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A NEW PROCESS IMPROVEMENT APPROACH FOR MANAGEMENT CONSULTANCY ORGANISATIONS

MARNÉ DE VRIES

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EXECUTIVE SUMMARY

Organisations of the 21st century realise that they need to move away from balance sheet accounting systems as the primary tool of management. Intangible assets, such as knowledge, skills and process assets, may be worth much more than their physical assets and require effective management to gain a competitive advantage.

Due to the nature of their assignments, management consultancy organisations could benefit even more from leveraging their knowledge, skills and process assets. These firms depend on the expertise of their people, focusing on customer relations, employing multidisciplinary teams of professionals in creatively solving problems in a project management environment. Continuous improvement of their processes and effective reuse of knowledge obtained in previous projects or processes could fast-track solution delivery, reduce costs and consequently increase profits.

Many models for process-improvement and knowledge management currently exist, which could be used in leveraging organisational intangible assets. Though the intricate interaction between the domains of process improvement management and knowledge management is clear in current models, a fully-integrated model does not exist. The close-knit relationship between these domains poses the opportunity for integrating improvement models from both domains in synergistically leveraging their improvement results.

The aim of this study is to demonstrate the integration possibilities of process improvement and knowledge management in an attempt to improve the practices of both during the same exercise.

A content analysis was performed to analyse current improvement models (including performance improvement, knowledge management, process management, maturity and audit models). Maturity models were then selected as a vehicle for integrating the various domains. The selected maturity models were evaluated for comprehensiveness in terms of management consultancy organisations and deficiencies were identified.

A blended model was designed (combining and extending current models) and partially validated at a management consultancy organisation. Model validation was enabled by using an appraisal tool (BMAT – Blended Model Appraisal Tool), which was designed and built to incorporate appraisal components from the various maturity models and their required extensions. The results that were obtained from the model validation exercise highlighted organisational problem areas (at the appraised organisation) that would require immediate improvement efforts.

The study is concluded by confirming the integration possibilities of process improvement management and knowledge management domains. Further empirical research is proposed for validating the complete blended model.

University of Pretoria, etd De Vries, M (2006)

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University of Pretoria, etd De Vries, M (2006)

TABLE OF CONTENTS

CD CONTENT

The following electronic files are available on the attached CD.

Path on CD	Content
\Database\BMAT.mdb	Blended Model Appraisal Tool database.
\Reports\Appraisal Result Report.pdf	Waymark practice appraisal results.
\Reports\KM Appraisal Result Report.pdf	Waymark KM appraisal results.
\Reports\Institutionalisation Practices.pdf	Institutionalisation practices from various maturity models.
\Reports\Implementation PA.pdf	Implementation process areas, its goals, practices, sub-practices and other informative elements.
\Reports\KM Sub-Practices.pdf	A report generated from BMAT listing various sub-practices that could be classified as knowledge management sub-practices.

LIST OF FIGURES

LIST OF TABLES

ABBREVIATIONS

Terminology	Description
AQPF	American Quality and Productivity Federation.
BMAT	Blended Model Appraisal Tool.
BPM	Business Process Management.
BPMS	Business Process Management System.
CMMI	Capability Maturity Model Integration.
DSS	Decision Support System.
EAI	Enterprise Application Integration.
EFQM	European Foundation for Quality Management.
ERP	Enterprise Resource Planning.
ES	Expert System.
EVA	Economic Value Added.
HRMS	Human Resource Management System.
IPPD	Integrated Product and Process Development.
IT	Information Technology.
KM	Knowledge Management.
KMM	Knowledge Management Model.
KMAT	The Knowledge Management Assessment Tool developed by the American Productivity & Quality Centre and Arthur Andersen.
KPA	Key Performance Area.
P-CMM	People Capability Maturity Model.
POP3/SMTP server	Post Office Protocol - A protocol used to retrieve e-mail from a mail server. SMTP - Simple Mail Transfer Protocol - a protocol for sending e-mail messages between servers. The newer version, POP3, can be used with or without SMTP.
SCAMPI	Standard CMMI Appraisal Method for Process Improvement.
SEI	Software Engineering Institute of the Carnegie Mellon University.
TCP/IP	Transmission Control Protocol / Internet Protocol - TCP is one of the main protocols in TCP/IP networks. Whereas the IP protocol deals only with packets, TCP enables two hosts to establish a connection and exchange streams of data (http://www. webopedia.com/TERM/T/TCP.html).
TQM	Total Quality Management.
V-KMMM	VISION KMMM: A Knowledge Management Maturity Model developed by Weerdmeester, Pocaterra, & Hefke [3].

1. INTRODUCTION AND BACKGROUND

1.1 ORGANISATIONAL CONTEXT

The new e-business economy of today has changed the understanding of what creates value for organisations. Intangible assets (e.g. intellectual capital, which includes the knowledge and skills of employees) are now one of the most important sources of value creation. A company may have a book price (appearing on its balance sheet) of R10 000 000, yet have a worth of R100 000 000 on the stock exchange. Intellectual capital accounts for the R90 000 000 difference (Bahra [26]).

The World Bank (cited in Bahra [26], p. 49) noted that "the balance between knowledge and resources has shifted so far towards the former that knowledge has become perhaps the most important factor determining the standard of living…Today's most technologically advanced economies are truly knowledge based". "To make knowledge work productive is the great management task of this century, just as to make manual work productive was the great management task of the last century" (Drucker, cited in Bahra [26], p. 58).

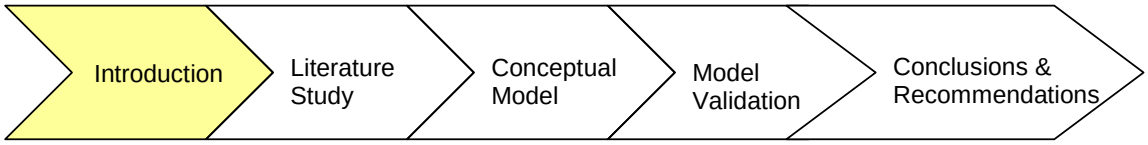
People's skills, knowledge and creativity (also called human capital) have become important in the creation of economic value (Bahra [26]). Employees also realise their value and command the highest fees from organisations that will "recognise and respect their talent and allow them to learn and earn and develop their skill base" (Bahra [26], p. 51). The relationship between employee and employer is changing – the balance of power is shifting to the talented, creative individual. Employees realise that job security is something of the past. "Three career moves and eight job changes will be the norm in the future" (Walter, cited in Bahra [26], p. 49).

