation of the intelligence process:

1. Original thinking in team-members is facilitated.
V0.5B PRM

Rationale

2. Situations are realistically understood.

3. Cause(s) of objective-achieving outcomes are generated.

Informative Notes

Outcome 1 – the leader encourages a high-level of original thinking in the team, enabling new solutions to problems to be developed, unbound by the orthodoxy. This can be achieved by explicitly encouraging thinking beyond the conventional, setting the expectation that this will be so. The leader can reward original thinking. In short, it becomes a group-norm.

(Remainder removed to save space. See Appendix)

1.5 Individualized consideration

Purpose: The purpose of the individualized consideration process is to convey to team-members their value as individuals.

Outcomes: As a result of the successful implementation of the individualized consideration process:

1. Individual team-members are valued.

2. Individual team-members are unified into team.

3. Empathy towards individual team-members is practiced.

4. Objective-achieving team behavior is rewarded.

Informative Notes

Outcome 1 – the leader manifests an understanding of team-members within a mind-set of respect. This leads to a valuing of the member as an individual. On perceiving this mind-set in the leader, the member’s commitment is reinforced.

(Remainder removed to save space. See Appendix).

1.6 Management-by-exception
### V0.5B PRM

<table>
<thead>
<tr>
<th><strong>Purpose:</strong></th>
<th>The purpose of the management-by-exception process is to empower team-members to act independently until and unless non-compliance of standards has occurred.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcomes:</strong></td>
<td>As a result of the successful implementation of the management by exception process:</td>
</tr>
<tr>
<td>1.</td>
<td>Independent team behavior that is objective-achieving is encouraged.</td>
</tr>
<tr>
<td>2.</td>
<td>Non-objective-achieving team behavior is corrected.</td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – when the team is doing their job the leader leaves them alone. In effect, the leader does not give the impression of being a ‘micro-manager’. If the team is inexperienced, coaching of specific skills towards objective(s) achievement is warranted. The leader should evaluate the potential negative impact of such coaching before performing.

(Remainder removed to save space. See Appendix)

#### 1.7 Team recruitment

<table>
<thead>
<tr>
<th><strong>Purpose:</strong></th>
<th>The purpose of the team recruitment process is to recruit persons with skills appropriate to the achievement of project goals.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcomes</strong></td>
<td>As a result of the successful implementation of team recruitment process:</td>
</tr>
<tr>
<td>1.</td>
<td>Team members with appropriate skills are recruited.</td>
</tr>
</tbody>
</table>

3.1 becomes 1.7.

Remove ‘virtual’ from title.

Moved to generic category from virtual category in entirety since there is insufficient reason to leave it as a virtual only process and there are no outcomes that are specific to virtual the category.
### V0.5B PRM

<table>
<thead>
<tr>
<th>Informative Notes</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome 1 – the leader recruits team members with the requisite skills for the project under consideration. Where the project is complex, a more diverse set of team-member skills will be needed. General</td>
<td>Remove mention of ‘virtual’ from this former virtual category process.</td>
</tr>
<tr>
<td>Geographically dispersed, complex and/or co-located teams will normally require a broad base of potential expertise to be drawn upon when assembling a team. This is particularly true when the task to be performed is a complex one.</td>
<td></td>
</tr>
</tbody>
</table>

### 1.8 Team environment

**Purpose:** The purpose of the team environment process is to establish the project’s work environment.

**Outcomes:** As a result of the successful implementation of the team environment process:

1. Appropriate physical infrastructure and facilities are provided.

<table>
<thead>
<tr>
<th>Informative Notes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcome 1 – team environment is defined broadly to include all required physical infrastructure and supporting facilities; from office space to computer and photocopiers (etc).</td>
<td>Former outcomes 1 &amp; 2 have been removed from this genericised process. They are specific to integrated and virtual teams.</td>
</tr>
</tbody>
</table>

(Remainder removed to save space. See Appendix)

### 1.9 Team structure

2.2 becomes 1.9.

Remove ‘integrated’ from title.
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Purpose:</strong> The purpose of the team structure process is to create a flexible, goal-oriented team structure.</td>
<td>Moved to generic category from integrated category in entirety since there is insufficient reason to leave it as an integrated only process and there are no outcomes that are specific to the integrated category.</td>
</tr>
</tbody>
</table>

**Outcomes:** As a result of the successful implementation of the team structure process:

1. Objective-aligned team structure is established.
2. Adaptable team structure is established.
3. Appropriate team roles are assigned.

**Informative Notes**
Outcome 1 – the leader establishes a team structure that is broadly consistent with the project’s objectives and requirements.  
(Remainder removed to save space. See Appendix)

2.3 becomes 1.10  
Remove mention of ‘integrated’ from title

**1.10 Team requirements**

**Purpose:** The purpose of the team requirements process is to allocate project requirements to teams.  
Remove ‘integrated’ from purpose.  
Moved to generic category from integrated category in entirety since there is insufficient reason to leave it as an integrated only process and there are no outcomes that are specific to the integrated category.

**Outcomes:** As a result of the successful implementation of team requirements process:
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Team structure is verified.</td>
<td>Remove mention of ‘integrated’ from this former integrated category process.</td>
</tr>
<tr>
<td>2. Team sponsor(s) are appointed.</td>
<td>2.4 becomes 1.11</td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – the leader verifies the team structure by allocating the project requirements before team members are recruited to verify that the team structure is appropriate to objectives.  
(Remainder removed to save space. See Appendix)

**1.11 Team formation**

Purpose: The purpose of the team formation process is to constitute the team structure.  
Remove ‘integrated’ from purpose.  
Moved to generic category from integrated category in entirety since there is insufficient reason to leave it as an integrated only process and there are no outcomes that are specific to the integrated category.

Outcomes: As a result of the successful implementation of the team formation process:  
Remove ‘integrated’ from outcome heading

1. Team structure consistent with project requirements is established.
2. Team leaders consistent with requirements are appointed.
3. Team charter consistent with requirements is established.
4. Resources consistent with project requirements are allocated.
<table>
<thead>
<tr>
<th><strong>V0.5B PRM</strong></th>
<th><strong>Rationale</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Informative Notes</strong></td>
<td>Remove ‘integrated’ from</td>
</tr>
<tr>
<td><em>Outcome 1 – the leader delegates to team sponsor(s) the task of recruiting and organising team(s) that are organised appropriately for the project requirements.</em></td>
<td></td>
</tr>
<tr>
<td><em>(Remainder removed to save space. See Appendix)</em></td>
<td></td>
</tr>
<tr>
<td><strong>1.12 Team roles</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Purpose:</strong> The purpose of the virtual team roles process is to define member roles.</td>
<td><strong>3.2 becomes 1.12</strong>  Remove ‘virtual’ from title. Corresponds to supplementary process 3.2.</td>
</tr>
<tr>
<td><strong>Outcomes:</strong> As a result of the successful implementation of the team roles process:</td>
<td><strong>Moved to generic category from integrated category. This process contains the generic outcomes only. The outcomes specific to virtual teams are contained in 3.2.</strong></td>
</tr>
<tr>
<td>1. Team member roles are understood.</td>
<td><strong>Former outcomes 1 &amp; 2 have been removed from this genericised process. They are specific to virtual teams only.</strong></td>
</tr>
<tr>
<td>2. Contingency plans for team member absences are developed.</td>
<td></td>
</tr>
<tr>
<td><strong>Informative Notes</strong></td>
<td></td>
</tr>
<tr>
<td><em>Outcome 1 – the leader ensures everyone clearly understands their roles, particularly those performing multiple roles.</em></td>
<td></td>
</tr>
<tr>
<td><em>(Remainder removed to save space. See Appendix)</em></td>
<td></td>
</tr>
<tr>
<td><strong>1.13 Team rules</strong></td>
<td><strong>2.7 becomes 1.13</strong>  Remove ‘integrated’ from title</td>
</tr>
</tbody>
</table>
### V0.5B PRM

**Purpose:** The purpose of the team rules process is to establish rules for optimal integrated teams conduct in support of goals.

<table>
<thead>
<tr>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove ‘integrated’ from purpose. Moved to generic category from integrated category in entirety since there is insufficient reason to leave it as an integrated only process and there are no outcomes that are specific to the integrated category.</td>
</tr>
</tbody>
</table>

**Outcomes:** As a result of the successful implementation of the team rules process:

<table>
<thead>
<tr>
<th>Remove ‘integrated’ from outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Criteria for optimal team performance in support of objectives are established.</td>
</tr>
<tr>
<td>2. Empowered operating conduct for optimal team performance in support of objectives is established.</td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – the leader sets the standard of expected performance so team leaders and members are clear about the standard to which they must work.  
*(Remainder removed to save space. See Appendix)*

1.14 **Team boundaries**

<table>
<thead>
<tr>
<th>3.3 becomes 1.14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove ‘virtual’ from title and subsequently.</td>
</tr>
</tbody>
</table>

**Purpose:** The purpose of the team boundaries process is to manage team boundaries.

| Moved to generic category from integrated category in entirety since there is insufficient reason to leave it as an integrated only process and there are no outcomes that are specific to the integrated category. |

**Outcomes:** As a result of the successful implementation of the team boundaries process:
1. Team boundaries are managed.

2. Blended team culture is facilitated.

**Informative Notes**

*Outcome 1 – the leader ensures that boundaries concerning functional, organisational, and cultural matters are maintained in a stable and well-defined manner. The more complex the project, the more important that role boundary definition is stable and well-understood by all, thus minimising the potential for confusion.*

*(Remainder removed to save space. See Appendix)*

### 1.15 Team authority & decision-making

**Purpose:** The purpose of the team authority and decision-making process is to create efficiently functioning teams by establishing mechanisms that allows team leaders and members to recognise clear channels of responsibility.

**Outcomes:** As a result of the successful implementation of establishing team authority and decision-making mechanisms:

1. Clear channels of responsibility are established.
2. Responsibilities are understood.
3. Team authority and decision-making mechanisms are understood.

*Remove ‘integrated’ from purpose and subsequently. Moved to generic category from integrated category in entirety since there is insufficient reason to leave it as an integrated only process and there are no outcomes that are specific to the integrated category.*
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Informative Notes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Outcome 1</strong> – the leader creates clear and unambiguous channels of authority and responsibility within the team hierarchy (team leaders and members).</td>
<td></td>
</tr>
<tr>
<td>(Remainder removed to save space. See Appendix)</td>
<td></td>
</tr>
<tr>
<td><strong>1.16 Team collaboration</strong></td>
<td>2.6 becomes 1.16</td>
</tr>
<tr>
<td><strong>Purpose:</strong> The purpose of the team collaboration process is to ensure effective collaboration among interfacing teams elements.</td>
<td>The generic outcome of team collaboration process was moved here from 2.6. The remaining outcome that is specific to integrated teams remains in the supplementary process ‘Interfacing team collaboration’</td>
</tr>
<tr>
<td><strong>Outcomes:</strong> As a result of the successful implementation of team collaboration process:</td>
<td></td>
</tr>
<tr>
<td>1. Environment for collaboration is established.</td>
<td></td>
</tr>
<tr>
<td><strong>Informative Notes</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Outcome 1</strong> – the leader sets up an environment conducive to efficient collaboration. This may include morale-building activities.</td>
<td></td>
</tr>
<tr>
<td>(Remainder removed to save space. See Appendix)</td>
<td></td>
</tr>
<tr>
<td><strong>1.17 Team performance management</strong></td>
<td>3.5 becomes 1.17</td>
</tr>
<tr>
<td><strong>Purpose:</strong> The purpose of the team performance process is to manage team performance through the development of empowered performance-management functions that allow team members to manage themselves.</td>
<td>Remove ‘virtual’ from title. Corresponds to supplementary process 3.3. Moved to generic category from virtual category. This process contains the generic outcomes only. The outcomes specific to virtual teams are contained in 3.3.</td>
</tr>
</tbody>
</table>
### V0.5B PRM

<table>
<thead>
<tr>
<th>Outcomes:</th>
<th>As a result of the successful implementation of the virtual team performance management process:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Self-managing performance functions are developed.</td>
</tr>
<tr>
<td>2.</td>
<td>High-capability self-managing performance functions for complex asynchronous tasks are developed.</td>
</tr>
<tr>
<td>3.</td>
<td>Anticipatory self-management functions for proactive adaptation to change are developed.</td>
</tr>
</tbody>
</table>

**Rationale**

- Former outcome 3 has been removed from this genericised process. It is specific to virtual teams only.

---

**Informative Notes**

- Informative Notes
  - Outcome 1 – the leader develops explicit performance management functions early in the project lifecycle that allow team members to self-manage their performance. Self-management is defined broadly, and might include methods such as the daily team scrum to create a mind-set that help members synchronise their individual efforts for the rest of the day.

(Remainder removed to save space. See Appendix)

**1.18 Team development & coherence**

**Purpose**: The purpose of the team development and coherence process is to establish team development functions to promote productivity and coherence.

**Outcomes**: As a result of the successful implementation of the team development and coherence process:

1. Development practices for team coherence are established.
2. Stable team membership is maintained.
Informative Notes
Outcome 1 – the leader of both short-term and long-term projects establishes effective team development functions early in the project lifecycle. In the case of short-term projects, this facilitates the timely completion of the project. With long-term projects, this facilitates the establishment of long-term working relationships and complex workflow arrangements.

(Remainder removed to save space. See Appendix)

1.19 Team and home organization balance

Purpose: The purpose of the team and home organization process is to balance integrated team and home organization responsibilities.

Outcomes: As a result of the successful implementation of the integrated and home team balance process:

1. Guidelines for balancing team and home organization responsibilities are established.

Informative Notes
Outcome 1 – the leader provides guidelines that make clear how team-leaders and members can successfully balance their responsibilities to both team and home organisation.

(Remainder removed to save space. See Appendix)

Table 37: Stage 5 (V0.5A to V0.5B) representative reordering of processes for clarity


7.8. Stage 6: Composition tree review (V0.5B to V0.6 PRM)

This table traces the transition from V0.5B PRM (Expert Panel Review) to V0.6, subject to a Composition Tree notation analysis (Dromey, 2007a). Composition trees are a comprehensive statement of the system vocabulary.

The analysis focuses on the initial identification of components and attributes. The development of a full composition tree such as might be done for a set of software requirements is arguably not required since the components processes of the leadership PRM are not to be applied sequentially, with dependencies and consequences as is the case with software requirements. The leadership PRM components function together as a whole, not as a chain or sequence. Therefore constructing a composition tree would yield a flat structure as seen below, not the tree hierarchy that would result from applying the method to a set of software requirements.

Figure 22: PRM Architecture; high level functional view

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Doctor of Philosophy Thesis, David Tuffley, Griffith University, 2009
Note that Composition Tree notation was developed to validate software system requirements. Its application to a PRM is not specifically prescribed, so a significant degree of interpretive latitude exists as to how it is best applied in this project. The application of Composition Tree as seen below uses it to good effect on a process by process, outcome by outcome basis. It identifies a number of improvements. Arguably, this represents a valid, if unprecedented application of Composition Tree notation to the validation of PRMs, as shall be discussed in the Findings chapter. It should also be noted that Composition Tree is not a central element of the Design Research process as originally planned. Its addition to the DR approach in this project was considered worthwhile given the potential benefits of using this formal method to the validation of PRMs and Models of Organisational Behavior more generally.

The Composition Tree notation analysis does not follow directly before or after the Behavior Tree notation analysis review stage because Professor Dromey was unavailable at the time needed were the two reviews to be performed sequentially. This is not necessarily a problem, since arguably the two stages do not need to be performed sequentially.

7.8.1. Composition Tree notation analysis: part 1

Part 1 analysis identifies the components and their associated attributes on a process by process, outcome by outcome basis. It will be seen that by doing so significant improvements are identified. For example, in V0.52 PRM, Process 1.1 is *Shared Vision*. It is clearly seen that ‘shared’ is an attribute of Vision, and does not belong in the title. Therefore in V0.6 PRM Process 1.1 is simply ‘Vision’. The attribute ‘shared’ is dealt with in Outcome 2 of that process.

In part 2, the components and attributes are aggregated to determine possible duplications and redundancies.

*See Appendix for full table. This table is a representative subset of the full table, which is too large to include in this Chapter.*
The input from the Expert Panel calls for a restructuring of the PRM, evolving the original three independent category architecture (generic, integrated, virtual) to become a single generic category with two supplementary categories depending on the generic category.

(Remainder removed to save space. See Appendix)

<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>The input from the Expert Panel calls for a restructuring of the PRM, evolving the original three independent category architecture (generic, integrated, virtual) to become a single generic category with two supplementary categories depending on the generic category.</td>
<td></td>
<td>The input from the Expert Panel calls for a restructuring of the PRM, evolving the original three independent category architecture (generic, integrated, virtual) to become a single generic category with two supplementary categories depending on the generic category.</td>
<td>Therefore, given the presence of a major change plus many small changes, the Expert Panel revisions will be done in two steps; Step A implements the many small changes as seen in the previous table, with Step B, the major restructure, shown in the table below. Both Experts made the point repeatedly in their analysis feedback that the categories should be merged. The column to the right shows the gist of their comments, as given in their summing up.</td>
</tr>
</tbody>
</table>

1. **Generic team leadership factors**

   **Purpose:** The purpose of the generic team leadership factors is to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).
### 1.1 Shared vision

**Purpose:** The purpose of the shared vision process is to create and communicate a shared vision in ways that inspires people to realise that vision.

**Outcomes:** As a result of the successful implementation of shared vision process:

1. A shared vision of the goal(s) is created.

<table>
<thead>
<tr>
<th>1.1 VISION</th>
<th>1.1.1 Exists</th>
<th>1.1.2 Shared</th>
<th>1.1.3 Committed</th>
<th>1.1.4 Resilient</th>
<th>1.1.5 Objectives</th>
<th>1.1.6 Positive Expectation</th>
</tr>
</thead>
</table>

**Informative Notes:** generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams. (Remainder removed to save space. See Appendix)

---

### 1.1 Vision

**Purpose:** The purpose of the vision process is to create and communicate a shared vision in ways that inspires people to realise that vision.

**Outcomes:** As a result of the successful implementation of vision process:

1. A vision of the goal(s) is created.

**Informative Notes:** generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams. (Remainder removed to save space. See Appendix)

---

### Applying the Composition Tree technique

Applying the Composition Tree technique to identify the components and attributes of said components highlights that 'shared' is an attribute of 'vision' so process should be simply called 'Vision', with 'shared' being dealt with in Outcome 2.

Remove 'shared'. The vision is not shared until it is communicated in the next outcome.
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. A shared vision of the goal(s) is communicated to the team.</td>
<td></td>
<td>2. The vision of the goal(s) is communicated to the team.</td>
<td>Remove ‘shared’. The vision does not become shared until it is communicated.</td>
</tr>
<tr>
<td>3. Commitment by team to achieving the goal(s) is gained.</td>
<td></td>
<td>3. Commitment by team to the shared vision is gained.</td>
<td>Reword to emphasise commitment to the shared vision as the starting point. Commitment to objectives then derives from this.</td>
</tr>
<tr>
<td>4. Resilience by team to goal-frustrating events is encouraged.</td>
<td></td>
<td>[Moved to 1.4 Action orientation]</td>
<td>Remove outcome to a more relevant Process – composition tree identifies that this is dealt with in 1.4 Action orientation. More logical to deal with resilience there. No need to double up, in any case.</td>
</tr>
<tr>
<td>5. Practical objective(s) for goal(s) achievement are developed.</td>
<td></td>
<td>[Becomes Outcome 1 of a new Process 1.2 Objectives.]</td>
<td>Objectives are a derivative of vision and goals. Logically belong in their own process. Therefore create new process 1.2 Objectives and delete this outcome from here.</td>
</tr>
<tr>
<td>6. Positive expectation for achieving objective(s) is encouraged.</td>
<td></td>
<td>[Becomes Outcome 2 of a new Process 1.2 Objectives.]</td>
<td>Objectives are a derivative of vision and goals. Logically belong in their own process. Therefore create new process 1.2 Objectives and delete this outcome from here.</td>
</tr>
</tbody>
</table>

**Informative Notes**

**Outcome 1** -- the shared vision of the goal is seen as achievable. The goals will still be abstract at this point. The goal(s) become concrete when translated into objective(s).

(Remainder removed to save space. See Appendix)

**Informative Notes**

**Outcome 1** -- the vision of the goal is seen by the leader as achievable. The goals will still be abstract at this point. The goal(s) become concrete when translated into objective(s).

(Remainder removed to save space. See Appendix)
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
</table>

### 1.2 Objective(s)

**Purpose:** The purpose of the objective(s) process is to create and communicate objective(s) based on the vision and derived goals.

**Outcomes:** As a result of the successful implementation of the objective(s) process:

1. Practical objective(s) for goal(s) achievement are developed.  
   - Former Outcome 5 from Process 1.1 Vision

2. Positive expectation for achieving objective(s) is encouraged.  
   - Former Outcome 6 from Process 1.1 Vision

*Outcome 1 – from the shared vision and subsequent goals described in the previous Process a set of practically-worded objectives are developed that give the team a concrete set of outcomes to achieve.*

(Reminder removed to save space. See Appendix)

### 1.2 Integrity & competence

#### 1.3 Integrity

Remove ‘competence’ from title, since it can be said to be an attribute of integrity.
### Purpose:
The purpose of the integrity and competence process is to consistently act with integrity and competence over time in pursuit of the shared vision.

### Outcomes:
As a result of the successful implementation of the integrity and competence process:

1. Integrity is consistently practiced.
2. Competence is consistently exhibited.

### Informative Notes
Outcome 1 – the leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle.

(Remainder removed to save space. See Appendix)

---

### 1.2 INTEGRITY

<table>
<thead>
<tr>
<th>1.2</th>
<th>Practices / Demonstrates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2.1</td>
<td>Competence</td>
</tr>
</tbody>
</table>

### Purpose:
The purpose of the integrity process is to consistently act with integrity and competence over time in pursuit of the vision.

### Outcomes:
As a result of the successful implementation of the integrity process:

1. Integrity is consistently practiced.
2. Competence is consistently exhibited.

### Informative Notes
Outcome 1 – the leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle.

(Remainder removed to save space. See Appendix)

---

### 1.3 ACTION-ORIENTATION & RESILIENCE

**Purpose:** The purpose of the action and resilience process is to be inclined towards action and resilience.

<table>
<thead>
<tr>
<th>1.3</th>
<th>ACTION-ORIENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3.1</td>
<td>Objective-achieving behavior</td>
</tr>
</tbody>
</table>

### 1.4 ACTION-ORIENTATION

**Purpose:** The purpose of the action-orientation process is to be inclined towards action and resilience.

---

1. Remove 'and competence'.
2. Remove 'and competence'.
3. Add this to the outcome 2 informative material: 'Competence in this context can be seen as an aspect of integrity in that it would be dishonest of an incompetent leader to act in a capacity that requires competence.'
4. Remove 'resilience' from title, since it can be said to be an attribute of action-orientation.
### Outcomes

As a result of the successful implementation of the action-orientation and resilience process:

1. Objective-achieving behavior is decisively pursued.
2. Objective-frustrating events are met with resilience.
3. Viability of continuing pursuit of current objective(s) is evaluated.

**Informative Notes**

Outcome 1 – the leader consistently displays the ability to think and act decisively in pursuit of objective(s).

(Remainder removed to save space. See Appendix)

### 1.4 Intelligence

**Purpose:**

The purpose of the intelligence process is to apply appropriate cognitive resources in the achievement of goals.

**Outcomes:**

As a result of the successful implementation of the intelligence process:

<table>
<thead>
<tr>
<th>1.4</th>
<th>INTELLIGENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4.1</td>
<td>Original thinking</td>
</tr>
<tr>
<td>1.4.2</td>
<td>Realistic perception</td>
</tr>
<tr>
<td>1.4.3</td>
<td>Objective-achieving behavior</td>
</tr>
</tbody>
</table>

### 1.5 Intelligence

**Purpose:**

The purpose of the intelligence process is to apply appropriate cognitive resources in the achievement of goals.

**Outcomes:**

As a result of the successful implementation of the intelligence process:

1. Objective-achieving behavior is decisively pursued.
2. Objective-frustrating events are met with resilience.
3. Viability of continuing pursuit of current objective(s) is evaluated.

**Informative Notes**

Outcome 1 – the leader consistently displays the ability to think and act decisively in pursuit of objective(s).

(Remainder removed to save space. See Appendix)
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Original thinking in team-members is facilitated.</td>
<td>1. Original thinking in team-members is facilitated.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Situations are realistically understood.</td>
<td>2. Situations are realistically understood.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Cause(s) of objective-achieving outcomes are generated.</td>
<td>3. Cause(s) of objective-achieving outcomes are generated.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – the leader encourages a high-level of original thinking in the team, enabling new solutions to problems to be developed, unbound by the orthodoxy. This can be achieved by explicitly encouraging thinking beyond the conventional, setting the expectation that this will be so. The leader can reward original thinking. In short, it becomes a group-norm.

(Remainder removed to save space. See Appendix)

**1.5 Individualized consideration**

Purpose: The purpose of the individualized consideration process is to convey to team-members their value as individuals.

<table>
<thead>
<tr>
<th>1.5 INDIVIDUALIZED CONSIDERATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5.1 Members valued</td>
</tr>
<tr>
<td>1.5.2 Unified team</td>
</tr>
</tbody>
</table>

**1.6 Individualized consideration**

Purpose: The purpose of the individualized consideration process is to convey to team-members their value as individuals.

No change required (except new sequence number)
Outcomes: As a result of the successful implementation of the individualized consideration process:

1. Individual team-members are valued.
2. Individual team-members are unified into team.
3. Empathy towards individual team-members is practiced.
4. Objective-achieving team behavior is rewarded.

Informative Notes
Outcome 1 – the leader manifests an understanding of team-members within a mind-set of respect. This leads to a valuing of the member as an individual. On perceiving this mind-set in the leader, the member’s commitment is reinforced.

(Remainder removed to save space. See Appendix)

1.6 Management-by-exception

1.7 Management-by-exception
### Purpose:
The purpose of the management-by-exception process is to empower team-members to act independently until and unless non-compliance of standards has occurred.

### Outcomes:
As a result of the successful implementation of the management by exception process:

1. Independent team behavior that is objective-achieving is encouraged.
2. Non-objective-achieving team behavior is corrected.

#### Informative Notes
Outcome 1 – when the team is doing their job the leader leaves them alone. In effect, the leader does not give the impression of being a ‘micro-manager’. If the team is inexperienced, coaching of specific skills towards objective(s) achievement is warranted. The leader should evaluate the potential negative impact of such coaching before performing.

(Remainder removed to save space. See Appendix)

<table>
<thead>
<tr>
<th>1.6</th>
<th>MANAGEMENT BY EXCEPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6.1</td>
<td>Independence when objective-achieving</td>
</tr>
<tr>
<td>1.6.2</td>
<td>Correction when non-objective-achieving</td>
</tr>
</tbody>
</table>

#### Informative Notes
Outcome 1 – when the team is doing their job the leader leaves them alone. In effect, the leader does not give the impression of being a ‘micro-manager’. If the team is inexperienced, coaching of specific skills towards objective(s) achievement is warranted. The leader should evaluate the potential negative impact of such coaching before performing.

(Remainder removed to save space. See Appendix)

### 1.7 Team recruitment

### 1.8 Team recruitment
### V0.5B PRM

**Purpose:** The purpose of the team recruitment process is to recruit persons with skills appropriate to the achievement of project goals.

**Outcomes**

As a result of the successful implementation of team recruitment process:

1. Team members with appropriate skills are recruited.

---

**Informative Notes**

Outcome 1 – the leader recruits team members with the requisite skills for the project under consideration. Where the project is complex, a more diverse set of team-member skills will be needed.

(remainder removed to save space. See Appendix)

### V0.6 PRM

**Purpose:** The purpose of the team recruitment process is to recruit persons with skills appropriate to the achievement of project goals.

**Outcomes**

As a result of the successful implementation of team recruitment process:

1. Team members with appropriate skills are recruited.

---

**Informative Notes**

Outcome 1 – the leader recruits team members with the requisite skills for the project under consideration. Where the project is complex, a more diverse set of team-member skills will be needed.

(remainder removed to save space. See Appendix)

### 1.8 Team environment

**Purpose:** The purpose of the team environment process is to establish the project's work environment.

**Outcomes**

As a result of the successful implementation of the team environment process:

1. Infrastructure provided

---

**Purpose:** The purpose of the team environment process is to establish the project's work environment.

**Outcomes**

As a result of the successful implementation of the team environment process:

1. Infrastructure provided

---

**Action**

No change required (except new sequence number)
1. Appropriate physical infrastructure and facilities are provided.

Note 1.8.2 & 3 above come from supplementary Process 2.1 Integrated team environment, and supplementary Process 3.1 Virtual team environment. Both outcomes are common to both supplementary processes.

Informative Notes
Outcome 1 – team environment is defined broadly to include all required physical infrastructure and supporting facilities; from office space to computer and photocopiers (etc).

(Remainder removed to save space. See Appendix)

1.9 Team structure

Purpose: The purpose of the team structure process is to create a flexible, goal-oriented team structure.

Outcomes: As a result of the successful implementation of the team structure process:

1. Objective-aligned team structure is established.

1.10 Team structure

Purpose: The purpose of the team structure process is to create a flexible, goal-oriented team structure.

Outcomes: As a result of the successful implementation of the team structure process:

1. Objective-aligned team structure is established.
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Adaptable team structure is established.</td>
<td></td>
<td>2. Adaptable team structure is established.</td>
<td></td>
</tr>
<tr>
<td>3. Appropriate team roles are assigned.</td>
<td></td>
<td>3. Appropriate team roles are assigned.</td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – the leader establishes a team structure that is broadly consistent with the project’s objectives and requirements.

(Remainder removed to save space. See Appendix)

### 1.10 Team requirements

**Purpose:** The purpose of the team requirements process is to allocate project requirements to teams.

**Outcomes:** As a result of the successful implementation of team requirements process:

<table>
<thead>
<tr>
<th>1.0 TEAM REQUIREMENTS</th>
<th>1.0.1 Verified requirements</th>
<th>1.0.2 Appointed sponsors</th>
</tr>
</thead>
</table>

### 1.11 Team requirements

**Purpose:** The purpose of the team requirements process is to allocate project requirements to teams.

**Outcomes:** As a result of the successful implementation of team requirements process:

1. Team structure is verified.
2. Team sponsor(s) are appointed.
### 1.11 Team formation

**Purpose:** The purpose of the team formation process is to constitute the team structure.

**Outcomes:** As a result of the successful implementation of the team formation process:

1. Team structure consistent with project requirements is established.
2. Team leaders consistent with requirements are appointed.
3. Team charter consistent with requirements is established.
4. Resources consistent with project requirements are allocated.

### 1.12 Team formation

**Purpose:** The purpose of the team formation process is to constitute the team structure.

**Outcomes:** As a result of the successful implementation of the team formation process:

1. Team structure consistent with project requirements is established.
2. Team leaders consistent with requirements are appointed.
3. Team charter consistent with requirements is established.
4. Resources consistent with project requirements are allocated.
Informative Notes
Outcome 1 – the leader delegates to team sponsor(s) the task of recruiting and organising team(s) that are organised appropriately for the project requirements.
(Remainder removed to save space. See Appendix)

<table>
<thead>
<tr>
<th>1.12 Team roles</th>
<th>1.13 Team roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose: The purpose of the virtual team roles process is to define member roles.</td>
<td>Purpose: The purpose of the virtual team roles process is to define member roles.</td>
</tr>
<tr>
<td>No change required (except new sequence number)</td>
<td></td>
</tr>
<tr>
<td>Outcomes: As a result of the successful implementation of the team roles process:</td>
<td>Outcomes: As a result of the successful implementation of the team roles process:</td>
</tr>
<tr>
<td>1. Team member roles are understood.</td>
<td>1. Team member roles are understood.</td>
</tr>
<tr>
<td>2. Contingency plans for team member absences are developed.</td>
<td>2. Contingency plans for team member absences are developed.</td>
</tr>
</tbody>
</table>

1.12 TEAM ROLES

<table>
<thead>
<tr>
<th>1.12</th>
<th>TEAM ROLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.12.1</td>
<td>Understood</td>
</tr>
<tr>
<td>1.12.2</td>
<td>Flexible</td>
</tr>
<tr>
<td>1.12.3</td>
<td>Singular in synchronous</td>
</tr>
<tr>
<td>1.12.4</td>
<td>Singular and/or multiple in asynchronous</td>
</tr>
</tbody>
</table>

Note 1.12.3 and 4 above come from supplementary Process 3.2 Virtual team roles. Both supplementary processes.
### 1.13 Team rules

**Purpose:** The purpose of the team rules process is to establish rules for optimal integrated teams conduct in support of goals.

**Outcomes:** As a result of the successful implementation of the team rules process:

1. Criteria for optimal team performance in support of objectives are established.
2. Empowered operating conduct for optimal team performance in support of objectives is established.

<table>
<thead>
<tr>
<th>1.13</th>
<th>TEAM RULES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.13.1</td>
<td>Optimised performance</td>
</tr>
<tr>
<td>1.13.2</td>
<td>Empowerment</td>
</tr>
</tbody>
</table>

### 1.14 Team rules

**Purpose:** The purpose of the team rules process is to establish rules for optimal integrated teams conduct in support of goals.

**Outcomes:** As a result of the successful implementation of the team rules process:

1. Criteria for optimal team performance in support of objectives are established.
2. Empowered operating conduct for optimal team performance in support of objectives is established.

No change required (except new sequence number)
### 1.14 Team boundaries

**Purpose:** The purpose of the team boundaries process is to manage team boundaries.

**Outcomes:** As a result of the successful implementation of the team boundaries process:

1. Team boundaries are managed.
2. Blended team culture is facilitated.

### 1.15 Team boundaries

**Purpose:** The purpose of the team boundaries process is to manage team boundaries.

**Outcomes:** As a result of the successful implementation of the team boundaries process:

1. Team boundaries are managed.
2. Blended team culture is facilitated.
Informative Notes
Outcome 1 – the leader ensures that boundaries concerning functional, organisational, and cultural matters are maintained in a stable and well-defined manner. The more complex the project, the more important that role boundary definition is stable and well-understood by all, thus minimising the potential for confusion.
(Remainder removed to save space. See Appendix).

1.15 Team authority & decision-making

Purpose: The purpose of the team authority and decision-making process is to create efficiently functioning teams by establishing mechanisms that allows team leaders and members to recognise clear channels of responsibility.

Outcomes: As a result of the successful implementation of establishing team authority and decision-making mechanisms:

1. Clear channels of responsibility are established.

1.16 Team authority

Purpose: The purpose of the team authority process is to create efficiently functioning teams by establishing mechanisms that allows team leaders and members to recognise clear channels of responsibility.

Outcomes: As a result of the successful implementation of establishing team authority mechanisms:

1. Clear channels of responsibility are established.

Remove 'decision-making' because it is an attribute of Team authority.
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Responsibilities are understood.</td>
<td></td>
<td>2. Responsibilities are understood.</td>
<td></td>
</tr>
<tr>
<td>3. Team authority and decision-making mechanisms are understood.</td>
<td></td>
<td>3. Team authority and decision-making mechanisms are understood.</td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – the leader creates clear and unambiguous channels of authority and responsibility within the team hierarchy (team leaders and members).

(Remainder removed to save space. See Appendix)

---

**1.16 Team collaboration**

**Purpose:** The purpose of the team collaboration process is to ensure effective collaboration among interfacing teams elements.

<table>
<thead>
<tr>
<th>1.16</th>
<th>TEAM COLLABORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.16.1</td>
<td>Environment exists</td>
</tr>
<tr>
<td>1.16.2</td>
<td>Interface collaboration</td>
</tr>
</tbody>
</table>

Note 1.16.2 above comes from supplementary Process 2.2. Interfacing team collaboration

---

**1.17 Team collaboration**

**Purpose:** The purpose of the team collaboration process is to ensure effective collaboration among interfacing teams elements.

**Outcomes:** As a result of the successful implementation of team collaboration process:

| 1. Environment for collaboration is established. |

---

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### 1.17 Team performance management

**Purpose:** The purpose of the team performance process is to manage team performance through the development of empowered performance-management functions that allow team members to manage themselves.

**Outcomes:** As a result of the successful implementation of the virtual team performance management process:

1. Self-managing performance functions are developed.
2. High-capability self-managing performance functions for complex asynchronous tasks are developed.

*Note: 1.17.4 above comes from supplementary Process 3.3 Virtual team performance management.*

### 1.18 Team performance management

**Purpose:** The purpose of the team performance process is to manage team performance through the development of empowered performance-management functions that allow team members to manage themselves.

**Outcomes:** As a result of the successful implementation of the virtual team performance management process:

1. Self-managing performance functions are developed.
2. High-capability self-managing performance functions for complex asynchronous tasks are developed.
### 3. Anticipatory self-management functions for proactive adaptation to change are developed.

#### Informative Notes

**Outcome 1** – the leader develops explicit performance management functions early in the project lifecycle that allow team members to self-manage their performance. Self-management is defined broadly, and might include methods such as the daily team scrum to create a mind-set that help members synchronise their individual efforts for the rest of the day.

(Reminder removed to save space. See Appendix)

#### 1.18 Team development & coherence

**Purpose:** The purpose of the team development and coherence process is to establish team development functions to promote productivity and coherence.

**Outcomes:** As a result of the successful implementation of the team development and coherence process:

<table>
<thead>
<tr>
<th>1.18 TEAM DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.18.1 Development practices for coherence</td>
</tr>
<tr>
<td>1.18.2 Stable membership</td>
</tr>
</tbody>
</table>

#### 1.19 Team development

**Purpose:** The purpose of the team development process is to establish team development functions to promote productivity and coherence.