Consultancy firms are some of the very first adopters of KM practices. This sector's main asset is people; consequently consultancy firms heavily invest in training and development, but are also characterised by a high staff turnover rate. These organisations are engaged in multiple projects with various clients. Each project contains a set of project-specific processes, tasks and project team members. The challenge is to efficiently utilise employee expertise and knowledge within consultancy firms, ensuring that the KM investments are balanced with strategic business objectives, other organisational improvement initiatives and their relative value addition.

Due to the strong process orientation of management consultancy firms, KM and organisational learning initiatives need to enhance this process perspective. This study will explore the capabilities of current models (especially maturity models) of integrating the process-orientation perspective with knowledge management.

1.2 DOCUMENT CONTENT AND STRUCTURE

This section introduces the main chapters of the document and the purpose of each chapter.



Chapter 1 - Introduction and Background: The purpose of this chapter is to provide an organisational context for the study. The main chapters of the document are introduced as well as the proposed research topic and rationale for the study. A problem statement is formulated and the required research questions are listed.

Chapter 2 - Literature Study: This chapter provides background on various topics that would enable the researcher to address some of the research questions. The result of the literature study confirms the requirement for an integrated model that would address the complex interactions between process improvement management and knowledge management. The chapter is supported by a list of terminology supplied in Appendix B.

Chapter 3 – Conceptual Model: The idea of integrating various maturity models is demonstrated and a procedure is described for building the integrated model.

Chapter 4 – Model Validation: The strategy for validating the integrated model by conducting an appraisal is discussed. This includes the selection of an appraisal methodology, instruments and tools. The requirements for a custom-built appraisal tool is mentioned and the appraisal constraints are highlighted.

Using the approach that was defined, this chapter also provides detail regarding the appraisal that was conducted at a management consultancy organisation. This includes an appraisal plan (defining the selected project, appraisal team and schedule) and the rationale that was used in characterising the sub-practices while processing the appraisal data. The appraisal data is then summarised and interpreted.

Chapter 5 – Conclusions and Recommendations: The research results are compared with the initial research proposition to evaluate the success of the study. Recommendations are made for further research that would provide empirical evidence in support of the research proposition.

1.3 PROPOSED RESEARCH TOPIC

Five management themes developed and explored in the last quarter of the 20th century, have been particularly influential in changing the way that people and organisations work (Abel and Oxbrow [27]). These are:

- Total Quality Management;
- Business Process Re-Engineering;
- Intangible Assets;
- Learning Organisations and
- Knowledge Management.

These themes have one common thrust: moving away from balance sheet and financial accounting as the primary tool of management towards a broader understanding of what creates value and sustainable business success (Abel and Oxbrow [27]). According to Abel and Oxbrow [27], these themes are not exclusive or exhaustive, but the way in which they complement each other has expanded them.

During an informal content analysis of various literature sources, the author also detected a close interrelationship between business process-improvement management and knowledge management. During a preliminary study of various maturity models, overlapping practices were also detected in process-improvement management maturity models and KM maturity models.

Management consulting firms rely heavily on the overlapping themes: process-improvement management and knowledge management. According to Apostolou and Mentzas [34], these firms depend on the expertise of their people: they focus on customer relations; employ multidisciplinary teams of professionals in solving problems; the nature of their assignments is project- and process- focused; they emphasise creativity for solving client problems.

The purpose of this study is to analyse various knowledge management / business performance measurement / process management / maturity models in an attempt to discover their integration possibilities, especially aimed at management consulting firms. The aim is to develop an effective, blended maturity model, which should simultaneously address the overlapping and distinct objectives and key performance areas in two closely-related domains: process improvement management and knowledge management.

1.4 RATIONALE FOR THE STUDY

According to Abell and Oxbrow [27] (p. 35), KM “is part of a continuous business improvement model”. Many organisations that are taking a close interest in KM also have adopted other business improvement ideas, such as Total Quality Management programmes, the Balanced Scorecard and the Learning Organisation approach. These approaches reflect the common desire to increase organisational capability and flexibility – “to develop an environment that gives the best chance of gaining competitive advantage” (Abell and Oxbrow [27], p. 38).

A broad agreement exists in literature that KM has to be linked to business strategy and to the creation of economic value to be a sustained effort (Maier and Remus [43] and Snyman and Kruger [44]). A limited number of strategic models, however, provide a link between **KM efforts** (e.g. knowledge-oriented processes, organisational structures / cultures and the implementation of technologies) and **business strategy** (Maier and Remus [43]).

KM strategies, often based on the traditional SWOT analysis, improve the internal capabilities of an organisation (its strengths and weaknesses), but fail to address the external environment of the organisation (its opportunities and threats). Maier and Remus [43] believe that a **process orientation** can be used to address these external environmental factors, especially market-oriented factors, like business fields, customer groups and new competitors – "business processes can be organised in terms of strategic fields (market-oriented strategy) or organisational core competencies (resource-based strategy)" (Maier and Remus [43], p. 1462).

The problem is that KM initiatives seldom form part of business strategies or process-improvement initiatives. Though organisations realise the importance of KM, they are unwilling to invest in KM initiatives. KM is often perceived as another technology solution that may not provide sufficient return on investment or substantially increase the overall business performance.

The rationale is that business processes could be used in combination with KM strategies as an operational instrument for continuous improvement and implementing strategic business objectives. Though each organisation may have its own unique set of process-improvement / knowledge-management initiatives in reaching its strategic objectives, these initiatives should be well integrated to leverage their synergistic impact.

By using an effective measurement model, one should be able to measure the integration aspects of the process-improvement / knowledge-management initiatives in a specific firm.

1.5 PROPOSED PROBLEM STATEMENT

The inter-dependency among process-improvement and KM domains leads to the following proposition: to leverage the value of KM in management consultancy organisations, full integration of process-improvement and KM principles, practices and initiatives are required.