**Outcomes:** As a result of the successful implementation of the team development process:

- Coherence' removed because attribute of 'Team development'
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Development practices for team coherence are established.</td>
<td></td>
<td>1. Development practices for team coherence are established.</td>
<td></td>
</tr>
<tr>
<td>2. Stable team membership is maintained.</td>
<td></td>
<td>2. Stable team membership is maintained.</td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes**

Outcome 1 – the leader of both short-term and long-term projects establishes effective team development functions early in the project lifecycle. In the case of short-term projects, this facilitates the timely completion of the project. With long-term projects, this facilitates the establishment of long-term working relationships and complex workflow arrangements.

(remainder removed to save space. See Appendix)

**1.19 Team and home organization balance**

**Purpose:** The purpose of the team and home organization process is to balance integrated team and home organization responsibilities.

**Outcomes:** As a result of the successful implementation of the integrated and home team balance process:

<table>
<thead>
<tr>
<th>1.19</th>
<th>TEAM &amp; HOME ORG BALANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.19.1 Guidelines</td>
<td></td>
</tr>
</tbody>
</table>

**1.20 Team and home organization balance**

**Purpose:** The purpose of the team and home organization process is to balance integrated team and home organization responsibilities.

**Outcomes:** As a result of the successful implementation of the integrated and home team balance process:

---

Doctor of Philosophy Thesis, David Tuffley, Griffith University, 2009
<table>
<thead>
<tr>
<th>V0.5B PRM</th>
<th>Composition Tree notation analysis</th>
<th>V0.6 PRM</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Guidelines for balancing team and home organization responsibilities are established.</td>
<td></td>
<td>1. Guidelines for balancing team and home organization responsibilities are established.</td>
<td></td>
</tr>
</tbody>
</table>

**Informative Notes**

*Outcome 1 – the leader provides guidelines that make clear how team-leaders and members can successfully balance their responsibilities to both team and home organisation. (Remainder removed to save space. See Appendix)*

<table>
<thead>
<tr>
<th>Informative Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Outcome 1 – the leader provides guidelines that make clear how team-leaders and members can successfully balance their responsibilities to both team and home organisation.</em> (Remainder removed to save space. See Appendix)</td>
</tr>
</tbody>
</table>

Table 38: Stage 6 (V0.5B to V0.6) representative composition tree review part 1
### 7.8.2. Composition Tree notation analysis: part 2 (vocabulary)

In part 2, the components and attributes are aggregated to determine where linkages between components and attributes exist. This gives a tabular indication of how the various components and attributes are connected.

<table>
<thead>
<tr>
<th>COMPONENT &amp; Attribute</th>
<th>Linkages to other COMPONENTS and/or Attributes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1 VISION</strong></td>
<td></td>
</tr>
<tr>
<td>1.1.1 Exists</td>
<td></td>
</tr>
<tr>
<td>1.1.2 Shared</td>
<td></td>
</tr>
<tr>
<td>1.1.3 Committed</td>
<td></td>
</tr>
<tr>
<td>1.1.4 Resilient</td>
<td>1.3.2</td>
</tr>
<tr>
<td>1.1.5 Objectives</td>
<td>1.4.3</td>
</tr>
<tr>
<td>1.1.6 Positive Expectation</td>
<td></td>
</tr>
<tr>
<td><strong>1.2 INTEGRITY</strong></td>
<td></td>
</tr>
<tr>
<td>1.2.1 Practices / Demonstrates</td>
<td></td>
</tr>
<tr>
<td>1.2.2 Competence</td>
<td></td>
</tr>
<tr>
<td><strong>1.3 ACTION-ORIENTATION</strong></td>
<td></td>
</tr>
<tr>
<td>1.3.1 Objective-achieving behavior</td>
<td></td>
</tr>
<tr>
<td>1.3.2 Resilience</td>
<td></td>
</tr>
<tr>
<td>1.3.3 Viability</td>
<td></td>
</tr>
<tr>
<td><strong>1.4 INTELLIGENCE</strong></td>
<td></td>
</tr>
<tr>
<td>1.4.1 Original thinking</td>
<td></td>
</tr>
<tr>
<td>1.4.2 Realistic perception</td>
<td></td>
</tr>
<tr>
<td>1.4.3 Objective-achieving behavior</td>
<td>1.1.5, 1.9.2</td>
</tr>
<tr>
<td><strong>1.5 INDIVIDUALIZED CONSIDERATION</strong></td>
<td></td>
</tr>
<tr>
<td>1.5.1 Members valued</td>
<td></td>
</tr>
<tr>
<td>1.5.2 Unified team</td>
<td>1.8 to 1.19</td>
</tr>
<tr>
<td>1.5.3 Empathy</td>
<td></td>
</tr>
<tr>
<td>1.5.4 Reward</td>
<td></td>
</tr>
<tr>
<td><strong>1.6 MANAGEMENT BY EXCEPTION</strong></td>
<td>1.17, 1.17.1 to 1.17.4</td>
</tr>
</tbody>
</table>
1.6.1  Independence when objective-achieving

1.6.2  Correction when non-objective-achieving

1.7  TEAM RECRUITMENT

1.7.1  Appropriate skills

1.8  TEAM ENVIRONMENT

1.8.1  Infrastructure

1.8.2  On-demand, synchronous, hi-res ICT provided

1.8.3  On-demand, synchronous, hi-res ICT used

1.9  TEAM STRUCTURE

1.9.1  Objective-aligned

1.9.2  Adaptable

1.9.3  Roles

1.10  TEAM REQUIREMENTS

1.10.1  Verified requirements

1.10.2  Appointed sponsors

1.11  TEAM FORMATION

1.11.1  Appropriate structure

1.11.2  Team leader(s)

1.11.3  Team charter

1.11.4  Resources

1.12  TEAM ROLES

1.12.1  Understood

1.12.2  Flexible

1.12.3  Singular in synchronous

1.12.4  Singular and/or multiple in asynchronous

1.13  TEAM RULES

1.13.1  Optimised performance

1.13.2  Empowerment

1.14  TEAM BOUNDARIES

1.14.1  Managed

1.14.2  Blended culture

1.15  TEAM AUTHORITY
1.15.1 Channels of responsibility
1.15.2 Responsibilities understood
1.15.3 Decision-making authority understood

1.16 TEAM COLLABORATION
1.5.2, 1.16.2
1.16.1 Environment exists
1.8
1.16.2 Interface collaboration
1.16

1.17 TEAM PERFORMANCE MANAGEMENT
1.5.2, 1.13.1
1.17.1 Self-managing
1.17.1 to.4
1.17.2 Hi-capability self-manage when complex
1.17.1 to.4
1.17.3 Anticipatory self-management
1.17.1 to.4
1.17.4 Hi-capability self-manage across complex boundaries
1.14, 1.17.1 to.4

1.19 TEAM & HOME ORG BALANCE
1.5.2
1.19.1 Guidelines

Table 39: Stage 6 (V0.5B to V0.6) composition tree review part 2

7.9. Version 1.0 PRM

Version 1.0 of the PRM emerges from the six review stages outlined in detail in this chapter. Unlike the previous data tables in this Chapter, the table below shows the PRM in its entirety. V1.0 is a starting from which the PRM can be applied and reviewed by participant project managers. It is a work-in-progress and is expected to evolve.

Version 1.0 contains the required introductory material prescribed by ISO/IEC 15504 and 24774 as being necessary for inclusion on PRMs.

V1.0 PRM

Title: Leadership of integrated virtual teams (LIVT-PRM)

Domain: The LIVT- PRM is intended for use primarily in the software engineering domain by project managers seeking to effectively lead complex virtual teams.

Scope: The LIVT- PRM defines the activities that characterise effective leadership in integrated virtual environments.
# V1.0 PRM


**Process description**: The processes are described in accordance with ISO/IEC 15504-2:2003 Section 6.2.3 and 6.2.4, namely:

- **a)** a process shall be described in terms of its purpose and outcomes;
- **b)** in any process description the set of process outcomes shall be necessary and sufficient to achieve the purpose of the process;
- **c)** process descriptions shall be such that no aspects of the measurement framework as described in Clause 5 of this International Standard beyond level 1 are contained or implied.

**Community of interest**: The specific community of interest for the LIVT-PRM are practicing and aspiring project managers of complex virtual teams operating in a technology development environment. In general terms, the LIVT-PRM contains no software engineering specific terms that would restrict its use to that domain only. It is therefore applicable more broadly to complex virtual teams operating in other engineering domains, and indeed non-engineering domains.

**Model architecture**: 20 generic leadership processes applicable to any situation requiring leadership. The generic processes are supplemented by two integrated and three virtual team leadership processes; these supplementary processes all have a generic component present as one of the 20 generic processes. When the situation requires either/or integrated and virtual leadership, these supplementary practices are applied.

**Explanatory note**: the outcomes of the LIVT-PRM are applicable at an individual (personal factors), team and organisational level. Outcomes in the latter two levels describe aspects of desired team and organisational behavior that, if performed repeatedly, will result in consistently achieving the prescribed purpose. The leader has responsibility for achieving all outcomes regardless of which level they apply to. This re-focuses attention from conformance to prescribed activities and tasks, to a focus on demonstration of desired organizational behavior which takes us away from the traditional role of a PRM. The LIVT-PRM represents a new category of process reference model, described provisionally as a Reference Model for Organisational Behavior.

## 1. Generic team leadership factors

**Purpose**: The purpose of the generic team leadership factors is to elaborate the basic leadership factors required of any leader (including co-located, virtual, integrated).

**Outcomes**: As a result of the successful implementation of Generic leadership processes the degree to which a leader embodies such processes and is able to practice them may be identified.
Informative Notes: generic leadership skills form a basis for closer examination of leadership factors in integrated teams operating in virtual environments. This foundational layer is built upon with specific factors relating to leadership in integrated teams, and specific challenges facing leaders of virtual teams.

What is the difference between managers and leaders? Abraham Zeleznik suggests that the differences between managers and leaders lie at a deep level of the human psyche. Attitudes towards chaos and order are the basis of the difference. A manager aims for stability and control, seeking to resolve problems quickly, sometimes at the cost of understanding the nature of the problem fully. Leaders, by contrast, accept or at least tolerate chaos and lack of structure so that they might perceive and come to understand the underlying causes of situations. In this sense, Zeleznik argues, leaders have more in common with creative thinkers like artists and scientists than they do with managers.

1.1 Vision

Purpose: The purpose of the vision process is to create and communicate a shared vision in ways that inspires people to realise that vision.

Outcomes: As a result of the successful implementation of shared vision process:

1. A vision of the goal(s) is created.

2. The vision of the goal(s) is communicated to the team.

3. Commitment by team to the shared vision is gained.
Informative Notes

Outcome 1 – the vision of the goal is seen by the leader as achievable. The goals will still be abstract at this point. The goal(s) become concrete when translated into objective(s).

Outcome 2 – the shared vision should be communicated in a way that creates positive expectation among the team.

Outcome 3 – the way in which the shared vision of the abstract goal(s) is communicated should generate strong commitment to the achievement of the goal(s)

General:
The shared vision is a clear and unambiguous expression of an envisioned future. It is the basis for a common understanding among stakeholders of the aspirations and governing ideals of the team in the context of that desired outcome. Conditional on being effectively communicated by the leader to the team, the shared vision grounds the team’s governing ideas and principles and allows for appropriate objectives to be derived.

Highly effective groups are often convinced they are engaged in important work, sometimes nothing short of being on a ‘mission from God’. The work becomes an abiding obsession, a quest that goes well beyond mere employment. This intensely shared vision and sense of purpose endows cohesion and persistence.

Creating and communicating a compelling vision of the future is an aspect of charisma; inspirational motivation, optimism, individualized consideration and contingent reward all appear to optimise team performance by creating a positive affective climate.

In summary when promulgating a shared vision, the following factors should be considered:

1. the project’s objectives
2. the conditions and outcomes the project will create
3. interfaces the project needs to maintain
4. the visions created by interfacing groups
5. the constraints imposed by outside authorities (e.g., environmental regulations)

1.2 Objective(s)

Purpose: The purpose of the objective(s) process is to create and communicate objective(s) based on the vision and derived goals.

Outcomes: As a result of the successful implementation of the objective(s) process:

1. Practical objective(s) for goal(s) achievement are developed.
2. Positive expectation for achieving objective(s) is encouraged.
Informative Notes
Outcome 1 – from the shared vision and subsequent goals described in the previous Process a set of practically-worded objectives are developed that give the team a concrete set of outcomes to achieve.
Outcome 2 – having developed concretely-worded objectives, the leader generates in the team an optimistic mind-set and outlook towards the achievement of the objectives

General:
Once the leader has developed a compelling vision of what is to be accomplished, and managed to communicate it in a way that generates enthusiasm and commitment by the team, the leader, in consultation with team members if practical, develops a set of practically-worded objective(s) of what is to be achieved.

1.3 Integrity

Purpose: The purpose of the integrity process is to consistently act with integrity and competence over time in pursuit of the vision.

Outcomes: As a result of the successful implementation of the integrity process:

1. Integrity is consistently practiced.
2. Competence is consistently exhibited.

Informative Notes
Outcome 1 – the leader consistently displays integrity, characterised by openness to truth, trustworthiness, and adherence to principle.
Outcome 2 – the leader manifests competence, characterised by technical and interpersonal skills, and advanced conceptual and reasoning skills. Competence in this context can be seen as an aspect of integrity in that it would be dishonest of an incompetent leader to act in a capacity that requires competence.

General
Principle-centred leadership creates a climate in which team members can rely on a leader to act according to guiding principle rather than exigent circumstances. Involves doing the ‘right thing’ all of the time, even when it is easier not to under the circumstances.

Such a leader leads by example, leads by having an open, enlightened mind, leads by remaining true to him/herself. Such a person is a natural leader, one who is respected and whose example is followed. The antithesis is the tyrant who is closed-minded and who uses force to make people cooperate.

Such a leader acts from a sense of oneness with those being led. This sense of oneness is cultivated in a general sense by learning to recognise the interdependence and connectedness of the group members.

Such a leader avoids using unnecessary force to achieve ends, understanding that to do so create a new set of problems.

Self-worth is encouraged when the leader minimises the perceived distance between their sense of their own position and the position of those they lead. By identifying with the group members the leader can better understand the psychological needs of the members, and so their decisions are more aligned with those needs. By extension, an effective leader might go so far as to practice humility as a way of engendering the trust and respect of the group members. The interests of the members are naturally promoted because they are the interests of the leader as well. Therefore, effective leaders win the confidence of group members because the members sense the leader’s identification with them.
1.4 Action-orientation

Purpose: The purpose of the action-orientation process is to be inclined towards action and resilience.

Outcomes: As a result of the successful implementation of the action-orientation:

1. Objective-achieving behavior is decisively pursued.
2. Objective-frustrating events are met with resilience.
3. Viability of continuing pursuit of current objective(s) is evaluated.

Informative Notes

Outcome 1 – the leader consistently displays the ability to think and act decisively in pursuit of objective(s).

Outcome 2 – the leader consistently displays a willingness to try again until success is achieved when progress is frustrated.

General

Action-oriented leaders are able to overcome the inertia and disincentives that reside in situations that others might succumb to. Action-orientation is particularly relevant in goal-frustrating situations when others might give up.

Action-oriented implies taking action when necessary, and refraining from action when none is required – the ‘leave well-enough alone’ principle. In this way, a leader creates confidence in the group by being calm and in control.

Leaders are more likely to develop resilience when their guiding vision (that they have communicated effectively to the group) is sufficiently strong to supersede the alternative situation that has been imposed on them, and which threatens the realization of the goal. It is having the integrity of character to remain true to the original goal in the face of adversity.

1.5 Intelligence

Purpose: The purpose of the intelligence process is to apply appropriate cognitive resources in the achievement of goals.

Outcomes: As a result of the successful implementation of the intelligence process:

1. Original thinking in team-members is facilitated.
2. Situations are realistically understood.
3. Cause(s) of objective-achieving outcomes are generated.
Informative Notes

Outcome 1 – the leader encourages a high-level of original thinking in the team, enabling new solutions to problems to be developed, unbound by the orthodoxy. This can be achieved by explicitly encouraging thinking beyond the conventional, setting the expectation that this will be so. The leader can reward original thinking. In short, it becomes a group-norm.

Outcome 2 – the leader displays a realistic understanding of situations, which enables appropriate action to be taken. Appropriate in this sense means achievement of objectives.

Outcome 3 – the leader takes responsibility for outcomes by consciously generating the circumstances or causes that lead to the events and outcomes that support objectives achievement. In other words, generating the right conditions for objectives to be achieved.

General

Abstract conceptualization allows a leader to mentally manipulate abstractions in problem-solving, efficiency-enhancing ways. This ability is related to the ability to create a unifying vision for the project, which can be seen as a higher level abstract conceptualization skill. The skill being discussed in this process relates more to how to make it happen.

Without necessarily dispensing with the benefits of accumulated experience and lessons learned, creative, unorthodox thinking can lead to solutions that elude conventional thinking. Persistent problems often require new ways of thinking. Original thinkers are not so influenced by the opinions of those that say ‘it cannot be done’, they are more likely to think ‘we haven’t thought of a solution yet’. It is to be free from the restraints of tradition - the ‘wisdom of the ages’ that can sometimes be a straitjacket for the mind. A leader who brings this approach to leadership allows the team to function naturally, in proper response to the conditions in which it finds itself. A tradition-bound leader will base his decisions on precedent ‘what did my predecessors do in this situation’. These prefabricated responses lack insight and run a high risk of not being appropriate for the situation at hand.

Good judgment is a fundamental ability that informs almost all of a leader’s activities. It is the foundation of appropriate action. Good judgment is conditional upon a rational, objective mind-set in which people, objects and events are viewed realistically for what they are in any particular set of circumstances, rather than relying on stereotypes and prescribed understandings to guide action.

Accepting responsibility requires the courage to accept the truth/reality of a situation, even when it is unpleasant. Effective leaders accept that the circumstances in which they find themselves are largely the result of their own previous actions. They do not blame others (Macaluso, 2003). They are able to see the linkages between cause and effect, how their behavior affects corporate vision and how their leadership can affect the profitability of the organisation. Effective leaders are proactive, rather than reactive, taking the initiative to improve matters (Macaluso, 2003).

1.6 Individualized consideration

Purpose: The purpose of the individualized consideration process is to convey to team-members their value as individuals.

Outcomes: As a result of the successful implementation of the individualized consideration process:

1. Individual team-members are valued.
2. Individual team-members are unified into team.
3. Empathy towards individual team-members is practiced.
4. Objective-achieving team behavior is rewarded.

**Informative Notes**

**Outcome 1** – the leader manifests an understanding of team-members within a mind-set of respect. This leads to a valuing of the member as an individual. On perceiving this mind-set in the leader, the member’s commitment is reinforced.

**Outcome 2** – the leader engenders a sense of unity in the team. A ‘group-mind’ that thinks as one mind. Team-members performance is enhanced by this sense of oneness with the team.

**Outcome 3** – the leader empathises with team members to understand their individual experiences and situation. This ability to place oneself ‘in the shoes of another’ reinforces the perception in the team-member that they are understood and valued.

**Outcome 4** – the leader encourages goal-achieving behavior in team by rewarding such behavior. By implication negative reinforcement is avoided unless absolutely necessary. The absence of positive reinforcement functions in place of negative, and avoids resentment build-up in team-members.

**General**

Team members recognize that the leaders to some extent know them as an individual. The antithesis of this is a team member who feels that the leader regards them as mere units of production, expendable.

An aspect of original thinking is the ability to recognize the individual talents of team members, and unite them into a single enterprise.

Empathy is distinct from sympathy. Sympathy involves becoming emotionally attached to people and outcomes, whereas empathy is dispassionate, non-judgmental. An analogy from the medical domain is that of a doctor using empathy to accurately understand a patient’s condition/situation. The doctor cannot sympathise with the patient, unless they are to risk becoming overwhelmed by the suffering they encounter in the course of a day.

In behavioral psychology terms, rewarding desirable performance implies positive reinforcement for desirable behavior. A common mistake is to take desirable performance for granted, effectively ignoring it, while taking action to punish when undesirable performance occurs. While necessary to do the latter on occasion, it must be remembered that the leader’s attention is a reward in itself and adopting a reward for desirable performance approach shows significant benefits.

**1.7 Management-by-exception**

**Purpose:** The purpose of the management-by-exception process is to empower team-members to act independently until and unless non-compliance of standards has occurred.

**Outcomes:** As a result of the successful implementation of the management by exception process:

1. Independent team behavior that is objective-achieving is encouraged.

2. Non-objective-achieving team behavior is corrected.
Informative Notes
Outcome 1 – when the team is doing their job the leader leaves them alone. In effect, the leader does not give the impression of being a ‘micro-manager’. If the team is inexperienced, coaching of specific skills towards objective(s) achievement is warranted. The leader should evaluate the potential negative impact of such coaching before performing.
Outcome 2 – the leader takes action to correct the behavior of team members when they engage in non-objective-achieving behavior. When they have gotten ‘off the track’ or gone ‘off on a tangent’. This corrective action must be done with an attitude of respect, and should not resemble negative reinforcement except in extreme or repetitive instances.

General
The ‘reward desirable performance’ process notwithstanding, under some circumstances, it is appropriate to operate on a management by exception basis. This empowered approach is appropriate when a member is expected to act independently, with a degree of autonomy. The member might be a sub-contractor who maintains a professional approach to his/her work and can be relied upon to perform professionally and to a high standard.

1.8 Team recruitment

Purpose: The purpose of the team recruitment process is to recruit persons with skills appropriate to the achievement of project goals.

Outcomes: As a result of the successful implementation of team recruitment process:

1. Team members with appropriate skills are recruited.

Informative Notes
Outcome 1 – the leader recruits team members with the requisite skills for the project under consideration. Where the project is complex, a more diverse set of team-member skills will be needed.

General
Geographically dispersed, complex and/or co-located teams will normally require a broad base of potential expertise to be drawn upon when assembling a team. This is particularly true when the task to be performed is a complex one.

1.9 Team environment

Purpose: The purpose of the team environment process is to establish the project’s work environment.

Outcomes: As a result of the successful implementation of the team environment process:

1. Appropriate infrastructure is provided.

Informative Notes
Outcome 1 – team environment is defined broadly to include all required physical infrastructure and supporting facilities; from office space to computer and photocopiers (etc).

General
Team members must be in a position to communicate with each other in ways that approximate normal face-to-face interactions. This implies that voice-only telephone and email are insufficient for this purpose. Video telephones and/or web-cam based audio-visual channels that deliver frame-rates that replicate natural movement and speech would be desirable.
1.10 Team structure

**Purpose:** The purpose of the team structure process is to create a flexible, goal-oriented team structure.

**Outcomes:** As a result of the successful implementation of the team structure process:

1. Objective-aligned team structure is established.
2. Adaptable team structure is established.
3. Appropriate team roles are assigned.

**Informative Notes**

Outcome 1 – the leader establishes a team structure that is broadly consistent with the project’s objectives and requirements.

Outcome 2 – the leader establishes a structure that is able to dynamically adapt to changeable conditions (i.e. cost, schedule, risk, resource projections, business processes, the project’s defined process, and organizational guidelines).

**General**

Factors influencing appropriate team structure include product requirements, cost, schedule, risk, resource projections, business processes, the project’s defined process, and organizational guidelines are evaluated to establish the basis for defining teams and their responsibilities, authorities, and interrelationships.

The Work Breakdown Structure (WBS) and derived product-oriented hierarchy may provide an appropriate team structure. More complex structuring occurs when the WBS is not product oriented, product risks are not uniform, and resources are constrained.

The team structure is a dynamic entity that is adjusted to changes in people, requirements, and the nature of tasks, and to tackle many difficulties. The team structure should be continuously monitored to detect malfunctions, mismanaged interfaces, and mismatches of the work to the staff.

1.11 Team requirements

**Purpose:** The purpose of the team requirements process is to allocate project requirements to teams.

**Outcomes:** As a result of the successful implementation of team requirements process:

1. Team structure is verified.
2. Team sponsor(s) are appointed.
Informative Notes
Outcome 1 – the leader verifies the team structure by allocating the project requirements before team members are recruited to verify that the team structure is appropriate to objectives.
Outcome 2 – the leader identifies and recruits suitable team sponsor(s) for each of the individual teams within the larger integrated team.

General
This allocation of requirements to teams is done before any teams are formed to verify that the team structure is workable and covers all the necessary requirements, responsibilities, authorities, tasks, and interfaces. Once the structure is confirmed, team sponsors are chosen to establish the individual teams in the structure.

1.12 Team formation
Purpose: The purpose of the team formation process is to constitute the team structure.

Outcomes: As a result of the successful implementation of the team formation process:

1. Team structure consistent with project requirements is established.
2. Team leaders consistent with requirements are appointed.
3. Team charter consistent with requirements is established.
4. Resources consistent with project requirements are allocated.

Informative Notes
Outcome 1 – the leader delegates to team sponsor(s) the task of recruiting and organising team(s) that are organised appropriately for the project requirements.
Outcome 2 – the leader delegates to team sponsor(s) the task of recruiting/appointing suitable team-leaders whose capabilities are consistent with the project requirements.
Outcome 3 – the leader delegates to team sponsor(s) the task of developing a team charter appropriate to the project requirements.
Outcome 4 – the leader delegates to team sponsor(s) the task of allocating the resources necessary to meet the project requirements.

General
With more complex teams, the leader might delegate to the sponsors the task of appointing team leaders and team members, and establishing the team charter for each integrated team based on the allocation of requirements. It also involves providing the resources required to accomplish the tasks assigned to the team.

1.13 Team roles
Purpose: The purpose of the virtual team roles process is to define member roles.

Outcomes: As a result of the successful implementation of the team roles process:

1. Team member roles are understood.
2. Contingency plans for team member absences are developed.
Informative Notes

Outcome 1 – the leader ensures everyone clearly understands their roles, particularly those performing multiple roles.

Outcome 2 – the leader develops contingency plans for when team members are unavailable for further work.

General

Clearly defined team roles avoid role confusion and significant wasted effort. The effort spent by the leader on making sure everyone understands their role(s) should rise where members are performing multiple roles and the potential for confusion is high.

Contingency planning for the absence of key resources is recommended, with evidence to suggest such planning affords a high ROI for the leader.

1.14 Team rules

Purpose: The purpose of the team rules process is to establish rules for optimal integrated teams conduct in support of goals.

Outcomes: As a result of the successful implementation of the team rules process:

1. Criteria for optimal team performance in support of objectives are established.

2. Empowered operating conduct for optimal team performance in support of objectives is established.

Informative Notes

Outcome 1 – the leader sets the standard of expected performance so team leaders and members are clear about the standard to which they must work.

Outcome 2 – optimal team performance in pursuit of the project objectives is facilitated by establishing empowered team member operating conduct. The degree of empowerment will depend on the specific nature of a project. Some will need more active supervision, some less.

General

Operating rules and guidelines for the integrated teams define and control how teams interact to accomplish objectives. These rules and guidelines also promote the effective leveraging of the teams’ efforts, high performance, and productivity. Integrated team members must understand the standards for work and participate according to those standards.

1.15 Team boundaries

Purpose: The purpose of the team boundaries process is to manage team boundaries.

Outcomes: As a result of the successful implementation of the team boundaries process:

1. Team boundaries are managed.

2. Blended team culture is facilitated.
Informative Notes

Outcome 1 – the leader ensures that boundaries concerning functional, organisational, and cultural matters are maintained in a stable and well-defined manner. The more complex the project, the more important that role boundary definition is stable and well-understood by all, thus minimising the potential for confusion.

Outcome 2 – the leader manages team boundaries where teams cross cultures by facilitating an adaptive blended culture based on mutual respect, trust and reciprocity.

General

Managing team boundaries in a way that allows complex tasks to be performed by teams requires that the boundaries be in a condition that allows defined operating procedures and stable relationships to be maintained. This implies that the boundaries are less changeable over the course of the project lifecycle. Simpler tasks may be more tolerant to change where people move into and out of the team and where explicit operating procedures are less critical.

Teams that span diverse functional, organizational and/or cultural boundaries will have poor cohesion unless the leader works to establish a common culture that is a blend of each member’s individual culture. From this basis of common culture, team cohesion can be established and cultivated in a way that develops mutual respect, trust and reciprocity (mutual obligation).

1.16 Team authority

Purpose: The purpose of the team authority process is to create efficiently functioning teams by establishing mechanisms that allows team leaders and members to recognise clear channels of responsibility.

Outcomes: As a result of the successful implementation of establishing team authority mechanisms:

1. Clear channels of responsibility are established.
2. Responsibilities are understood.
3. Team authority and decision-making mechanisms are understood.

Informative Notes

Outcome 1 – the leader creates clear and unambiguous channels of authority and responsibility within the team hierarchy (team leaders and members).

Outcome 2 – the leader communicates these channels of authority and responsibility to all team-leaders and members.

Outcome 3 – the leader communicates the nature of the team authority and decision-making mechanisms and how they operate to all team-leaders and members.

General

Teaming introduces challenges to leadership because of the cultural changes required when people and integrated teams are empowered and decisions are driven to the lowest level appropriate. Effective and efficient communication mechanisms are critical to timely and sound decision making in the integrated work environment. Once an integrated team project structure is established and training is provided, mechanisms to handle empowerment, decision making, and issue resolution also need to be provided.

1.17 Team collaboration
**V1.0 PRM**

**Purpose:** The purpose of the team collaboration process is to ensure effective collaboration among interfacing teams elements.

**Outcomes:** As a result of the successful implementation of team collaboration process:

1. Environment for collaboration is established.

**Informative Notes**

Outcome 1 – the leader sets up an environment conducive to efficient collaboration. This may include morale-building activities.

**General**

The success of any project depends on how effectively teams collaborate with one another to achieve project objectives.

### 1.18 Team performance management

**Purpose:** The purpose of the team performance process is to manage team performance through the development of empowered performance-management functions that allow team members to manage themselves.

**Outcomes:** As a result of the successful implementation of the virtual team performance management process:

1. Self-managing performance functions are developed.

2. High-capability self-managing performance functions for complex asynchronous tasks are developed.

3. Anticipatory self-management functions for proactive adaptation to change are developed.

**Informative Notes**

Outcome 1 – the leader develops explicit performance management functions early in the project lifecycle that allow team members to self-manage their performance. Self-management is defined broadly, and might include methods such as the daily team scrum to create a mind-set that help members synchronise their individual efforts for the rest of the day.

Outcome 2 – the leader develops higher-order performance self-management functions where it is necessary to perform complex tasks asynchronously. This condition represents a situation of heightened need for effective self-management of performance by team members.

Outcome 3 -- the leader develops performance management functions that anticipate change, and proactively adapts the self-managing team-member to changing environmental conditions.

**General**

Where temporal distribution degrades the quality of the information that a leader normally uses to carry out performance management, compensatory measures should be established that (a) allow team members to effectively manage their own performance, and (b) have an anticipatory element that helps team members to avoid potential problems and adapt to changing environmental conditions.

### 1.19 Team development
V1.0 PRM

**Purpose**: The purpose of the team development process is to establish team development functions to promote productivity and coherence.

**Outcomes**: As a result of the successful implementation of the team development process:

1. Development practices for team coherence are established.
2. Stable team membership is maintained.

**Informative Notes**

Outcome 1 – the leader of both short-term and long-term projects establishes effective team development functions early in the project lifecycle. In the case of short-term projects, this facilitates the timely completion of the project. With long-term projects, this facilitates the establishment of long-term working relationships and complex workflow arrangements.

Outcome 2 – the leader maintains stable team membership where tasks are performed in virtual environments. A greater degree of team membership stability is required where complex tasks are performed in virtual environments.

**General**

It is important for both short and long-term projects that the critical team development functions are established as early as possible. For short-term, discrete lifecycle projects, there is usually only time to focus on the most critical of functions, for example effective working relationships.

For long-term, continuous lifecycle projects, these functions are even more important in the sense that stable long-term working relationships are usually required, performing work of a complex nature that requires complex workflow arrangements. Such projects usually require reciprocal workflow arrangements in which integrated teams work collaboratively.

Team development activities that promote coherence are likely to be more important when the virtual team operates in real-time. Virtual team leaders are adept at identifying appropriate technology to facilitate the necessary degree of team coherence to achieve success.

Complex tasks require more stable team membership to enable the virtual team to achieve the projects objective(s). Less complex tasks may be more tolerant to dynamic team membership.

**1.20 Team and home organization balance**

**Purpose**: The purpose of the team and home organization process is to balance integrated team and home organization responsibilities.

**Outcomes**: As a result of the successful implementation of the integrated and home team balance process:

1. Guidelines for balancing team and home organization responsibilities are established.
Informative Notes

Outcome 1 – the leader provides guidelines that make clear how team-leaders and members can successfully balance their responsibilities to both team and home organisation.

General

A ‘home organization’ is the part of the organization to which team members are assigned when they are not on a specific project team. A home organization may be called a ‘functional organization,’ ‘home base,’ ‘home office,’ or ‘direct organization.’ Home organizations are often responsible for the career growth of their members (e.g., performance appraisals and training to maintain functional and discipline expertise).

In a team environment, reporting procedures and rating systems assume that members’ responsibilities are focused on the project team, not on the home organization. However, the responsibility of team members to their home organizations is also important, specifically for process implementation and improvement. Workloads and responsibilities should be balanced between projects and functions, and between career growth and advancement. Organizational mechanisms should exist that support the home organization while aligning the workforce to meet business objectives in a teaming environment.

Sometimes teams persist beyond their productive life in organizations that do not have a home organization for the team members to return to after the integrated team is dissolved. Therefore, there should be guidelines for disbanding the integrated teams and maintaining home organizations.

2. Integrated team leadership factors

Purpose: The purpose of the integrated team leadership factors is to supplement the Generic processes by elaborating the factors relevant to the leadership of integrated (or complex) teams.

Outcomes: As a result of the successful implementation of integrated team processes the corresponding generic team processes are supplemented to cater for integrated environments.

Informative Notes:

The processes contained in this category are supplementary to the generic processes seen in the first category. That is, they are to be added onto the generic process, not substituted for the generic process.

So in integrated environments, all of the relevant generic process outcomes plus all of the integrated process outcomes are applicable.

The Purpose statement of each of the integrated team leadership processes below designates the Generic process to which it is attached.

2.1 Integrated team environment

Purpose: The purpose of the integrated team environment process is to supplement Generic Process 1.9 by establishing the project's integrated work environment.

Outcomes: As a result of the successful implementation of the integrated team environment process:

1. On-demand, synchronous, hi-resolution communications media is provided.

2. On-demand, synchronous, hi-resolution communications media is used.
Informative Notes

This is a supplementary process specific to integrated team environments.

Outcome 1 – team-members should if possible have ready access to hi-resolution videoconferencing facilities that are sufficiently rich-textured that participants are able to see the nuances of non-verbal communication in the remote participants. The audio must be high-fidelity enough to hear the nuances of verbal communication.

Outcome 2 – team-members in virtual integrated environments are in no doubt that these facilities are available and should be used frequently or at least as often as necessary to maintain a level of contact roughly equivalent to co-located teams who interact face-to-face when required.

General

Team members in virtual integrated environments must be in a position to communicate with each other in ways that approximate normal face-to-face interactions. This implies that voice-only telephone and email are insufficient for this purpose. Video telephones and/or web-cam based audio-visual channels that deliver frame-rates that replicate natural movement and speech would be desirable.

2.2 Interfacing team collaboration

Purpose: The purpose of the interfacing team collaboration process is to supplement Generic Process 1.17 by ensuring effective collaboration among interfacing teams.

Outcomes: As a result of the successful implementation of interfacing team collaboration process:

1. Environment for integrated team collaboration is established.

Informative Notes

Outcome 1 – the leader sets up the mechanisms by which the disparate elements of an integrated team can be made to function smoothly together (for example an Interface Control Group or Committee supported by hi-res ICT).

General

The success of an integrated team-based project is a function of how effectively and successfully the integrated teams collaborate with one another to achieve project objectives. This collaboration may be accomplished using interface control working groups.

3. Virtual team leadership factors

Purpose: The purpose of the virtual team leadership factors is to supplement the Generic processes by elaborating the factors relevant to the leadership of virtual (or non-co-located) teams.

Outcomes: As a result of the successful implementation of virtual team processes the corresponding generic team processes are supplemented to cater for virtual environments.
Informative Notes:
The processes contained in this category are supplementary to the generic processes seen in the first category. That is, they are to be added onto the generic process, not substituted for the generic process.

So in virtual environments, all of the relevant generic process outcomes plus all of the virtual process outcomes are applicable.

The Purpose statement of each of the virtual team leadership processes below designates the Generic process to which it is attached.

3.1 Virtual team environment

Purpose: The purpose of the virtual team environment process is to supplement Generic Process 1.9 by establishing the project's virtual work environment.

Outcomes: As a result of the successful implementation of the virtual team environment process:

1. On-demand, synchronous, hi-resolution communications media is provided.

2. On-demand, synchronous, hi-resolution communications media is used.

Informative Notes
This is a supplementary process specific to virtual team environments.

Outcome 1 – team-members should if possible have ready access to hi-resolution videoconferencing facilities that are sufficiently rich-textured that participants are able to see the nuances of non-verbal communication in the remote participants. The audio must be high-fidelity enough to hear the nuances of verbal communication.

Outcome 2 – team-members in virtual integrated environments are in no doubt that these facilities are available and should be used frequently or at least as often as necessary to maintain a level of contact roughly equivalent to co-located teams who interact face-to-face when required.

General
Team members in virtual integrated environments must be in a position to communicate with each other in ways that approximate normal face-to-face interactions. This implies that voice-only telephone and email are insufficient for this purpose. Video telephones and/or web-cam based audio-visual channels that deliver frame-rates that replicate natural movement and speech would be desirable.