1.6 RESEARCH QUESTIONS

1.6.1 Primary Research Questions

The following research questions will be addressed in this study:

- What is meant by maturity models? How do these models relate to business performance improvement? Which models currently exist and for what domains? Are these various models integrated?
- How feasible is a blended maturity model? How should the various processes and practices be prioritised in an ordinal framework (five levels) to ensure a sequential, staged model that integrates the domains of process-improvement / knowledge management?

1.6.2 Secondary Research Questions

The following questions will be addressed in providing background information, which will contribute to addressing the primary research questions.

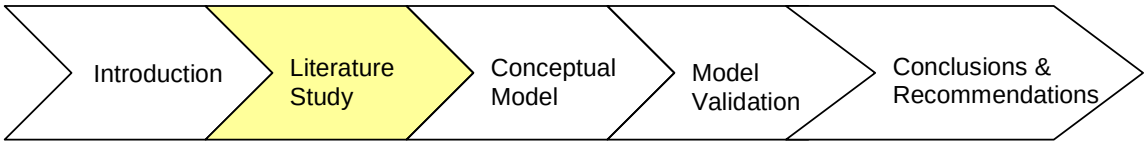
- What is meant by the concept knowledge management? Which theories and models currently exist?
- How does knowledge management apply to management consultancy firms?
- What is meant by business performance measurement? What models exist and to what extent do they address knowledge management performance?
- What is business process management? What business process improvement methods exist?
- How does business process management relate to process-improvement initiatives / methods and business performance measurement models?
- What is the role of technology in process-improvement / knowledge management?

1.7 RESEARCH APPROACH

The study is based on a model / method-building approach. According to Mouton (2001), this approach consists of a set of postulates that are taken to be true. Theoretical propositions are then deducted from the postulates and finally tested against empirical data.

In this study, a theoretical proposition is made, which leads to the formulation of an integrated model. The defined model is then partially validated at a single management consultancy organisation. Additional empirical research at various management consultancy organisations would be required to validate the effectiveness of the complete, integrated model.

2. LITERATURE STUDY



2.1 INTRODUCTION

The literature study will highlight the integrative nature of various disciplines, which indicates the necessity to view business strategy, business performance measurement, process management and KM from a holistic perspective. The purpose is to understand current disciplines and their relevant measurement models and to provide a foundation for integration.

The various topics and their relevance related to the research questions will now be discussed shortly.

Knowledge Management

The following research questions are addressed:

- What is meant by the concept KM? Which theories and models currently exist?

Various KM theories, models and processes are discussed, also stating the prerequisites, barriers and challenges of effective KM.

Knowledge Management in Management Consultancy Firms

The following research question is addressed:

- How does knowledge management apply to management consultancy firms?

Various KM elements that are evident in management consultancy firms and the project management environment are discussed.

Performance Measurement Theories, Models and Methods

The following research question is addressed:

- What is meant by business performance measurement? What models exist and to what extent do they address knowledge management performance?

Various business performance measurement theories and models are discussed. The performance measurement models are then related to business strategies and knowledge management, indicating the necessity for integrating these various concepts to ensure effective organisational performance measurement.

Process Management and Process Improvement Methods

The following research questions are addressed:

- What is business process management? What business process improvement methods exist?

- How does business process management relate to process improvement initiatives, process improvement methods and business performance measurement models?

Background is provided on business process management, also relating it to business process improvement. Business process-improvement initiatives (applying process improvement methods) are then related to performance measurement in measuring organisational effectiveness and process efficiency.

Maturity Models and Audit Models

The following research questions are addressed:

- What is meant by maturity models? How do these models relate to business performance improvement? Which models currently exist and for what domains? Are these various models integrated?

Maturity models (and similar models, e.g. audit models) are classified as business process-improvement methods, which ultimately ensure business performance improvement. Various maturity models for different domains (Systems Engineering, Software Engineering, Integrated Product and Process Development, Supplier Sourcing, and Knowledge Management) are analysed to identify integration possibilities of the various models.

The CMMI (Integrated Capability Maturity Model) is discussed in detail. This model is available in two representations – a continuous mode and staged mode. The purpose of each representation is discussed: the staged mode, following a benchmarking approach, while the continuous mode follows a strategic-driven approach.

Technology – an Enabler

The following research question is addressed:

- What is the role of technology in process-improvement / knowledge management?

Various literature sources are quoted in support of the proposition that technology is only an enabler for managing processes and knowledge effectively. Different technologies that are enablers in process improvement management and KM are discussed subsequently.

Requirement for a Blended Model

The following research questions are addressed:

- How feasible is a blended maturity model? How should the various processes and practices be prioritised in an ordinal framework (five levels) to ensure a sequential, staged model that integrates the domains of process-improvement / knowledge management?

The requirement for an integrated model is motivated, based on the close interaction between process-improvement management and KM. The advantages and disadvantages of using maturity models for domain integration (process-improvement management and KM) and usefulness in terms of project management phase integration are also discussed.

2.2 KNOWLEDGE MANAGEMENT

2.2.1 Knowledge Management Theories and Models

KM is a philosophy that has the primary objective of optimising knowledge in an organisation. Abell and Oxbrow [27] believe that nobody can manage knowledge. “What you can do, what a company does, is to manage the environment that optimises knowledge” (Abell and Oxbrow [27], p. 36). The managed environment should lead to an optimum corporate capability – “a unique mix of skills, expertise, processes, management and intellectual capital that enables an organisation to respond to and develop its markets” (Abell and Oxbrow [27], p. 105).

The champions and disciples of KM believe that KM should achieve the following key objectives in an organisation:

- “Know what you know,
- learn what you need to know and
- use knowledge effectively” (Angela and Oxbrow [27], p. 39)

2.2.1.1 Codification versus Personalisation Approach

According to Hansen (cited in Abell and Oxbrow [27]), organisations that offer standardised products usually follow a codification strategy, codifying reusable knowledge. Organisations that have highly customised and innovative products and services require a personalisation strategy, building relationships and sharing knowledge via person-to-person contact.