3.2 Virtual team roles

Purpose: The purpose of the virtual team roles process is to supplement Generic Process 1.13 by defining virtual team member roles.

Outcomes: As a result of the successful implementation of the virtual team roles process:

1. Singular roles per member in synchronous virtual environments are defined.

2. Singular and/or multiple roles per member in asynchronous virtual environments are defined.
Informative Notes
This is a supplementary process specific to virtual team environments.

Outcome 1 – the leader defines clear, stable and singular team membership roles where tasks are performed synchronously in virtual environments.

Outcome 2 – the leader has the discretion to define singular and/or multiple roles per member when project operates in asynchronous environments.

General
While virtual team members may on occasion perform multiple roles, it becomes increasingly important that roles are clearly defined when the task complexity increases, and the work is done synchronously. Rigid role definition becomes less important when the tasks are simpler, particularly when the tasks can be performed asynchronously.

When team members hold multiple roles within and across different teams, the leaders performance management job becomes more difficult in the sense that role ambiguity and role conflict are likely to occur. The leader must make clear for each member exactly what their role is, in other words what the leader’s expectations are in terms of commitment of time and effort.

3.3 Virtual team performance management

Purpose: The purpose of the virtual team performance process is to supplement Generic Process 1.18 by managing virtual team performance through the development of empowered performance-management functions that allow team members to manage themselves.

Outcomes: As a result of the successful implementation of the virtual team performance management process:

1. High-capability self-managing performance functions across complex team boundaries are developed.

Informative Notes
Outcome 1 – the leader develops higher-order performance self-management functions where it is necessary to perform tasks in virtual environments with complex team boundaries. This condition represents a situation of heightened need for effective self-management of performance by virtual team members.

General
Where temporal distribution degrades the quality of the information that a leader normally uses to carry out performance management, compensatory measures should be established that allow team members to effectively manage their own performance, particularly where virtual teams cross multiple boundaries (in terms of culture, organization and specific job functions) it is important for leaders to carefully assess the nature of these boundaries and to determine how best to tailor performance management for individual team members given the nature of the differences.

Note: V1.0 is for practical purposes a starting from which the PRM can be applied and further reviewed by participant project managers. It is a work-in-progress and is expected to evolve over time.

Table 40: Version 1.0 PRM
7.10. Conclusions

To summarise, the data was collected and analysed in six stages, corresponding to six design review iterations as per a Design Research approach (Hevner, 2004):

1. Initial data gathering & review
2. Second data gathering & review
4. Behavior Tree notation review
5. Expert panel review
6. Composition Tree notation review

A broad range of research objectives necessitated a diverse selection of collection methods (also in keeping with Hevner’s (2004) guidelines for valid design Research).

For reference, a reiteration is made of the research objectives and how each instrument (or review cycle) related:

<table>
<thead>
<tr>
<th></th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>Stage 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quals of effective leaders</td>
<td>Yes</td>
<td>Yes</td>
<td>Partially</td>
<td>Partially</td>
<td>Yes</td>
<td>Partially</td>
</tr>
<tr>
<td>Dev PRM</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Is it PRM?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Is DR good for PRMs?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Are Behav &amp; Compos Tree good for PRMs?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 41: Correlation of data collection methods and research objectives

It will be seen that there is broad support for the research objectives by all but the behavior tree notation and composition tree notation data collection methods. These latter appear to have special relevance to the validation of a models integrity in both a semantic and vocabulary sense.
The guiding principle with the selection of these data collection methods is how well they combine to form a robust and comprehensive Design Research approach to the development of an artefact in the software engineering domain. Bearing in mind that DR has been used extensively in various engineering domains to produce artefacts that are robust and useful in a real-world context, its use in this project is consciously aimed at producing a model that will prove useful to project managers of distributed, complex projects wishing to improve the way they do their jobs.
8. Findings

The findings are discussed in terms of the defined research objectives:

1. To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments.

2. Based on the identified qualities and characteristics, to develop a Process Reference Model (PRM) for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007.

3. To determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior.

4. To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior and/or Process Reference Models in the software engineering domain.

5. To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.

8.1. Qualities of effective leaders

Research objective 1: To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments.

The findings in relation to this research objective for each review stage can be summarised as follows:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>Stage 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quals of effective leaders</td>
<td>Yes</td>
<td>Yes</td>
<td>Partially</td>
<td>Partially</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 42: Research objective 1 summary findings
8.1.1. RO1 & Stage 1: Initial data gathering & review

The qualities and characteristics of effective leaders were derived from a broad-based literature review, drawing on material from the academic domains of software engineering, management and social psychology. Some consideration was given to literature written by well-recognised authors such as Peter Drucker and Warren Bennis, whose stature and credibility in the field of management is large, and whose work has found a wider audience beyond their academic disciplines, but who may nonetheless be described as being academically rigorous in their published work, regardless of audience size. Some consideration was also given to such renowned writers as the ancient Greek Philosopher Plato, whose *Republic* is a seminal work on the subject of leadership and governance more generally.

The literature not only contains descriptions of the characteristics of effective leaders, it also pointed clearly to the difficulty in defining what leadership actually is. It is clear that no commonly accepted definition for leadership exists. Opinions vary, consensus has not been reached. It seems reasonable to conclude from this that leadership manifests itself in differing ways, depending on the circumstances. There must be an underlying set of principles that informs the practice of leadership, given its long history of discussion. These leadership principles are not perhaps directly observable, but may be inferred by the presence of certain indications and characteristics that vary according to the context (time and place, cultural context).

To the extent possible given the constraints of this project, the V0.1 PRM as derived from the literature makes every effort to recognize these underlying leadership principles, independent of contextual variables. Capturing the essence of these leadership principles and presenting them to the real-world of project management is the primary goal of this project, and may be inferred from the stated research question and first objective.

*Stage 1 review therefore significantly helped to verify that the leadership qualities identified by the literature review are correct. It did this by subjecting the V0.1 PRM to scrutiny by practicing project managers operating distributed and sometimes complex teams; the very people to whom the finished PRM is aimed. These reviewers arguably can recognise leadership when they see it manifesting in their practice. The participants also validated the V0.1 PRM by identifying work products and activities that instantiate the process outcomes. An outcome could not proceed to V0.2 PRM unless it had been validated in this way.*
8.1.2. RO1 & Stage 2: Second data gathering & review

Stage 2 examined the V0.2 PRM from a different angle by the same category of person who had participated in stage 1. Getting a divergent range of opinion required taking this second look from a different angle (as prescribed by Hevner, 2004) in order to identify aspects of the V0.2 PRM that did not make sense or seemed out of place to the participants. In stage 1 review, the participants validated the process outcomes by identifying activities and/or artefacts, in stage 2, they were not asked to provide more artefacts, rather to point out weaknesses.

The participants in stage 2 review did not find anything in V0.2 PRM that did not make sense or seemed out of place, hence no changes were made to the V0.2 PRM. Not finding any problems conformed that stage 1 review had been performed effectively. Nothing appears to have made it through to the V0.2 PRM that had not been properly understood and substantiated.

Therefore in relation to the research objective 'To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments' the stage 2 review confirms that stage 1 had been performed correctly and effectively. Had it not, changes would very likely have been identified in the stage 2 review.

8.1.3. RO1 & Stage: 3 ISO/IEC 15504-2 / ISO/IEC 24774 review

The qualities and characteristics of effective leaders are only partially made clear by the application of ISO/IEC 15504-2 and ISO/IEC 24774. Stage 3 review added no new substance to the V0.3 PRM in terms of leadership qualities, however it did perform the valuable service of clarifying the way these characteristics were expressed by applying the consistency principles contained in this ISO standard. For example, the principle that titles should be expressed as a noun phrase simplified the inconsistent way that titles were used in the V0.2 PRM. By applying these principles consistently throughout the V0.3 PRM, the reader is helped in his or her understanding of the PRM content, thus making clear the various leadership qualities.

After applying ISO/IEC 15504-2 and ISO/IEC 24774 it was found that the resulting PRM (V0.31 PRM) was somewhat disorganised due to the merging of processes.
V0.31 did not flow logically from one process to the next. So V0.31 was subjected to a reorganisation to become V0.32 which further assisted in the clarification and therefore understand-ability of the PRM. The rationale applied to the reorganisation was ‘what organisation might make the most sense to a practitioner reader?’ The content of V0.32 did not change relative to V0.31, only the way it was organised.

Therefore this stage partially supports the achievement of this research objective in the sense that it made consistent the way titles and outcomes were expressed.

ISO/IEC 15504-2 and ISO/IEC 24774 prescribes the standard way that PRMs are organised and expressed, so it is reasonable to find that using it is likely to make the leadership PRM understandable to practitioners in the software engineering world who are already familiar with other PRMs (like CMMI and SPICE).

8.1.4. RO1 & Stage 4: Behavior Tree notation review

The application of Dromey’s behavior tree notation to the V0.3 PRM identified the presence of significant errors, omissions and duplications. It cannot however be said that this review added anything substantive to our understanding of the qualities and characteristics of effective leaders of integrated teams operating in virtual environments. But like the ISO/IEC 15504-2 and ISO/IEC 24774 review before it, this review was nonetheless effective at clarifying and simplifying the way the model is expressed.

The basic idea of behavior tree notation is to formulate a statement of the model components that is complete and accurate by answering six questions; who, what, when, where, why and how. When applied to the V0.3 PRM we see results such as this; before the notation, Process 1 Shared vision had an outcome 1.1 that was expressed in the following way ‘Leader creates a shared vision of what is to be accomplished, ideally seen as an accomplished fact’. After the behavior tree notation was applied, this outcome became ‘Leader creates a shared vision of the goal(s).’ The rationale was that the goal(s) not ‘what is to be accomplished’ that is important in this instance. The redundant qualification (ideally seen as an accomplished fact) could then be removed to Informative Material where it still performs a valuable task of placing the outcome into context.

The notation associated with this example is seen below:
Table 43: Sample behavior tree notation

<table>
<thead>
<tr>
<th>1.1.1</th>
<th>LEADER</th>
</tr>
</thead>
<tbody>
<tr>
<td>what</td>
<td>SHARED VISION/</td>
</tr>
<tr>
<td>what (of)</td>
<td>GOAL(S)</td>
</tr>
<tr>
<td>who (with)</td>
<td>TEAM</td>
</tr>
</tbody>
</table>

It should be noted that the Behavior Tree method was developed to validate software system requirements. Its application to validating a PRM is not prescribed, so a significant degree of interpretive latitude exists as to how it is best applied in this project. This took the form of applying the essential five W’s and one H to each process outcome to produce good results, identifying numerous improvements. Arguably, this represents a valid, if unprecedented application of Behavior Tree notation to the validation of PRMs. It certainly points to the need for further investigation in future projects. It should also be noted that Behavior Engineering is not a central element of the Design Research process as originally planned. Its addition to the DR approach in this project was considered worthwhile as an exploratory exercise given the potential benefits of using this formal method to the validation of PRMs and Models of Organisational Behavior more generally.

Therefore this stage partially supports the achievement of this research objective by distilling the essential underlying point and placing it into clear focus for the reader. This process of clarification is seen to be valuable on this project because the essential nature of leadership appears very often to be obscured by contextual factors relevant to particular situations (the cultural milieu). Saying, as in the example above ‘Leader creates a shared vision of the goal(s)’ gets to the essential truth without the baggage of phrases like ‘.. of what is to be accomplished, ideally seen as an accomplished fact.’

It must be noted that an adapted form of Behavior Tree notation was applied in this project which is a simplified version of Behavior Engineering (BE). A full BE analysis, while beyond the scope of this project, is certainly indicated as a future project.

### 8.1.5. RO1 & Stage 5: Expert panel review

The members of the expert panel are recognized experts with process models in software engineering who graciously agreed to participate. One of them, Dr Bill Curtis,
is also a recognized expert on teamwork and leadership, having been a primary author on the People-CMM development project.

Of the four who agreed to participate (Bill Curtis, Linda Ibrahim, Alec Dorling and SuZ Garcia) only Bill Curtis and Linda Ibrahim provided substantive feedback, as seen in the data analysis chapter. Unforeseeable circumstances prevented Alec Dorling and SuZ Garcia from returning their feedback.

Having two sets of expert data is arguably sufficient for this project, since the nature and scope of the two sets of data was relatively consistent. More than two sets of data would have been desirable, though given this consistency, the additional data may not have contributed much additional unique content to the review. In any event, the feedback provided by Curtis and Ibrahim was excellent for the breadth of its coverage and the level of detail to which they both went.

Salient among the reviewer’s comments at a broad level was that many of the leadership factors allocated to the Integrated and Virtual categories were also applicable in a generic sense, and therefore belong in the Generic leadership category. Both reviewers suggested a major reorganisation of the PRM that would do away with the three category architecture chosen so that it could be applied flexibly to any combination of simple/complex, virtual/collocated team environment. As attractive as this architecture was, the views of the expert panel were compelling, so a reorganisation was necessary. It was decided to incorporate into the Generic category all leadership factors from the Integrated and Virtual categories that had broader relevance in a generic sense, boosting the Generic category considerably. However those factors that were nonetheless applicable in Integrated and Virtual environments remained in those categories, becoming ‘supplementary’ processes that linked directly to the corresponding generic process.

The supplementary process approach is a novel one, but is arguably a logical and satisfactory way of dealing with the competing interests outlined above.

*Therefore, the expert panel improved our understanding of the qualities and characteristics of effective leaders of integrated teams operating in virtual environments by contributing their in-depth knowledge and experience to the way leadership is defined in the PRM. The expert reviewers’ perspective on the nature of leadership is mature, and the PRM certainly benefited from their input.*
8.1.6. **RO1 & Stage 6: Composition Tree notation review**

The application of Dromey’s composition tree notation to the V0.5 PRM identified the presence of correctable defects not noticed in any of the previous reviews. Composition tree notation concentrates on identifying the system vocabulary of terms used, (while the behavior tree notation concentrates on semantic correctness). Composition tree notation is a comprehensive vocabulary of terms that makes the presence of synonyms apparent, and results in uniformity in the way terms are used, thus further reducing ambiguity.

As with behavior tree notation review (stage 4) it cannot be said that this review added anything substantive to our understanding of the qualities and characteristics of effective leaders of integrated teams operating in virtual environments. Like behavior tree notation review (stage 4) and the ISO/IEC 15504-2 / ISO/IEC 24774 review (stage 3), this review was nonetheless effective at clarifying the way the model is expressed and proved to be a worthwhile review stage for the reasons discussed below.

When applied to the V0.5 PRM we see results such as this; before the composition tree notation, Process 1 *Shared vision* becomes Process 1 *Vision*. It highlights that ‘shared’ is an attribute of ‘vision’ so process should be simply called ‘Vision’, with ‘shared’ being dealt with in Outcome 2. So ‘shared’ is removed because the vision is not shared until it is communicated.

The notation associated with this example is seen below. Note how shared is clearly placed as an attribute of Vision:

<table>
<thead>
<tr>
<th>1.1</th>
<th>VISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1</td>
<td>Exists</td>
</tr>
<tr>
<td>1.1.2</td>
<td>Shared</td>
</tr>
<tr>
<td>1.1.3</td>
<td>Committed</td>
</tr>
<tr>
<td>1.1.4</td>
<td>Resilient</td>
</tr>
<tr>
<td>1.1.5</td>
<td>Objectives</td>
</tr>
<tr>
<td>1.1.6</td>
<td>Positive Expectation</td>
</tr>
</tbody>
</table>

Table 44: Sample composition tree notation

To contrast this with stage 4 behavior tree notation review this same process was modified thus; Process 1 *Shared vision* had an outcome 1.1 that was expressed in the following way ‘Leader creates a shared vision of what is to be accomplished, ideally
seen as an accomplished fact’. After the behavior tree notation was applied, this outcome became ‘Leader creates a shared vision of the goal(s).’ The rationale was that the goal(s) not ‘what is to be accomplished’ that is importance in this instance. The redundant qualification (ideally seen as an accomplished fact) could then be removed to Informative Material where it still performs a valuable task of placing the outcome into context.

Therefore this stage partially supports the achievement of this research objective by further distilling the word usage of the draft PRM. As with stage 4, this process of distillation is seen to be valuable on this project because the essential nature of leadership appears very often to be obscured by contextual factors relevant to particular situations. Rewording ‘Shared vision’ to become ‘Vision’ is an improvement as it distils the process to its essence.

Based on the above reasoning, it may be argued that the leadership factor called ‘Vision’ is a fundamental underlying leadership factor that is true in any situation requiring leadership. The way that vision is applied will vary according to the cultural context, but we can see past these outward indications to the underlying factor. Behavior tree and composition tree notation have also helped to identify the other essential attributes of vision (that it exists, is communicated in a way that gains commitment, that it inspires resilience in the face of goal-frustrating events, produces a set of practically-worded objectives and creates a sense of positive expectation).

It must be noted that an adapted form of Composition Tree notation was applied in this project which is a simplified version of Behavior Engineering (BE). A full BE analysis, while beyond the scope of this project, is certainly indicated as a future project.

8.2. Leadership PRM

Research objective 2: Based on the identified qualities and characteristics, to develop a Process Reference Model (PRM) for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007.

The findings in relation to this research objective for each review stage can be summarised as follows:
Table 45: Research objective 2 summary findings

### 8.2.1. RO2 & Stage 1: Initial data gathering & review

Stage 1 review was aimed at validating the V0.1 PRM by the establishing the presence of activities and/or artefacts that serve as instantiations of process outcomes. This is a foundational activity in the development of any PRM. Stage 1 review successfully established which process and outcomes could be validated in this way, and which could not. Those that could not were modified or merged with other outcomes during the transition from V0.1 to V0.2 PRM.

*It may therefore be argued that RO2 (to develop a Process Reference Model for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007) was successfully addressed by stage 1 review insofar as it performed the first and indispensable step of validating the PRM with artefacts and/or activities.*

### 8.2.2. RO2 & Stage 2: Second data gathering & review

Stage 2 examined the V0.2 PRM from a different angle by the same category of person (not the same people) who had participated in stage 1 in order to identify the presence of elements of the V0.2 PRM that did not make sense or seemed out of place to the reviewers. In stage 1 review, the participants validated the process outcomes with artefacts, in stage 2, they were not asked to provide more artefacts, rather to point out weaknesses.

*Stage 2 review assisted with RO2 i.e. the development of an ISO/IEC 24774-conformant PRM by confirming that stage 1 review had been performed effectively and correctly, since stage 2 review did not identify any substantive changes to the V0.2 PRM.*
8.2.3. **RO2 & Stage: 3 ISO/IEC 15504-2 / ISO/IEC 24774 review**

Stage 3 review is clearly the main instrument by which the emerging PRM was made to be compliant with ISO/IEC 15504-2 and ISO/IEC 24774. The stages before and after also contributed to this compliance in lesser ways, since said compliance had been a pervasive constraint from the beginning to the end of the project. With compliance might come understanding and acceptance from software engineering academics and practitioners, and therefore the possibility of greater uptake.

After applying ISO/IEC 15504-2 and ISO/IEC 24774 it was found that the resulting PRM (V0.31 PRM) was somewhat disorganised due to the merging of processes. V0.31 did not flow logically from one process to the next. So V0.31 was subjected to a reorganisation to become V0.32 which further assisted in the clarification and therefore understand-ability of the PRM. The rationale applied to the reorganisation was ‘what organisation might make the most sense to a practitioner reader?’ The content of V0.32 did not change relative to V0.31, only the way it was organised.

*Stage 3 review therefore is the primary instrument by which the PRM is made compliant with ISO/IEC 15504-2 and ISO/IEC 24774 (as prescribed in RO2).*

8.2.4. **RO2 & Stage 4: Behavior Tree notation review**

The application of Dromey’s behavior tree notation to the V0.3 PRM highlighted the presence of improvement opportunities that raised the overall standard of clarity and usability of the PRM.

*Therefore stage 4 review contributed to the development of the PRM. A full Behavior Engineering analysis is a desirable future project.*

8.2.5. **RO2 & Stage 5: Expert panel review**

Stage 5 review contributed significantly to the development of the PRM by bringing a wealth of domain knowledge and PRM-building expertise to the project. The literature review and stages 1, 2, 3 and 4 reviews all contributed to the development of the PRM, however the expert reviewers appear to have brought something to the process that only deep experience and knowledge can bring. Their input changed the draft PRM
more than any other review, for example the architecture of the PRM evolved from a three tiered model of generic, virtual and integrated team leadership factors whose processes could function independently of each other, to a model in which all factors were seen as generic (applying in all situations) but with supplementary processes dealing with specific integrated and virtual team leadership factors that depend upon the parent process in the generic category.

Therefore stage 5 review contributed significantly the development of the PRM.

### 8.2.6. RO2 & Stage 6: Composition Tree notation review

The application of Dromey’s composition tree notation to the V0.3 PRM highlighted the presence of improvement opportunities that raised the overall standard of clarity and usability of the PRM.

Therefore stage 6 review contributed to the development of the PRM. A full Behavior Engineering analysis is a desirable future project.

### 8.3. Is it a PRM or a RMOB?

**Research objective 3:** To determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior.

The findings in relation to this research objective for each review stage can be summarised as follows:

<table>
<thead>
<tr>
<th>Is it a PRM?</th>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>Stage 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is it a PRM?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 46: Research objective 3 summary findings

Before evaluating the findings in relation to each review stage and research objective, mention will be made of the specific requirements for PRMs.
8.3.1. ISO/IEC 15504-2:2003

A Process Reference Model is defined in part 1 of ISO/IEC 15504:2003 (section 3.48) as a model comprising definitions of processes in a life cycle described in terms of process purpose and outcomes, together with an architecture describing the relationships between the processes.

ISO/IEC 15504-2:2003 section 6.2.3 prescribes the nature and content of a Process Reference Model in the following way. This will be used to establish compliance with ISO/IEC 15504-2:2003 as a necessary first step to determine whether what has been developed in this project is a PRM or a Model for Organisational Behavior, a broader term.

### 6.2.3 Requirements for Process Reference Models

**6.2.3.1** A Process Reference Model shall contain:

| a) a declaration of the domain of the Process Reference Model; |
| b) a description, meeting the requirements of 6.2.4 of this International Standard, of the processes within the scope of the Process Reference Model; |
| c) a description of the relationship between the Process Reference Model and its intended context of use; |
| d) a description of the relationship between the processes defined within the Process Reference Model. |

**6.2.3.2** The Process Reference Model shall document the community of interest of the model and the actions taken to achieve consensus within that community of interest:

| a) the relevant community of interest shall be characterized or specified; |
| b) the extent of achievement of consensus shall be documented; |
| c) if no actions are taken to achieve consensus, a statement to this effect shall be documented. |

**6.2.3.3** The processes defined within a Process Reference Model shall have unique process descriptions and identification

NOTE Any elements contained in a Process Reference Model that are not included in this Clause are to be considered informative.

### 6.2.4 Process descriptions

| a) a process shall be described in terms of its purpose and outcomes; |
| b) in any process description the set of process outcomes shall be necessary and sufficient to achieve the purpose of the process; |
| c) process descriptions shall be such that no aspects of the measurement framework as described in Clause 5 of this International Standard beyond level 1 are contained or implied. |
The fundamental elements of a Process Reference Model are the descriptions of the processes within the scope of the model. The process descriptions in the Process Reference Model incorporate a statement of the purpose of the process which describes at a high level the overall objectives of performing the process, together with the set of outcomes which demonstrate successful achievement of the process purpose. These process descriptions shall meet the following requirements:

An outcome statement describes one of the following:

- production of an artefact;
- a significant change of state;
- meeting of specified constraints, e.g. requirements, goals etc.

Table 47: Definition of PRM from ISO/IEC 15504-2:2003

8.3.2. ISO/IEC TR 24774:2007

The scope of application of ISO/IEC 24774 is highly inclusive. Section 1 of the standard says this document is intended for use by all parties that define process models … these process models may be for the purpose of process definition, implementation or assessment. It does not exclude developing PRMs for activities such as leadership.

On the question of whether leadership process may be rightly called processes for the purposes of reference modelling, section 2 of ISO/IEC 24774 makes the distinction between procedures and process in the following way; a procedure is a set of steps to be followed that, when completed, might or might not achieve the intended objective. This is similar to following a recipe when cooking. On the other hand, a process is executed with knowledge of the intended purpose and outcomes to achieve the desired result. What is being defined in the Leadership PRM is definitely a process by this definition and not a procedure.

In this project a PRM has been developed that is consistent in content and structure with ISO/IEC 24774:2007 Software and systems engineering -- Life cycle management -- Guidelines for process description. This general purpose standard outlines the elements used to describe a process; title, purpose statement, outcomes, activities and tasks.

The list below is quoted from ISO/IEC 24774:2007:

- The **title** conveys the scope of the process as a whole, It is expressed as a short noun phrase that summarize the scope of the process, identify the
principal concern of the process, and distinguish it from other processes within the scope of a process model.

- The **purpose** describes the goal of performing the process. It is expressed as a high level goal for performing the process, preferably stated in a single sentence. The implementation of the process should provide measurable, tangible benefits to the stakeholders through the expected outcomes.

- The **outcomes** express the observable results expected from the successful performance of the process. Outcomes are expressed in terms of a positive, observable objective or benefit. The list of outcomes associated with a process shall be prefaced by the text, ‘As a result of successful implementation of this process:’ The outcomes should be no longer than two lines of text, about twenty words. The number of outcomes for a process should fall within the range 3 to 7. Outcomes should express a single result. The use of the word ‘and’ or ‘and/or’ to conjoin clauses should be avoided. Outcomes should be written so that it should not require the implementation of a process at any capability level higher than 1 to achieve all of the outcomes, considered as a group.

- The **activities** are a list of actions that may be used to achieve the outcomes. Each activity may be further elaborated as a grouping of related lower level actions;

- The **tasks** are specific actions that may be performed to achieve an activity. Multiple related tasks are often grouped within an activity.

ISO/IEC 24774:2007 clearly prescribes that the outcomes should not go beyond what is stated in the purpose. There should be no capability level issues expressed in the outcomes. Secondly, the outcomes must address all of the issues that are apparent in the purpose statement. Nothing should be missed. The outcomes must therefore be necessary and sufficient to satisfy the purpose.

**General conclusion.** The Leadership PRM project consciously and systematically applies the requirements for valid PRMs, as prescribed by the normative references ISO/IEC 15504 and 24772, as outlined above. The Leadership PRM has been empirically proven to conform to these requirements, and therefore may arguably be said to be a valid PRM. Supporting this argument is the following:

- In addition to conformance to normative reference, the draft PRM was validated by peer practitioners who identified activities and/or artefacts that prove the
instantiation of the process. Any processes in the V0.1 and 0.2 PRM that could not be this substantiated did not go forward into later drafts.

- The V1.0 PRM having emerged from this project has proven amenable to having a Process Assessment Model (PAM) developed from it (see Appendix), albeit a PAM that assesses leadership at a performance level (level 1) only at this stage, although capability indicators may feasibly developed as a subsequent project.

- On the question of how much the community of interest was involved in the Leadership PRM development, a total of 10 community of interest representatives were consulted and had substantive input (four in stage 1, four in stage 2, two in stage 5). These comprised both experts and peer practitioners. In addition to these representatives were academic colleagues Dromey and Rout who contributed additional community of interest material.

- On the question of whether leadership can be formalised into a PRM, it has been shown in the literature review and elsewhere in this thesis that:
  
a) if you can’t describe what you are doing as a process, you don’t know what you are doing (Deming, 2000),

b) commitment to defined process in the software development domain is desirable (Humphrey, 2002),

c) that leadership can be learned (Drucker, 1996),

d) all models are wrong, but some are useful (Box, 1996),

e) that the widest possible range of an organisation’s activities should be understood in terms of processes rather than functions (Repenning and Sterman, 1997), and

f) managers benefit from leadership training (Humphrey, 2002).

Given the factors discussed and listed above, it is therefore not only possible but desirable that leadership be expressed in process terms. Combine this with the broadly defined scope of applicability in the normative ISO/IEC references; and there is no empirical reason why a Leadership PRM may not be developed. As long as such a PRM conforms to the terms and prescriptions of the normative references, it may rightly be described as a PRM.
Note: It is acknowledged that there might be differing views on what can be described as a PRM. The matter is far from settled. The strong, empirically-based argument presented in this thesis is intended to contribute to that on-going debate. The position of this thesis beyond its assertion that this is a valid PRM is that some of the outcomes of the model describe aspects of desired organisational behavior that, if performed repeatedly, will result in consistently achieving the prescribed purpose. This re-focuses attention from conformance to prescribed activities and tasks, to a focus on demonstration of desired organizational behavior which takes us away from the traditional role of a PRM. It might therefore be valid to say that what has been produced in this project is a new category of process reference model, described provisionally as a Reference Model for Organisational Behavior.

8.3.3. RO3 & Stage 1: Initial data gathering & review

The pre review stage of the project involved using ISO/IEC 15504 and 24774 to create a PRM that complied with the requirements of those ISO standards. Stage 1 review then presented the V0.1 PRM to a series of peer practitioners who were already familiar with the concept and application of PRMs in a software engineering context. All, for example had done at least the SEI’s authorised Introduction to CMMI training. Some had done further CMMI training (Intermediate, Instructor and Lead Appraiser training). The reviewers gave substantive feedback on the content and arrangement of the PRM based on their experiences as project managers, but also from their informed understanding of PRMs. None of the reviewers questioned the validity of the V0.1 draft as a PRM. All accepted it at face value. All were positive in their assessment. Given their pre-existing familiarity with other software engineering PRMs it would be reasonable then to conclude that their input helped to confirm the V0.1 draft as a valid PRM.

Therefore, in relation to RO3 (to determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior) it may reasonably be concluded the stage 1 review contributed to its confirmation as a PRM.
8.3.4. RO3 & Stage 2: Second data gathering & review

Stage 2 examined the V0.2 PRM from a different angle by the same category of person who had participated in stage 1. The same practical experience and knowledge of PRMs in SE applied in stage 2 as in stage 1. Therefore the same reasoning may apply here as in stage 1 review. The reviewers gave substantive feedback on the content and arrangement of the PRM based on their experiences as project managers, but also from their informed understanding of PRMs. None of the reviewers questioned the validity of the V0.2 draft as a PRM. As with stage 1 review, all accepted it at face value, and all were positive in their assessment. Given their pre-existing familiarity with other software engineering PRMs it would be reasonable then to conclude that their input helped to confirm the V0.2 draft as a valid PRM.

Therefore, in relation to RO3 (to determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior) it may reasonably be concluded the stage 2 review contributed to its confirmation as a PRM.

8.3.5. RO3 & Stage: 3 ISO/IEC 15504-2 / ISO/IEC 24774 review

ISO/IEC 15504-2 and ISO/IEC 24774 were both carefully applied in the pre-review stage of the project. The stage 3 review then sought to confirm that ISO/IEC 15504-2 and ISO/IEC 24774 had been correctly applied.

One of the expert reviewers in stage 5 pointed out that stage 3 review had not been 100% thorough in that some of the titles were not expressed as a noun clause. This indicates that stage 3 was not completely successful as a conformance review. This was remedied by not only the expert review, but also by the behavior tree notation and composition tree notation review (4 and 6).

Minor oversights notwithstanding, stage 3 review certainly helped to establish conformance of the draft PRM to the relevant standards.

Therefore, in relation to RO3 it may be concluded that the stage 3 review contributed significantly to its confirmation as a PRM.
8.3.6. **RO3 & Stage 4: Behavior Tree notation review**

While Dromey’s behavior tree notation helped to clarify the V0.3 PRM, cannot be said to have added significantly to confirming its compliance with the relevant standards.

*Therefore, in relation RO3, stage 4 review did not serve to confirm the draft model as a PRM.*

8.3.7. **RO3 & Stage 5: Expert panel review**

Given the breadth and depth of the expert panel’s knowledge of PRMs, it may be strongly argued that their input strongly supports the claim that the draft model is a valid PRM. Neither of the reviewers questioned the implicit claim that draft model is a PRM.

The review comments necessitated a major restructuring of the PRM from a three-tiered architecture whose components could act independently to a single tier with two supplementary tiers that depend up the single tier. The rationale for the restructure was the assertion by the reviewers that the leadership processes residing in the integrated and virtual components were actually generic in nature, and therefore belonged logically to the generic category. Countering this argument is the assertion that some aspects of the integrated and virtual leadership processes were indeed only to be found in those environments, while other aspects of the same process could be said to be generic. Both arguments are valid, so a compromise solution seemed most appropriate. The solution was to split the integrated and virtual leadership processes into their constituent outcomes and relocate the generic outcomes to the generic category, while leaving the remaining outcomes where they were, and designating them *supplementary* in relation to the corresponding generic process.

*The expert panel implicitly confirmed the draft model as a valid PRM.*

8.3.8. **RO3 & Stage 6: Composition Tree notation review**

While Dromey’s composition tree notation helped to clarify the V0.3 PRM, cannot be said to have added significantly to confirming its compliance with relevant standards.

*Therefore, in relation RO3, stage 4 review did not serve to confirm the draft model as a PRM.*
8.4. Is Design Research good for PRM development?

Research objective 4: To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior and/or Process Reference Models in the software engineering domain.

The findings in relation to this research objective for each review stage can be summarised as follows:

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>Stage 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is DR good for PRMs?</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 48: Research objective 4 summary findings

It may be recalled from Chapter 5 that the research method deemed most appropriate after careful consideration of other approaches, most notably Action Research, is Design Research. This is modelled on the Reasoning in the Design Cycle method:

![Design Research method diagram](image)

Knowledge Flows: Awareness of Problem, Global enterprise, Multidisciplinary teams, Circumscription, Operation & Goal Knowledge

Process Steps: Proposal, Tentative Design, Artefact, Performance Measures, Conclusion

Outputs: PRM, PAM, Model validation

Figure 23: Design Research method used for this project (Vaishnavi and Kuechler, 2004/5, Takeda et al 1990).
Design Research has the virtue of being a pragmatic approach (Hevner, 2007) that has a guiding principle of needing to be relevant to real-world situations, the better to solve existing or emergent real-world problems. In this project, the real-world problem is the increasing complexity and therefore the coordination difficulties encountered by project managers of virtual teams.

Hevner (2007) conceives of Design Research as being comprised of three interdependent cycles; Relevance, Rigour and Design. When the three are applied reiteratively and rigorously, a useful and user-friendly artefact is produced that solves problems and is liked by those that use it. Underlying this high-quality usability aspect is the rigour with which the developers apply the design process. It will be seen from the volume of data generated by this project that a high degree of rigour requires full transparency of process and traceability of any changes made, including the reasoning behind the change. This is done so that others might follow and understand the process, and give them the means to apply the same process on their own projects in the future.

**General conclusion.** While Design Research emerges from the domains of architecture and industrial design, it has over the past half century been successfully used in the broad context of engineering to develop a wide variety of artefacts. Given this impressive performance record, there seemed to be no good reason why DR would not be successful at developing a PRM, despite it not having been explicitly done before (or at least not reported in the literature).

The constraints of PRM development seem well-suited to the DR process. Using Hevner’s (2004) Design Research guidelines as a formal guide, DR is valid and useful if it produces a viable artefact (including a model) that is technology-based. The usability of the artefact must be rigorously tested and progressively improved through multiple design iterations. The DR process used should be rigorously applied and be shown to contribute to the sum of known methods and techniques used by DR researchers and practitioners. Finally, the DR method used should be reported to the Design community so that others might derive benefit.

The method described in the above paragraph has been rigorously applied in every particular to this project. Arguably, the V1.0 PRM is an artefact whose usability has been tested by the community of interest, and modified reiteratively according to their feedback. Nothing about the draft PRM was sacred and untouchable, anything could be changed, and almost all of it was indeed changed during the six review cycles.
8.4.1. RO4 & Stage 1: Initial data gathering & review

Stage 1 review involved activities that are clearly prescribed by Hevner’s (2004) guidelines for valid Design Research, particularly guideline 3: the utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods. The four peer practitioners who contributed to stage 1 review did evaluate the utility, quality and efficacy of the PRM in general, while validating the PRM in particular.

Therefore, in relation to RO4 (To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior and/or Process Reference Models in the software engineering domain), stage 1 review demonstrated that Design Research is an effective method for developing PRMs by performing activities that conform to Hevner’s guidelines (2004).

8.4.2. RO4 & Stage 2: Second data gathering & review

Stage 2 review, in terms of this research objective, is very similar to stage 1 review. The findings from stage 1 could be restated here in stage 2 review.

Therefore, in relation to RO4, stage 2 review demonstrated that Design Research is an effective method for developing PRMs by performing activities that conform to Hevner’s guidelines (2004).

8.4.3. RO4 & Stage: 3 ISO/IEC 15504-2 / ISO/IEC 24774 review

Stage 3 review also satisfies Hevner’s (2004) guidelines for valid DR, specifically guideline 5 (application of rigorous methods) and guideline 6 (utilising available means while satisfying laws in the problem environment). Arguably, the ISO/IEC 15504-2 and ISO/IEC 24774 review can be interpreted as an application of these two guidelines.

Therefore, in relation to RO4, stage 3 review demonstrated that Design Research is an effective method for developing PRMs by performing activities that conform to Hevner’s guidelines (2004).
8.4.4. RO4 & Stage 4: Behavior Tree notation review

Stage 4 review also satisfies Hevner’s (2004) guidelines for valid DR, specifically guideline 5 (application of rigorous methods) and guideline 6 (utilising available means while satisfying laws in the problem environment). Arguably, the behavior tree notation review can be interpreted as an application of these two guidelines.

Therefore, in relation to RO4, stage 4 review demonstrated that Design Research is an effective method for developing PRMs by performing activities that conform to Hevner’s guidelines (2004). A full Behavior Engineering analysis is a desirable future project.