2.2.1.2 Snowden’s Theory

Snowden [7] believes that the future generation of KM considers KM as not only managing content, but also managing **context** and **narrative**. The new generation KM permits knowledge transfer on a just-in-time basis. This is possible due to the large number of existing informal networks that is used by employees. It is suggested that by stimulating current social networks, it is

possible to accelerate 10 years of social contact to 10 months of voluntary activity. The just-in-time-approach requires greater 'openness' to knowledge-suppliers to allow them to optimise their knowledge-supply to formal systems (Snowden [7]).

2.2.1.3 Nonaka's Knowledge Conversion Model

Nonaka (cited in Marwick [8]) models the different types of **Knowledge Conversions** as follows:

Tacit to Tacit *Socialisation* e.g. team meetings and discussions.	**Tacit to Explicit** *Externalisation* e.g. dialogue within a team, answer-questions sessions.
Explicit to Tacit *Internalisation* e.g. learn from a report.	**Explicit to Explicit** *Combination* e.g. e-mail and a report.

Table 1: Nonaka's Knowledge Conversion model (Marwick [8])

Abell and Oxbrow [27] provide some additional examples for each type of knowledge conversion:

Tacit to Explicit:

- Best practices databases.
- Directories of employee skills and expertise.
- Gathering of knowledge about clients, competitors, product developments and market environments.

Explicit to Explicit

Providing access to information and knowledge via intranets, portals and communication platforms.

Explicit to Tacit

This conversion process primarily includes individual development and learning.

Tacit to Tacit

According to Abell and Oxbrow [27] this knowledge conversion process focuses on "sharing, nurturing and building tacit knowledge". Knowledge sharing of best practices, lessons learned, master classes and stories is enabled via formal and informal conversations.

2.2.2 Knowledge Management Processes

Davenport, Jarvenpaa and Beers (cited in Ahmed *et al* [25]) identified five primary process orientations to knowledge:

1. *Finding* existing knowledge or searching for knowledge among multiple sources.
2. *Creating* new knowledge.
3. *Packaging* or assembling knowledge without creating new knowledge, e.g. publishing.
4. *Applying* or using existing knowledge.
5. *Reusing* knowledge or leveraging knowledge previously obtained by the organisation.

KM processes enable the creation of effective and robust corporate memories, facilitating organisational learning from previous corporate experience (Abell and Oxbrow [27]). The challenge is to create processes that will truly create a *dynamic* and *living* corporate memory, rather than a collection of static electronic filing cabinets.

2.2.3 Individual Skills and Competencies

KM environments are demanding in terms of people characteristic requirements. According to Abell and Oxbrow [27], a mix of skills and personalities is required to exploit creativity. Individuals should be willing to share ideas, be reflective, thoughtful, visionary, take personal risks (as confidence and trust are required), and be able to work in multidisciplinary teams.

Abell and Oxbrow ([27], p. 113) identified three skill sets that underpin the KM approach. These skill sets relate to individual skills, as well as skill sets of KM teams, communities and networks. The required skill sets are now discussed briefly.

2.2.3.1 Professional and technical core competencies

These competencies relate to the core set of skills that employees may have acquired through **education, training** and **experience**. The competencies are required by the profession or occupation, but are not the primary focus of KM approaches.

During a discussion summit in October 2000 (cited in Abell and Oxbrow [27]) eighteen chief knowledge officers identified the following core competencies for a KM culture:

- **Ability to learn** – curious, seeking new knowledge.
- **Self initiation** –acting on own account, instead of waiting for instructions.

- **Collaboration** – being a team player, not status driven.
- **Intellectual thinking** – having a systems approach in connecting processes and events.
- **Humility** – recognising that one can learn from mistakes.
- **Ability to think and do** – focusing on outcome.
- Appreciating **information management techniques**.

2.2.3.2 Organisational competencies

These include organisational skills that are required to survive and excel in an organisation. These skills are also required as key skills for KM individuals or teams and include communication, team work, negotiation, persuasion, facilitation, coaching, mentoring and a thorough understanding of business processes (Abell and Oxbrow [27]).

2.2.3.3 Knowledge management enabling competencies

These skills relate to those required to plan and implement KM approaches. The emphasis on certain skills changes as the organisation matures – this principle supports the KM maturity modelling concepts (addressed in section 2.6.4). During KM infancy, the emphasis will be placed on developing corporate KM processes, establishing business processes and developing management skills. These skills may diminish as core competencies as the organisation matures (Abell and Oxbrow [27]).

KM enabling skills could be divided into three categories:

Experience and diversity: Skills need to reflect the experience of the organisation, its processes, practices and lessons learned within the context of a specific sector or industry.

Information complexity: KM practitioners need to understand the flow, value and impact of information interacting with various stakeholders. Understanding the level of information complexity also requires thorough understanding of key business processes.

Management skills: The development of a knowledge environment is in essence a change management project. General management skills are thus required to deliver a successful knowledge environment.

2.2.4 Barriers and Challenges of Knowledge Management

The overall belief is that organisations do benefit by implementing KM initiatives (Dunford [31]). Unfortunately "…only a small percentage have had significant near term impact…some…have had some modest success, but over a very slow implementation horizon [and] a sizable number of the programs are out and out failures" (Pasternack and Viscio, cited in Dunford [31], p. 297).

Various barriers have caused numerous failed KM initiatives. This section discusses KM barriers as found in the literature, as well as the challenges to overcome these barriers.

2.2.4.1 Culture and Knowledge Sharing

Blair [11] maintains that an organisation culture could be one of the most important factors influencing whether knowledge sharing is encouraged or inhibited. Organisations that have a culture of being competitive internally (with competition between employees for projects) will have difficulty in convincing experts to share their expertise or knowledge with the less-knowledgeable (Blair [11]). An individual's knowledge makes him/her valuable to organisations.

Some organisations have applied different incentive schemes to encourage knowledge sharing. A prominent consulting company tried to convince its senior consultants to interact with junior consultants, in offering bonuses in exchange. As this strategy had little effect, the company had to threaten the senior consultants with loss of bonuses if they did not increase their communication with junior practitioners. This posed new management issues: how does one determine if communication between senior and junior practitioners enables juniors to become more knowledgeable? One tip from an expert could be more helpful than hundreds of e-mail messages (Blair [11]).