8.4.5. RO4 & Stage 5: Expert panel review

Stage 5 review involved activities that are clearly prescribed by Hevner’s (2004) guidelines for valid Design Research, particularly guideline 3: the utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods. The two domain experts who contributed to stage 5 review did evaluate the utility, quality and efficacy of the PRM.

Therefore, in relation to RO4, stage 5 review demonstrated that Design Research is an effective method for developing PRMs by performing activities that conform to Hevner’s guidelines (2004).

8.4.6. RO4 & Stage 6: Composition Tree notation review

Stage 4 review also satisfies Hevner’s (2004) guidelines for valid DR, specifically guideline 5 (application of rigorous methods) and guideline 6 (utilising available means while satisfying laws in the problem environment). Arguably, the composition tree notation review can be interpreted as an application of these two guidelines.

Therefore, in relation to RO4, stage 6 review demonstrated that Design Research is an effective method for developing PRMs by performing activities that conform to Hevner’s guidelines (2004).
8.5. Behavior & composition tree notation

Research objective 5: To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.

The findings in relation to this research objective for each review stage can be summarised as follows:

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
<th>Stage 3</th>
<th>Stage 4</th>
<th>Stage 5</th>
<th>Stage 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are Behav &amp; Compos Tree good for PRMs?</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Table 49: Research objective 5 summary findings

Using Dromey’s Behavior Engineering (of which behavior tree and composition tree notations are components) has proven useful in this DR project by providing a formal method to check the integrity of the purpose and outcomes statements that are the way processes have come to be expressed. The purpose/outcomes method of process definition was developed in the course of evolution of ISO/IEC 15504 (Rout, 2003).

If the processes that comprise the PRM are expressed in this purpose/outcome way it becomes apparent that the outcomes represent the results of desirable organizational behavior. If this behavior is reinforced over time to become institutionalised then the prescribed purpose will be achieved.

Behavior tree and composition tree notation is successfully applied to the PRM in this project by using formalised verification of the integrity, consistency and completeness of the model in ways that other methods, for example practitioner and expert reviews, are unable to deliver.

It will be seen in the data analysis chapter that applying behavior tree and composition tree notations to the draft outcomes of a process reference model produced significant improvement to the clarity of the outcomes by simplifying the language, reducing ambiguity and splitting outcomes into two where two ideas were embodied in the original.
In general terms, the improvements derived from the application of behavior tree notation is greater clarity and economy of words (eg. in first example below 17 words in V0.3 becomes 8 in V0.4 by rephrasing ‘what is to be accomplished’ to simply ‘goal(s)’ and removing the qualifier ‘ideally seen as an accomplished fact’ to the informative section. behavior tree notation highlighted where and how these economies of expression could be made to remove ambiguity; in other words the more informal language of V0.3 was rendered into formal language in V0.4 PRM.

An advantage of behavior tree notation here is that it provides a rigorous, consistently applied editorial logic for people without qualifications and/or much experience as editors. An experienced editor may achieve the same results without behavior tree notation, anyone else would arguably benefit from its application.

**General conclusion.** *Based on the evidence, it is concluded that behavior tree and composition tree notations are useful tools for developers of reference models in the model-based process improvement domain. A full Behavior Engineering analysis is a desirable future project.*

### 8.5.1. RO5 & Stage 1: Initial data gathering & review

*Not relevant to RO5 (To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to validate the Process Reference Model)*

### 8.5.2. RO5 & Stage 2: Second data gathering & review

*Not relevant to RO5.*

### 8.5.3. RO5 & Stage: 3 ISO/IEC 15504-2 / ISO/IEC 24774review

*Not relevant to RO5.*
8.5.4. **RO5 & Stage 4: Behavior Tree notation review**

The application of Dromey’s behavior tree notation to the V0.3 PRM identified numerous errors, omissions and duplications, despite having been practitioner-reviewed twice. Stage 4 review was therefore effective at clarifying and simplifying the way the model was expressed.

For example, when applied to the V0.3 PRM we see results such as this; before the notation, Process 1 *Shared vision* had an outcome 1.1 that was expressed in the following way ‘Leader creates a shared vision of what is to be accomplished, ideally seen as an accomplished fact’. After the behavior tree notation was applied, this outcome became ‘Leader creates a shared vision of the goal(s).’ The rationale was that the goal(s) not ‘what is to be accomplished’ that is importance in this instance. The redundant qualification *(ideally seen as an accomplished fact)* could then be removed to *Informative Material* where it still performs a valuable task of placing the outcome into context.

The notation associated with this example is seen below:

<table>
<thead>
<tr>
<th>1.1.1</th>
<th>LEADER [creates]</th>
</tr>
</thead>
<tbody>
<tr>
<td>what</td>
<td>SHARED VISION/</td>
</tr>
<tr>
<td>what (of)</td>
<td>GOAL(S)</td>
</tr>
</tbody>
</table>

Table 50: Sample behavior tree notation

*Therefore this stage fully supports the affirmation of this research objective by distilling the essential underlying point and placing it into clear focus for the reader. Clarification is valuable on this project because the essential nature of leadership appears often to be obscured by contextual factors relevant to particular situations. Saying, as in the example above ‘Leader creates a shared vision of the goal(s)’ gets to the essential truth effectively without unnecessary phrases like ‘.. of what is to be accomplished, ideally seen as an accomplished fact.’ A full Behavior Engineering analysis is a desirable future project.*

8.5.5. **RO5 & Stage 5: Expert panel review**

*Not relevant to RO5.*
8.5.6. RO1 & Stage 6: Composition Tree notation review

The application of Dromey's composition tree notation to the V0.5 PRM identified the presence of defects not found in previous reviews. Composition tree notation identifies the system vocabulary, (while the behavior tree notation concentrates on semantic correctness).

As with behavior tree notation review (stage 4) and the ISO/IEC 15504-2 and ISO/IEC 24774 review (stage 3), this review was effective at clarifying the way the model is expressed.

When applied to the V0.5 PRM we derive results such as this; before the composition tree notation, Process 1 *Shared vision* becomes Process 1 *Vision*, after applying the composition tree notation. It highlights that 'shared' is an attribute of 'vision' so process should be simply called 'Vision', with 'shared' being dealt with in Outcome 2. So 'shared' is removed because the vision is not shared until it is communicated.

The notation associated with this example is seen below. Note how shared is clearly placed as an attribute of Vision:

<table>
<thead>
<tr>
<th>1.1</th>
<th>VISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1.1</td>
<td>Exists</td>
</tr>
<tr>
<td>1.1.2</td>
<td>Shared</td>
</tr>
<tr>
<td>1.1.3</td>
<td>Committed</td>
</tr>
<tr>
<td>1.1.4</td>
<td>Resilient</td>
</tr>
<tr>
<td>1.1.5</td>
<td>Objectives</td>
</tr>
<tr>
<td>1.1.6</td>
<td>Positive Expectation</td>
</tr>
</tbody>
</table>

Table 51: Sample composition tree notation

Therefore this stage review fully affirms this research objective by further distilling the word usage of the draft PRM. As with stage 4, this process of distillation is valuable on this project because the essential nature of leadership is often obscured by contextual factors. Rewording 'Shared vision' to become 'Vision' is an improvement as it distils the process to its essence. Behavior tree and composition tree notation have also helped to identify the other essential attributes of vision (that it exists, is communicated in a way that gains commitment, that it inspires resilience in the face of goal-frustrating events, produces a set of practically-worded objectives and creates a sense of positive expectation). A full Behavior Engineering analysis is a desirable future project.
8.6. IPRC research questions

The revision process for the literature review revealed substantial alignment between the aims of this project, and the broader aims of the process research community, as represented by the International Research Consortium (IPRC).

The SEI-sponsored International Process Research Consortium’s roadmap for future SE process research (SEI, 2006) identifies the recommended future direction of process research. It is therefore an invaluable resource for researchers active in this domain who are seeking to inform their work with relevance and context.

The result of this collaboration (six workshops involving 27 IPRC members between 2004 and 2006) is a thematic guide to critical process research, described as the Process Research Framework (SEI, 2006). Four broad research themes emerged from the IPRC’s work:

- **Process and product quality relationships** – emphasising the product perspective, how process affects product characteristics.

- **Process engineering** – with emphasis on how to define processes.

- **Managing project processes** – emphasising the project organisation perspective, including the political, economic and/or social values of stakeholders.

- **Process deployment** – emphasising the people perspective, how to deploy the right processes into the right organisational structures so that the people concerned have optimal opportunities.

These four themes are comprised of 20 research nodes addressing around 230 research questions. They can act together to support structured thinking in the process domain (SEI, 2006). Underpinning these themes and nodes is a set of nine driving forces, derived from an original set of more than 100; value add, business diversification, technology change, system complexity, product quality, product turnaround, regulation, security and safety, and globalization.

The leadership PRM under development in this project has particular relevance to the process engineering and managing project processes – research themes.
In Theme E: Process Engineering, the following seven research questions have particular relevance to this project. In Theme P: Managing Project Processes, the following five questions are relevant.

<table>
<thead>
<tr>
<th>IPRC Research Framework</th>
<th>Relevance to Leadership PRM project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research questions</strong></td>
<td><strong>Theme E: Process Engineering</strong></td>
</tr>
<tr>
<td>E-1 How can usable best practice be identified?</td>
<td>Literature review and review cycles identify and validate usable best practice.</td>
</tr>
<tr>
<td>E-2 What kinds of processes are needed for value-creating networks; virtual teams, partnering, outsourcing, multi-site development, end-user development?</td>
<td>PRM specifically identifies processes needed to facilitate effective virtual teams in multi-site development contexts.</td>
</tr>
<tr>
<td>E-4 How to perform a gap analysis between today’s state and desirable future state?</td>
<td>PRM has the potential to be developed into a Process Assessment Model subsequent to this project. PAM offers the ability to perform such gap analysis.</td>
</tr>
<tr>
<td>E-5 How can we best specify a process?</td>
<td>Posits that using an ISO/IEC 24774 compliant process specification method is effective. This position is evaluated in light of the results.</td>
</tr>
<tr>
<td>E-6 How can process definitions be packaged together with a quantitative/qualitative model describing their behavior?</td>
<td>Leadership PRM defines processes, as in E-5 into a model that describes the qualities and characteristics of an effective leader.</td>
</tr>
<tr>
<td>E-8 Can a process be analysed to determine if it is implementable?</td>
<td>Leadership PRM initial review (V0.1 to V0.2) validates the draft PRM by asking practitioner project managers if the process outcome can be validated with objective evidence in the form of activities and/or artefacts. Only validated processes remain in the PRM as it progresses through review cycles.</td>
</tr>
<tr>
<td>E-9 What process evidence is required?</td>
<td>The collected results of the validation review referred to above are instantiations of the process outcomes, and as such constitute evidence of process performance.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Theme P: Managing Project Processes</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>P-3 What are the needed competencies for the required tasks on a specific project?</td>
</tr>
</tbody>
</table>
How do we make optimal use of available competencies? ... How do we effectively combine competencies available in different companies?

Leadership PRM specifically describes optimal usage patterns for HR competencies.

How do we manage development between different locations?

Leadership PRM specifically addresses the issue of how to lead non-co-located and/or complex project teams.

How do we make processes that are compliant with accepted standards?

This project posits that a ISO/IEC 24774 should be used for wide-scale PRM usage.

How do we manage virtual teams?  How are VT’s formed?

PRM is fundamentally about leading (enhanced management) virtual teams.

<table>
<thead>
<tr>
<th><strong>P-5</strong></th>
<th><strong>P-7</strong></th>
<th><strong>P-15</strong></th>
<th><strong>P-23</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How do we make optimal use of available competencies? ... How do we effectively combine competencies available in different companies?</strong></td>
<td><strong>How do we manage development between different locations?</strong></td>
<td><strong>How do we make processes that are compliant with accepted standards?</strong></td>
<td><strong>How do we manage virtual teams? How are VT’s formed?</strong></td>
</tr>
<tr>
<td>Leadership PRM specifically describes optimal usage patterns for HR competencies.</td>
<td>Leadership PRM specifically addresses the issue of how to lead non-co-located and/or complex project teams.</td>
<td>This project posits that a ISO/IEC 24774 should be used for wide-scale PRM usage.</td>
<td>PRM is fundamentally about leading (enhanced management) virtual teams.</td>
</tr>
</tbody>
</table>

In addition to the above, there are a number of other research questions in both themes that are too marginal to mention here, though nonetheless relevant to some degree.

Table 52: IPRC Research Framework Research questions (SEI 2006) and relevance to Leadership PRM project

_It may be seen from the table above that this project is aligned in at least 12 ways with the broader process research framework, as outlined in A Process Research Framework: The International Process Research Consortium (2006). This substantiates that this project has relevance to the academic research agenda, in addition to the relevance to the practitioner community discussed in Chapters 1 and 2._
9. Conclusions

The Design Research project described in this thesis set out to identify the essential nature of leadership and then to embody that information into a process model that might be useful for project managers running virtual teams. In performing this project, these two objectives have been achieved, as well as several other subordinate objectives, as discussed in this chapter and the previous. One of these is the development of a Design Research method for developing process reference models that might be useful in multiple domains from both an academic and practitioner point of view.

Also achieved was the identification of Behavior Engineering as a useful tool for validating Process Reference Models, though this formal method was originally developed to validate software system requirements.

9.1. Significance of the findings in relation to the research question

What are the qualities and characteristics of effective leaders of integrated teams operating in virtual environments?

The research question arises from a repeatedly recognised issue in the practitioner and academic literature of the importance of effective team functioning in technology development, particularly in relation to the emerging field of integrated teaming in a virtual environment.

This thesis has sought to answer the research question by formulating the five research objectives mentioned previously throughout the thesis. It will be noted that only the first research objective specifically addresses the question of what are the characteristics of effective leaders etc. This objective has been achieved, based on the results and findings discussed in the previous two chapters. The remaining four questions are derived from the first for the following reasons:
In order to determine whether the qualities of an effective leader have been captured, a way must be found to implement and test the qualities derived from the literature review. A PRM is a practical, working entity that exists to be used in a practical sense. Hence a PRM helps to validate the first RO by putting it to a test in a real-world environment, first by having practitioners and experts review it, and subsequently have people use it themselves on their own projects. This objective has been achieved, based on the results and findings discussed in the previous two chapters.

The objective ‘to determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior’ derives from the previous objective, (to formulate the ideal qualities of a leader into a PRM). It is necessary to test this proposition since no-one has previously developed an ISO 24774-conformant PRM dealing with Leadership. Leadership behavior is arguably difficult to express in terms of purpose/outcomes. As review stages 1 and 2 determined, activities and/or artefacts could be identified for each of the process outcomes that went forward from these first two reviews. This objective has been achieved, based on the results and findings discussed in the previous two chapters.

The objective to determine the suitability of Design Research (DR) as a method of developing PRMs seeks to (a) validate the research methodology as being suitable in relation to other potential research methods (action research, case study etc), and (b) to present to the software engineering community, and the design community more generally an effective way of developing a reference model that others might use. This objective has been achieved in both parts, based on the results and findings discussed in the previous two chapters.

The final objective, to evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to validate the Process Reference Model seeks to determine whether this formal method that shows considerable promise as a software requirements validation tool might be beneficially applied to the validation of PRMs. There is abundant evidence to be seen in the results that these formal notations are effective in this capacity. This objective has been achieved, based on the results and findings discussed in the previous two chapters.
9.2. Contribution of the thesis

In summary, this thesis establishes or adds to the body of research relating to the following:

9.2.1. Improved practical understanding of leadership

Leadership is a much studied but apparently not yet well-understood activity in human affairs. Despite the thousands of books and articles written on the topic since Plato’s Republic discussed the characteristics of effective rulers, no clear consensus yet exists as to how leadership might be defined.

This project took a broad-based review of the leadership literature and distilled the characteristics of effective leaders into a relatively compact and manageable list. The list was then reviewed by practitioners, experts and formal methods to validate the content. This activity was successfully completed, so arguably the content of the V1.0 PRM is a reasonably comprehensive list of the basic qualities of a good leader.

The project therefore contributes a working definition of leadership as applicable in the context of a technology development project team that may be co-located or virtual, simple or complex in composition. The PRM is not tied specifically to technology development either; it could arguably be applied to projects in a wide variety of domains and sectors. Given the trend towards globalisation, the V1.0 PRM has the potential to assist many people in many projects involving very significant sums of money.

9.2.2. PRM for leadership of complex virtual teams

Complex virtual teams pursuing a variety of projects around the world represents a significant category of IT project. Both today and increasingly in the future. Yet coordinating such teams surely represents a challenge for many project managers for whom ordinary projects are already challenging enough. Virtual projects on a large scale have the difficulties of no physical proximity and increased complexity to contend with. Tools are therefore needed to help project managers with this challenge. A Process Reference Model (PRM), this thesis argues, is an appropriate tool to address this challenge.
PRMs have an important place in the broad field of engineering. They have been used to good effect for generations in the more established branches of engineering. Civil engineering, for example, became process driven during the Industrial Revolution when it was necessary to build infrastructure of an industrialised society on a mass scale. The craft of the bridge-builder handed down from journeyman/master to apprentice became formalised into a process that could be taught to student civil engineers and then applied to real projects. With the relatively recent arrival of computers on a mass scale, software engineering on the other hand is still maturing into a process model discipline. It appears to be one of the few, perhaps the only branch of engineering not yet experiencing the full benefits of pursuing its activities using a rigorously process-driven approach.

Certainly there are some exceptions here; technology developers who do perform their projects rigorously, particularly those in safety critical sectors like transport, defence and health. Yet equally certain is the distressingly large number of software developers who perform their projects with little or no process. Entrenched cultural practices in these organisations coupled with an unreflective outlook mean they ‘fly by the seat of their pants’. Such organisations make the same mistakes over and over, produce poor quality software with defects aplenty, over-budget, and over-schedule. This persistent problem could be solved by adopting a more rigorous, engineering process-driven approach, instead of an ad-hoc approach seen so often. It is this problem that the PRM developed in this project is intended to address.

The project therefore contributes significantly to the software engineering domain by providing a PRM that addresses an important problem and which is consistent with other PRMs in the domain like ISO/IEC 15504 (SPICE) and the SEI’s CMMI. Practitioners already familiar with these established PRMs may find the leadership PRM understandable and applicable given the consistency of approach. People not already familiar with established PRMs may nonetheless find the leadership PRM usable due to the inherent ease-of-use of the standard purpose/outcome format used. Its ease of use may serve as an access point to these other PRMs that seem more complicated.
9.2.3. Is it possible to have PRM for leadership?

The project explored the question of whether the model developed in the way that this one was developed can be accurately described as a Process Reference Model. PRMs in software engineering have traditionally focussed on performing the right tasks in the right way and in the right sequence to get the job done. Activities are performed and artefacts created in a largely externalised set of activities that can be observed and assessed against an objective assessment model.

Leadership, on the other hand, derives partly from a set of personality factors residing in the leader and partly from explicit actions performed by the leader at the team and organisational level. These explicit actions can be directly observed, but the implicit qualities cannot be, only their effects, as manifested by the attitudes and activities displayed by the leader.