Abell and Oxbrow [27] state that intrinsic motivation, rather than financial incentives, truly encourages knowledge sharing. Intrinsic motivation is more about ensuring those recognition systems that make individuals want to feel valued and part of the business.

McDermott & O'Dell [4] investigated companies that overcame the culture barrier and succeeded in sharing knowledge effectively. They found that these companies did not try to change their culture to fit their KM approach, but rather built their KM approach to fit their culture. The study conducted by McDermott *et al* [4] illustrated the following key principles:

- Knowledge systems and initiatives need to have a clear business purpose. The initiatives also need to be tied to the core values of the organisation to make knowledge sharing consistent with peers' expectations and managers' considerations.

- Best practice companies applied the current style of their organisation to integrate their KM initiatives seamlessly.

- None of the best practice companies considered reward and recognition systems could effectively motivate people to share knowledge. Companies rather built knowledge-sharing **into their daily work processes** and incorporated **knowledge sharing** as a **general part of their performance appraisal**. In all the best practice organisations, hiding knowledge, or failing to build on the ideas of others, would lead to serious career consequences – limiting one's career.

- Best practice companies legitimated networks (usually informal networks) that already existed and tried to increase their ability to maintain expertise about topics important to the company.

Ahmed [25] identified four factors that have a positive effect on people's eagerness to learn and share:

- Recruitment of suitable personnel (people who are good at teaching and learning).
- Role of human networks - also called communities of practice (CoP). Mechanisms need to exist in an organisation to bring people together.
- Rewards are required as a motivational tool.
- A KM champion or leader is imperative (Ahmed [25]).

Ahmed [25] also believes that several norms promote knowledge sharing and learning, such as future orientation, trust and openness, leadership commitment, employee training, cross-functional interaction, corporate identification and organisational structure. Ahmed [25] emphasises the importance of creating an organic, rather than mechanistic, organisational culture, to foster knowledge sharing.

Characteristics of a desirable organisational structure include:

- Freedom from rules.
- A participative and informal culture.
- Many views being considered.
- Face-to-face communication (little red tape).
- Interdisciplinary teams.
- Emphasis on creative interaction.
- Outward looking and willingness to adopt external ideas.
- Flexibility regarding changing needs.
- Non-hierarchy.
- Information flows downwards and upwards (Ahmed [25]).

Mechanistic structures hinder knowledge sharing due to the following characteristics:

- Rigid departmental separation and functional specialisation.
- Hierarchies.
- Bureaucracies.

- Rules and set procedures.
- Formal reporting.
- Long decision chains and slow decision-making.
- Little individual freedom of action.
- Communication via the written word.
- Much information flows upwards and directives flowing downwards (Ahmed [25]).

2.2.4.2 Extra Burden

Implementing a KM solution requires much time and effort – visible benefits are also not immediately available. Project members are usually pressurised into completing project deliverables on time and consider KM efforts as an additional burden (Rus *et al* [6]).

2.2.4.3 Quality of Knowledge

Many project members are reluctant to share knowledge as they believe that their knowledge would not be useful in future due to the pace of technology (Rus *et al* [6]). Knowledge workers in search of knowledge also experience problems in finding **useful knowledge** that is **applicable** to the task at hand.

Marwick [8] maintains that quality of output is one of the performance measures that may be measured by using current information technology. Portal infrastructures that hinder access to documents can accumulate metrics of document use and subsequently infer the usefulness and quality of a document. Another measure of quality is the number of times a document has been cited or hyperlinked. Other ways of judging the quality of a document is to associate annotations of experts' judgements or to use a workflow application for processing a document through subsequent quality review steps.

2.2.4.4 Process Issues

Abell and Oxbrow [27] identified a number of process issues that impede successful knowledge management:

- Integrating knowledge creation and utilisation into business processes.
- Ensuring knowledge access where it may have the most impact.
- Formalising informal processes that are applied by people to make a certain process workable.
- Building communities around business processes.
- Linking knowledge processes to business benefits.

2.2.4.5 Lack of Leadership

Knowledge sharing cannot be enforced. “You have to gain the hearts and minds of the workers. They are not like troops; they are more like volunteers.” (Anonymous, cited in Tiwana [28]). Strong leadership is required to facilitate cultural changes, organisational changes and successful KM implementation.

The leadership style required in the knowledge age differs substantially from the authoritarian leadership style in the past. The new style motivates, inspires, trusts and manages tacit knowledge to increase the speed of innovation (Abell and Oxbrow [27]).

Tiwana [28, p. 290] claims that the following leadership roles are required:

- **Championing** – promoting KM and its adoption.
- **Educating users and the management team** – promoting the value and use of KM, and designing performance measurement metrics and employee compensation systems to encourage knowledge sharing.
- **Measuring the impact of KM** – motivating investments made in order to implement KM initiatives.
- **Mapping and analysing existing knowledge** for possible reuse.
- **Creating and selecting the technology paths** that would be most suited to the organisational processes / work culture.
- **Integrating business processes with technology components** – starting with those processes that may have the largest impact.

2.2.5 Summary

Various KM theories, models and processes were discussed in section 2.2. The prerequisites, barriers and challenges of effective KM were also discussed to place KM in context. The next section highlights KM elements that are evident in management consultancy firms and the project management environment.

2.3 KNOWLEDGE MANAGEMENT IN MANAGEMENT CONSULTANCY FIRMS

2.3.1 Knowledge Elements in Management Consultancy Firms

Apostolou and Mentzas [34] state that the need to manage knowledge increases proportionately with the service intensity of companies. Service-oriented, knowledge-intensive companies also share common characteristics: their “products” are intangible (not consisting of goods); their “production process” is non-standardised and relies on team-work; most of their employees are educated and creative; their customers are treated individually and the ‘products’ are tailored to their clients’ requirements.

Management consulting firms (a sub-set of service-oriented companies) share all the above-mentioned characteristics. It is not surprising that consultancy firms consider KM to be a core and strategic approach for gaining a competitive advantage (Dunford [31]). Global management consulting industries are often considered as the prime example of knowledge-intensive firms (Alvesson and Starbuck, cited in Werr [33]).

The current understanding of KM in management consulting organisations is characterised by a classification of organisational knowledge as either articulate knowledge (represented by documents and databases) or tacit knowledge (represented by experience and skills possessed by individuals. Werr [33] performed an empirical study based on case studies in standardised service consultancy organisations - Accenture and Cap Gemini Ernst & Young. The aim was to investigate the potential complementarities between explicit knowledge (viewing knowledge as theory) and tacit knowledge (viewing knowledge as practice) in the context of management consulting organisations. Werr [33] argues that the simultaneous existence and complementary use of the two knowledge types represent the essence of organisational competence in management consulting.

Viewing knowledge only as **theory** places organisational competence in organisational methods, tools, processes, models, documents and databases. This view may be facilitated by a codification KM strategy, exemplified by Accenture and Ernst & Young. Viewing knowledge as **practice**, however, places organisational competence in the individuals and the communities to which it is linked. The last-mentioned view supports creative problem solving rather than focusing on the reuse of knowledge and is often supported by a personalisation strategy for KM. Examples of consultancy companies that follow a personalisation strategy are McKinsey and Bain & Company (Werr [33]).

Werr [33] also identified three knowledge elements commonly used by consultancy firms: **methods and tools**, **cases**, and **experience**. Each of these elements is now described in more detail, followed by a discussion on their **combined impact**.

2.3.1.1 Methods and Tools

Consultancy organisations apply a large number of methods and tools as a source of knowledge when planning and implementing consulting projects. Consultants are provided with models, templates and checklists to facilitate and organise their work (Werr [33]). The methods and tools are continually updated, improved and extended to reflect experience gained from ongoing projects. It is expected of consultants to keep up-to-date with new developments and to internalise the methods. The methods also form a common framework of understanding, a common language which facilitates effective communication between consultants (Werr[33]).

2.3.1.2 Cases

Cases are represented by documents that have been produced in previous projects. When designing a proposal for a new project, previous proposals

could, for instance be accessed from a database to reuse some sections or assess the new project duration compared to previous project durations.

Ernst & Young has a worldwide database of documents. One part is an unfiltered repository of documents produced in client projects, including proposals, process maps etc. The second part of the database contains 'the best of the best', structured for different industries and processes. The database is maintained by 'centres of excellence' (consultants) responsible for the development of a practice in a specific area of application (Werr [33]). A search on the database often leads to personal contact with someone involved in a previous (and relevant) project. According to Werr [33] these databases thus have a dual purpose: first, the direct transfer of knowledge between different projects; and second, establishing contacts for personal transfer of project-related experience.

2.3.1.3 Experience

Consultants that were involved in the study performed by Werr [33] stressed that current methods and cases had to be adapted to fit the characteristics of a specific project. These adaptations had to be based on experience. A senior consultant at Ernst & Young commented: "The method serves as a structure, not as a replacement for knowledge. You can't give a method to an inexperienced consultant and expect him to be able to run a project" (Werr [33]).

Both consultancy organisations (being studied) applied a hierarchical organisation structure ranging from junior consultant to partner. Consultants are allocated to projects in such a way that experience is efficiently used and transferred from more senior consultants to intermediate consultants and from intermediate consultants to junior consultants. Experienced consultants play a mentoring role, which leverages their knowledge, while young, inexperienced (and inexpensive) consultants perform a large part of the consulting work (Werr [33]).

The consultancy organisations also apply various other knowledge sharing opportunities, e.g. monthly project leader meetings and spontaneous hallway meetings. The organisations also provide directories of individuals linked to centres of excellence.

2.3.1.4 Combined Impact: Methods and Tools, Cases and Experience

The process of adapting the general, articulate knowledge (contained in **methods and tools**) and specific, articulate knowledge (contained in **cases**) requires **experience**. An experienced consultant needs to choose method activities and tools and promising solutions from previous cases that would be relevant to the new project. This translation process is not a conscious, analytical process, but rather an intuitive process, based on tacit knowledge (Werr [33]). As McDermott says: "…professionals do not just cut and paste 'best practice' from the past to the current situation, [rather] they draw from their experience to think about a problem" (cited in Dunford [31], p. 301).

The shared frame of reference provided by using similar methods and tools is seen as an important enabler of direct experience exchange between consultants (Werr [33]).

The study performed by Werr [33] supports this research proposition: KM in consultancy organisations requires the amalgamation of various different domains. The proposed domains (process improvement management, and KM) are included within the stated **methods and tools** (processes and practices applied by the organisation); **cases** (previously implemented project processes and their explicit knowledge artefacts); and **experience** (tacit learning on an individual level and on an organisational level, via tacit knowledge transfer).

2.3.2 Project Management in Management Consultancy Firms

Management consultancy firms are responsible for supplying solutions to problems experienced by their clients. The solutions are unique to each client and are delivered within a specific time frame. Management consultancy firms usually employ project management processes to manage several contracts with clients.

The Harvard Business School [36] identified four generic project management phases:

1. Defining and organising the project: Defining the project's objectives and organising the right people and necessary resources around those objectives. Jack, Bothell and Snead [55] also refer to this phase as the visualisation phase. This phase is concerned with understanding the needs and expectations of the client and balancing priorities between time, cost, scope, and quality. A key deliverable in this phase could be a project proposal, which may be accepted or rejected. On acceptance, a final contract may be negotiated between the client and the consultant.

2. Planning the project: This phase begins with the objective and works backward in identifying the tasks that need to be completed, the order in which these tasks need to be completed and the time and costs that will be incurred.

3. Managing the project execution: This phase requires effective management tasks in controlling and monitoring the implementation of the project, adhering to the schedule, budget and quality standards.

4. Closing down the project: The phase incorporates project evaluation against initial objectives, completing project documentation and identifying lessons learned for incorporation into future projects.

The nature of these processes, as well as the project team approach, usually leads to decentralisation and knowledge fragmentation. After finishing the project, team members are re-allocated to other projects and project documentation is stored in project folders, without proper referencing for future use (Disterer [37]).

Each project management phase could be effectively supported by several KM initiatives to increase the overall organisational efficiency.

Figure 1 (based on the four generic phases of The Harvard Business School [36]) highlights the vast number of opportunities for containing and sharing project-related knowledge. The rectangles represent project-related processes, the rounded blocks signify KM processes and arrow-blocks indicate human resource management processes.