The question remains, can a model that describes the characteristics of an effective leader be accurately called a Process Reference Model? Arguably it can if it (a) conforms to the requirements of ISO/IEC 24774 and 15504, (b) it is validated by multiple review iterations by practitioners who cite activities and/or artefacts that are performed in relation to outcomes, (c) it is reviewed and not refuted by a panel of experts with wide experience of PRMs in the software engineering domain, and (d) it is a model that an external observer may use to describe the behavior of an effective leader.

On the other hand, the outcomes of the model describe aspects of desired organisational behavior that, if performed repeatedly, will result in consistently achieving the prescribed purpose. This re-focuses attention from conformance to prescribed activities and tasks, to a focus on the demonstration of desired organizational behavior which takes us away from the traditional role of a PRM. It might be valid to say that what has been produced in this project is a new category of process reference model, described provisionally as a Reference Model for Organisational Behavior.

The project therefore contributes to the debate on what properly constitutes a reference model. Since this project takes the definition of a PRM as that given in ISO/IEC 24774, what has been developed is arguably a PRM. Therefore it is possible to have PRM for leadership.
9.2.4. Improved method for PRM development

Design Research (DR) has a good record since the second world war of developing high-usability artefacts that solve real-world problems. Not just in the industrial design and architectural domains where it began, but increasingly in the broader design community, including the engineering domain, as seen in the activities of Carnegie-Mellon’s SEI and MIT’s Media Lab.

No evidence was found in the literature of DR being used to develop a Process Reference Model. Using DR in this way is arguably a novel application of the method, one that others might use to good effect to develop other PRMs to solve other SE-domain problems.

The project therefore contributes significantly to the repertoire of Design Research methods and applications. A submission is planned for the high-impact interdisciplinary journal Design Studies in which the method is elaborated for the broader design community.

9.2.5. Is Behavior Engineering useful for validating PRMs?

Dromey’s Behavior Engineering (2006) has been developed primarily for the validation of software system requirements. It has proven highly effective in field trials. Given its effectiveness with requirements, the question of whether it might be effectively applied to PRM development remained to answer. This project applied a subset of Behavior Engineering (Behavior Tree and Composition Tree notation) to the review of the PRM. They were added as two separate review cycles (4 and 6). The reason they were not done consecutively was a matter of practicality and scheduling. Access to Professor Dromey was limited; hence briefing sessions on how to perform the analyses had to be scheduled when practical. Ideally, the two reviews might have been done consecutively, but in practice it did not matter much.

The improvements derived from the application of behavior tree notation are greater clarity and economy of words. Behavior tree notation highlighted where and how these economies of expression could be made; in other words the more informal language of V0.3 PRM was rendered into formal language in V0.4 PRM. Behavior tree notation offers a rigorous, consistently applied editorial logic for people without qualifications.
and/or much experience as editors. An experienced editor may achieve the same results without BT notation, anyone else would arguably benefit from its application.

Composition tree notation improved the draft PRM by compiling a complete vocabulary of terms. Synonyms or terms used loosely or inconsistently could be recognised and corrected.

*This project therefore contributes significantly to both the repertoire of useful Design Research methods, and the field of PRM development.*

### 9.2.6. IPRC research agenda

The IPRC research agenda is an invaluable road-map for the way forward for process researchers. This project is substantially aligned with the broader IPRC agenda; as such this is a significant strength of this project, adding to its credibility as a research project with sufficient relevance, in keeping with the best traditions of doing a PhD.

*This project therefore contributes significantly to the IPRC research agenda by being aligned in at least 12 ways with the broader process research framework, as outlined in A Process Research Framework: The International Process Research Consortium (2006). This substantiates that this project has relevance to the academic research agenda, in addition to the relevance to the practitioner community discussed in Chapters 1 and 2.*

### 9.3. Main findings

This research project has sought to find answers in relation to the stated research objectives. This section will indicate how each specific objective has been addressed and supported by the research, and summarises the conclusions that may reasonably be drawn.

The findings have been grouped according to how they relate to the research objectives. The objectives themselves being the tools chosen to explore the research objective:
## Research Objective (RO)  |  Conclusion
--- | ---
To identify the qualities and characteristics of effective leaders of integrated teams operating in virtual environments. | Stages 1, 2 and 5 contributed greatly to the achievement of this RO. Stages 3, 4 and 6 contributed partially. The literature review, and the three practitioner / expert reviews successfully identified the qualities and characteristics of good leaders through a combination of theory and practice. The theory as derived from the literature review was itself based on wisdom and experience. This theory was distilled and put to practical test in the three reviews (1,2 &5). The ISO 24774 and Behavior Engineering reviews contributed partially to this RO by clarifying the mode of expression and making it consistent, thus making it easier to understand the qualities of a leader.

Based on the identified qualities and characteristics, to develop a Process Reference Model (PRM) for the leadership of integrated teams operating in virtual environments, as prescribed by ISO/IEC 24774:2007. | All stages contributed to the achievement of this RO. The one RO that all stages contributed to; this project is as much about developing a method for developing PRMs as it is about identifying leadership qualities. The IPRC identifies improved methods of developing PRMs and getting people to use them as research priorities in the SE research domain. A strong argument is made here that this six stage method is a practical and effective way to develop PRMs. Efforts will be made to disseminate knowledge of the method so that others might use it.

To determine whether the Process Reference Model can be accurately termed a PRM or whether its characteristics warrant it being termed more generally a Reference Model of Organisational Behavior. | Stages 1, 2, 3 and 5 contributed greatly to the achievement of this RO. Stages 4 and 6 did not contribute at all. A significant question exists as to whether the V1.0 PRM can be accurately called a PRM, or a reference model of organisational behavior. Looking at a collection of processes that way highlights that the outcomes represent the results of desired organizational behavior, and will result in consistently achieving the prescribed purpose if they are institutionalised. Taking this approach refocuses attention from conformance to prescribed activities and tasks, to a focus on performing preferred organizational behavior through achievement of outcomes. There is a strong argument for the latter, however since this project was designed around the development of a PRM, a stronger argument exists for the V1.0 to be accurately called a PRM because it conforms to the critical requirements and characteristics of a PRM.
To evaluate the efficacy of the design research approach employed in this thesis to the development of Reference Models of Organisational Behavior in the software engineering domain.

All stages contributed to the achievement of this RO. This RO deliberately broadens the scope from PRMs only to include reference models of organisational behavior in order to be as inclusive as possible. The results indicate that the DR method used in this project is practical and effective at developing PRMs, and may include RMOBs if that is in fact what has been the result of this project.

To evaluate the efficacy of using Dromey’s formal Behavior Engineering notation (specifically Behavior Tree and Composition Tree notation) to verify Process Reference Models in general.

Stages 4 and 6 contributed greatly to the achievement of this RO. Stages 3, and 5 did not contribute at all.

Though Behavior Engineering was developed with software requirements validation as the primary use, it has nonetheless proven an excellent method of validating the semantic and compositional elements of the PRM. It forms an integral part of the PRM development method demonstrated in this project, since without it, the improvements made because of it would not have occurred unless something other method was used.

Table 53: Summary of research findings

The summary table above is further elaborated below:

**9.3.1. General purpose method for developing PRMs**

This project pioneers a new way of applying Design Research to the development of process reference models. While the PRM developed in this project is conformant to the standards applicable to software engineering, there is no reason why the same process may not be used for reference models applicable to other domains, such as business management.

It would only be necessary to substitute another applicable ISO standard in place of ISO/IEC 15504 and 24774. In the absence of other applicable standard(s), the purpose/outcome format prescribed by ISO/IEC 24774 could likely be retained to good effect. Arguably the Model-based process Improvement research efforts that informed the adoption of the purpose/outcome format for process models has applicability beyond the software engineering domain.
9.3.2. PRM for project managers

As with the previous 'strength' what has been developed for use in a specific domain (software engineering) has the potential for broader application.

Complex virtual projects being performed in the software engineering world are certainly a candidate for a model designed to help the project manager improve their performance. But the same requirement most likely exists in other domains of project management. A substantial proportion of the problems faced by technology development project managers would not be unique to them, being challenges faced by project managers pursuing a wide-range of project types. If the team is complex and/or virtual, then this PRM is applicable. There is nothing in the PRM that limits it to the SE domain.

9.3.3. IPRC research agenda

The process research community has a clear direction for the future through the efforts of the IPRC and its published research agenda (SEI, 2006). A major strength of this project is its substantial alignment with the IPRC agenda.

This alignment therefore gives this project academic relevance, in addition to its relevance to the world of practice.

9.3.4. Abduction plus deduction better than deduction or induction alone

Another strength of the project is its use of abductive reasoning. Abduction (in the logical sense) is at the heart of the design process. To abduce a solution to a problem means applying inference that takes the available data/evidence and formulates the best likely solution, or hypothesis. This is distinct from the more conventional ways of formulating solutions, namely deduction and induction (Sebeok, 1981).

The abductive process appears well-suited for solving problems for which there is no obvious or immediate solution. This kind of problem is not uncommon in the modern business environment, where conventional solutions to new problems may not be enough. Deduction and induction require the existence of established facts before conclusions can be reached. Hence in this project, we begin with abductive reasoning.
to explore the nature of the problem in the literature review, and then proceed to
deduction (see figures below).

![Diagram](image)

Figure 24: General methodology for Design Research (Vaishnavi and Kuechler, 2004/5, Takeda et al 1990) cited from ISWorld.

The general methodology has been adapted for this project in the following way.

![Diagram](image)

Figure 25: Adaptation of General Methodology of Design Research for this project (Vaishnavi and Kuechler, 2004/5, Takeda et al 1990).
9.4. Limitations of the research

9.4.1. Insufficient theoretical base for DR in this project

Basili (1996) observed that Design Research has an inadequate theoretical base upon which a joining of the scientific and engineering disciplines might occur. This limitation is also a strength in this project. While there was no precedent for using DR to develop a reference model, the project developed a precedent that can be used by others in the future.

The absence of existing DR tools, models and methods relating to Process Reference Models is acknowledged as a limitation in the sense that the project was unable to cite precedent in the approach it takes. This limitation was met by following closely and comprehensively the guidelines outlined by Hevner (2007) for valid Design Research. This project conforms to these guidelines in every respect. It can therefore be asserted that this project is valid DR, and the method used that others might take advantage of is also valid. The Leadership PRM so developed adds to the knowledge base by outlining a DR-based method for developing ISO/IEC 24774-conformant Process Reference Models in the software engineering/model-based process improvement domain.

9.4.2. Design is an undisciplined craft

It is said that Design is still an undisciplined craft relying on intuition, experience, and trial-and-error (Newell and Simon, 1976). How does one introduce sufficient rigour to an exercise in design to satisfy academic requirements? The short answer is by defining a rigorously developed process and then rigorously applying it, evaluating the effectiveness of it and then putting it out into the world for others to use. In other words, by establishing a precedent.

This project manages the negative effects of this limitation by producing a process-driven method for developing reference models and organisational behavior models. Design in the broader sense is becoming more process-driven, as seen in the curriculums of well-regarded Industrial Design degree-level courses.
9.4.3. **DR results are of transitory value**

Hevner (2007) comments on an attitude in the broader academic community that the results of design research are of transitory value. As the pace of technology development and innovation accelerates, the real value of DR will diminish as its methods and results quickly become redundant.

While this may be true in cases where the research is dealing with technology that will be redundant in the near future, it can be strongly argued that this limitation can be effectively overcome when the research is dealing with principles that have a much longer effective lifespan. What is seen on the surface may disappear, blown this way and that by the winds of change, but the underlying principles do not change. The principles of leadership do not change over time (though their outward expression may differ according to cultural context). The format and organising principles beneath Process Reference Models in software engineering will not change either. Expressing processes in terms of purpose and outcome is likely to endure into the foreseeable future because it works well that way, and no better way has been identified by the broader process research community.

It may therefore be said that this limitation is generally true, but in this specific instance, a process-driven application of DR is enduring because it applies to categories of activity, not specific instances of activity.

9.4.4. **Dissemination of DR essential but difficult**

Hevner (2007) observes that the communication of design research results to the world of practice is essential but a major challenge in many cases. Two avenues of dissemination are planned and in progress. The first is a submission to the high-impact (1.08) journal Design that outlines the DR method, and secondly the resulting PRM from this project will be adapted into a mass consumption book aimed at project managers around the world, from a wide variety of sectors, not just software engineering.
9.4.5. Avoiding the limitations of DR

Hevner (2007) discusses certain limitations inherent to Design Research.

<table>
<thead>
<tr>
<th>Design Research Limitation</th>
<th>Remedy/Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inadequate theory base for joining scientific and engineering disciplines (Basili, 1996).</td>
<td>Leadership PRM project acknowledges this by explicitly adding to the theory base of effective DR strategies.</td>
</tr>
<tr>
<td>There are not enough constructs, models, methods, and tools in the Design Research knowledge base to adequately represent real-world problems and solutions.</td>
<td>Leadership PRM project adds to the knowledge base by outlining a DR-based method for developing ISO/IEC 24774-conformant Process Reference Models in the software engineering/model-based process improvement domain.</td>
</tr>
<tr>
<td>Design is still an undisciplined craft relying on intuition, experience, and trial-and-error (Newell and Simon, 1976).</td>
<td>Leadership PRM project develops a process-driven method for developing reference models and organisational behavior models. Design in the broader sense is becoming more process-driven.</td>
</tr>
<tr>
<td>The results of design research are of only transitory value as the pace of technology development and innovation accelerates.</td>
<td>Again, a process-driven application of DR is applicable to categories of activity, not specific instances of activity.</td>
</tr>
<tr>
<td>Rigorous evaluation methods are difficult to apply in design research.</td>
<td>Leadership PRM project adopts a rigorous six stage review process, each of which examines the PRM from a different angle, including input from partitioners, application of ISO/IEC standards, and the formal methods (Dromey’s Behavior Engineering) producing empirical results that are used to evolve the PRM, with any and all changes being logged and explained in order to achieve full traceability.</td>
</tr>
<tr>
<td>Communication of design research results to the world of practice is essential but a major challenge.</td>
<td>The resulting PRM from this project will be adapted into a book for a practitioner audience. The intended audience is project managers from any sector who run complex virtual teams. The potential readership is therefore in the hundreds of thousands internationally.</td>
</tr>
</tbody>
</table>

Table 54: Limitations of Design Research and remedy/mitigation strategies
9.5. Opportunities for future research

9.5.1. Process Assessment Model

A logical extension to this project is to develop a Process Assessment Model (PAM) based on the PRM. This would essentially be to examine the application of the PRM in the world of practice. A PRM could be validated in the world of practice by:

- Using it as the basis for a prescriptive process model for organisations to implement processes that support effective leadership, and/or
- Using the PRM as the basis for a PAM whose purpose is to evaluate the organisations capability at supporting the leadership of virtual teams.

In relation to the second point it would be necessary to consider carefully whether the concept of process capability is applicable in this case. If process capability is applicable, then the question of what kind of indicators of process performance and capability are applicable would need to be addressed. The Stage 1 and 2 reviews of this project have made a contribution in this regard.

9.5.2. Behavior Engineering

Substantial scope exists to extend the application of Dromey's (2007) Behavior Engineering to the development of other Process Reference Models. Originally developed to validate software system requirements, Behavior Engineering appears to be a useful tool for validating Process Reference Models. Considerable scope exists to explore the capabilities of Behavior Engineering in the model based process improvement domain.

This project applied the notation associated with the Behavior Tree and Composition Tree analyses which is a beginning point when applying Behavior Engineering. The results of this project indicate clear benefit for people wishing to validate a PRM by applying the two kinds of notation mentioned above. Future research could develop the graphical tree structures that are the next step in the BE process.

As with the Process Assessment Model in the previous section, doing a full Behavior Engineering analysis on the Leadership PRM though desirable lies outside the scope of this project simply because the project needed to be kept a manageable size.
9.5.3. Leadership and memes

Considering leadership in a much wider context opportunities exist to explore how leadership is performed through the transmission of memes. If leadership is about persuading people to adopt a leader’s ideas and work towards the realisation of the leader’s vision of the future, it is reasonable to characterise this process as one in which memes (Dawkins, 1989) are transmitted from the mind of the leader to those of the followers. A meme being a unit of meaning or culture that reproduces itself in the minds of people as it is spread via various channels of communication.

History abounds with examples of ideologues that have influenced large numbers of people to accept their ideas. The ideologue then inspires those people to work towards the realisation of those ideas.

In the world of technology, people such as Steve Jobs and Bill Gates have influenced the patterns of technology usage of large numbers of people. In broader society the phenomenon is clearly evident too. Barak Obama’s successful campaign in 2008 involved creating a set of well-crafted memes (or policies) describing a vision of the future, which was then persuasively communicated to not just the American people, but to world at large.

In the 20th Century alone, the catastrophic conflicts between capitalism, communism and fascism illustrate how readily people respond to persuasively packaged memes. The fact that such a phenomenon has resulted in the deaths of more than 100 million people in that century alone indicates that a better understanding of the phenomena is required if we are to learn from the lessons of history.

Future research could therefore examine the process of memetic transmission, seeking to understand the factors that enhance and inhibit the transmission of memes. The application of this research has broad implications in project management, business management in general, social psychology and cultural anthropology.
9.6. *Concluding remarks*

A project of this nature is a synergistic combination of research and practice. Rigorous academic research and the development of tools to aid project managers working hard to complete complex virtual projects can be combined in a way that achieves multiple worthwhile outcomes, resulting in high degree of relevance and rigor.

This thesis builds on earlier work (Tuffley, 2008) in which an improved process for collecting, analysing, verifying, validating and managing software system requirements was applied in a commercial software development setting. The Action Research approach used in that project and the lessons learned has transformed into the Design Research approach which has proved itself an excellent tool for performing projects that set out to solve real-world problems.

This project contributes to our understanding of process models, in particular how processes can be defined more broadly to include categories of activity like leadership not previously considered to be processes but instantiations of organisational behavior.

By viewing a collection of processes this way, we see that some of the outcomes are the results of desirable organisational behavior that, if institutionalised, will result in consistently achieving the prescribed purpose. Analysing process performance then moves from a focus on conformance to prescribed activities and tasks, to a focus on demonstrating preferred organizational behavior through achievement of outcomes.

The approach also extends the reach of process to include character traits that cannot be observed directly, but whose existence can be inferred from the behavior that derives from those traits. There is evidence to support a claim that the method used in this project can be applied to other models of organisational behavior, for example governance (i.e Banking SPICE)

The project also extends our knowledge of how Design Research can be applied. This is a previously unknown application of DR. Others might use this method to develop their own process models and efforts will be made to disseminate this technique to the software engineering and design communities.

End
10. References


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11. Appendices

The Appendices contain:

1. **Draft Process Assessment Model** with representative content to illustrate that the Process Reference Model (PRM) is capable of serving as the basis for an ISO/IEC 15504-conformance Process Assessment Model

2. **Full data set.** As indicated in the thesis, the full data set is too large (100,000 words) to include in the body of the thesis. A representative data set is therefore included in the thesis, with the full set in the Appendix