2.3.3 Summary

Section 2.3 contextualised KM in terms of management consultancy firms. The primary KM elements (methods and tools, cases and experience) were discussed and how these elements are inextricably connected. This supports the proposition that KM (in management consultancy organisations) requires the amalgamation of various different domains. The section also explains the opportunities for sharing and reusing knowledge in a project management environment.

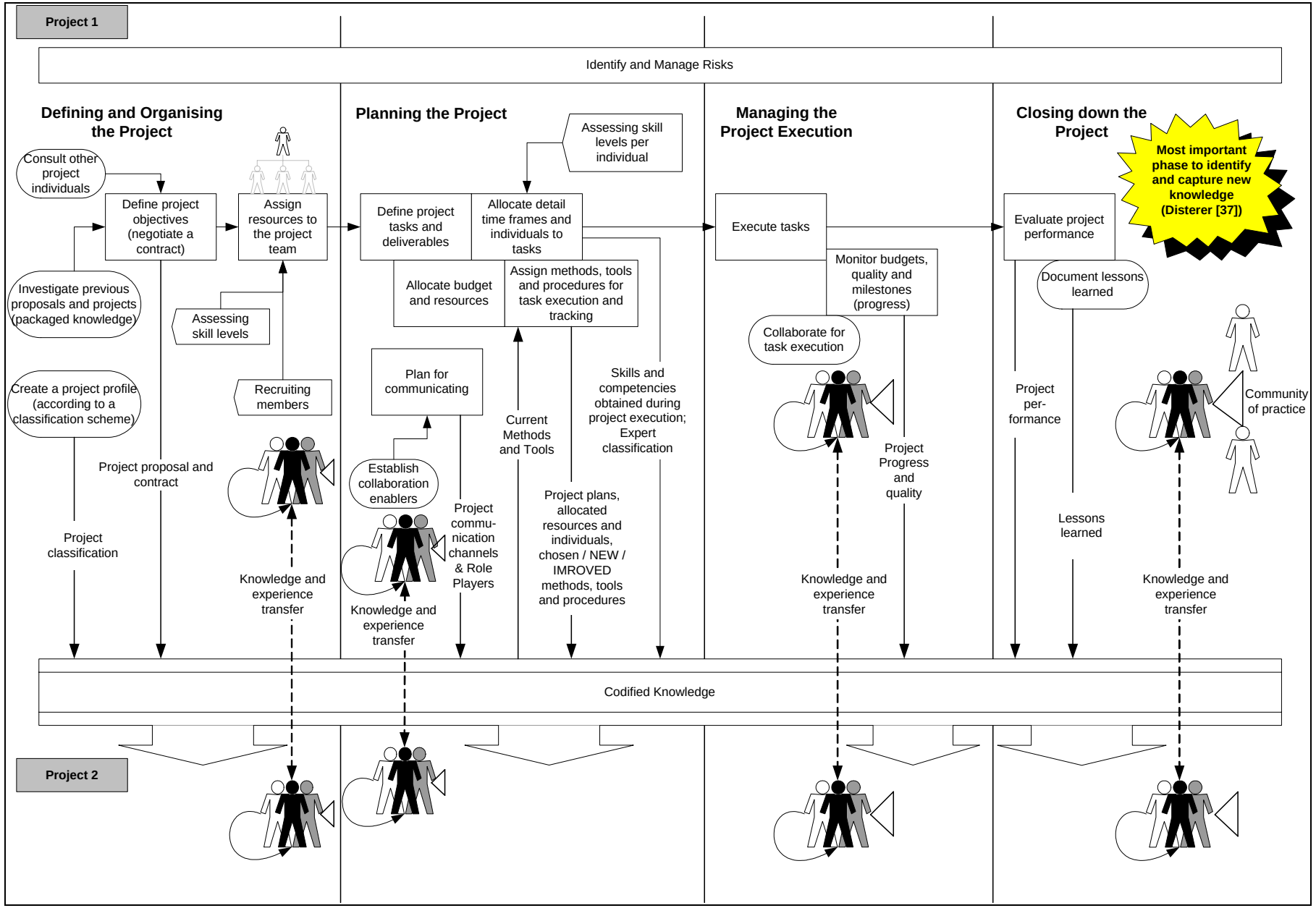


Figure 1: KM pertaining to Project Management Phases (based on the Project Management Phases of the Harvard Business School [36])

2.4 PERFORMANCE MEASUREMENT THEORIES, MODELS AND METHODS

2.4.1 Business Performance Measurement Theories and Models

"What gets measured, gets done" (Deming in Eckes [13], p. 70).

Business strategies not only direct businesses towards business decisions and strategic projects, but also determine the various measures that will be used to assess strategy implementation performance. Measurements are used to identify problem areas and direct attention to low-scoring measures that may have a high impact on the overall business performance.

Various different theories exist on measuring business performance. Today, most companies adopt a balanced view on measuring performance – not only managing financial performance, but including various other perspectives, such as customer satisfaction, internal business process improvement, and individual learning and growth. Research conducted on a number of leading European companies indicated a trend in managing performance improvement through focusing on the underlining drivers of performance (e.g. processes or resources) and sustaining the capabilities and competencies that allow companies to compete effectively in future (Bourne, Franco and Wilkes [40]).

Companies may either measure business performance against pre-defined targets (derived from business strategic goals) or against performance levels of similar companies, i.e. benchmarking. Various popular performance measurement models will now be discussed.

2.4.1.1 Economic Value Added (EVA) Model

This model was created by a consulting firm Stern Stewart and helps organisations to pursue their prime financial directive by maximising the wealth of their stakeholders. The EVA model was an improvement on the traditional financial measures such as return on equity (ROE) and return on investments (ROI), which did not guide strategic decision. The EVA model has a built-in charge for using capital – this ensures a balanced view on managing assets as well as income (Ahmed *et al* [25]).

The model unfortunately has a negative image, does not concentrate on the drivers of success but only on the outcomes, and only a limited number of stakeholders are included (Buytendijk *et al* [30]).

2.4.1.2 Balanced Scorecard Model

Kaplan and Norton (cited in Tiwana [28], p. 325) proposed the Balanced Scorecard technique to "maintain a balance between long-term and short-term objectives, financial and non-financial measures, lagging and leading indicators, and between internal and external perspectives". Strategy maps are used to build cause-and-effect relationships between objectives and metrics.

This model is widely recognised and provides a multidimensional measurement system that addresses four perspectives:

- **Financial:** including traditional accounting measures to create value for all stakeholders.
- **Customer:** measuring performance related to the performance of the organisation's products or services, as well as measuring customer satisfaction levels.
- **Internal business processes:** measuring the effectiveness and productivity of supply chain processes that would satisfy customer needs.
- **Learning and growth:** measuring knowledge-development within individuals that would influence organisational growth (Ahmed *et al* [25]).

The Balanced Scorecard model does not provide guidance on how to populate it with metrics and fails to include implicit stakeholders (Buytendijk *et al* [30]). It is seldom possible to adopt another firm's Balanced Scorecard due to delicate differences that exist between similar firms (Tiwana [28]).

Although the Balanced Scorecard model provides several measurement perspectives, it does not indicate the required management processes (and their interaction across various domains) to achieve the desired strategic objectives. The Balanced Scorecard model may be partially reconcilable with the **continuous** representation mode of the Integrated Capability Maturity Model (discussed in section 2.6.3). The continuous mode of the Integrated Capability Maturity Model allows a company to define its **own strategies** and incremental targets in terms of management and operational processes and practices that are required regarding a **specific domain of practice**. A blended maturity model, simultaneously addressing the domains of process improvement and knowledge management, for internal and external strategic perspectives does not exist.

2.4.1.3 Intellectual Capital (IC) Model

This model is similar to the Balanced Scorecard model, but the emphasis is on the human factor. The model contains five focus areas and provides historic, current and future perspectives. Figure 2 portrays how this model perceives the 'human' focus area – the heart of the organisation.

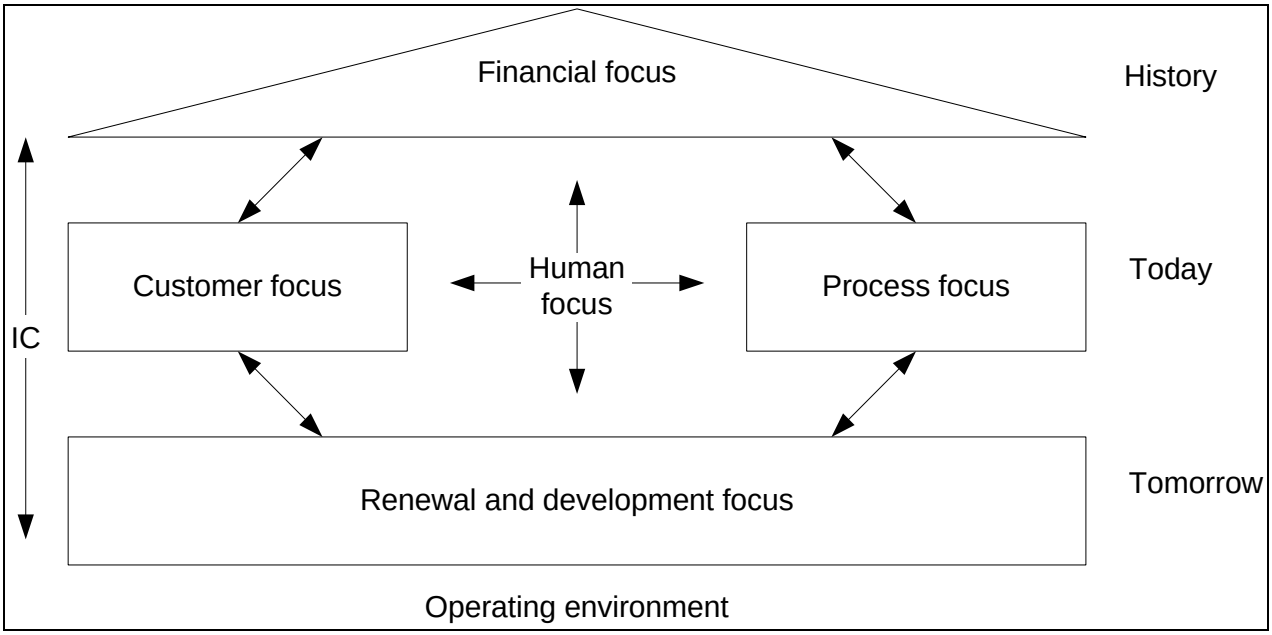


Figure 2: The Skandia Navigator (Ahmed *et al* [25], p. 102)

Other models in this category include the Intangible Asset Monitor (developed by Sveiby) and Ericsson Cockpit Communicator (Marr and Spencer [41]).

2.4.1.4 Best Practices or Benchmarking Models

Buytendijk *et al* [30] believe that benchmarking is one of the more effective methodologies when employed correctly. The aim is to follow the behaviour of a specific firm, industry or sector that excels in performance (Tiwana [28]), thus linking performance with reality. It is a practical approach based on best practices and takes market reality as its starting point (Buytendijk *et al* [30]).

Like any audit performed, benchmarking is often deployed as a once-off exercise, rather than as a continuous process. Though the quantitative comparison seems to be objective, the derivation of the numbers is still subjective (Buytendijk *et al* [30]).

This approach ties in with the general representation of maturity models – benchmarking a company against fixed maturity levels.

2.4.1.5 Quality Management and Measurement Models

Quality management is an underlying theme of various maturity models, audit models, process management and business performance measurement. Quality management theories that are mentioned elsewhere in this document will now be briefly discussed.

1. Total Quality Management (TQM)

TQM can be defined as “the application of quantitative methods and human resources to improve the materials and services provided as inputs to an organisation and to improve all of the processes within the

organisation. The goal of TQM is to meet the needs of the customer, now and in the future" (CMU/SEI [38], p. 11).

Quality management became important for manufacturing firms in the 1970s and 1980s. Quality assurance certificates were obtained by government departments and large companies – a prerequisite in becoming preferred suppliers. As quality standards gained ground, the concept of TQM also spread to other sectors, such as the service sector and education. Various industry networks developed, such as the British Quality Foundation, the European Foundation for Quality Management (EFQM) and the American Quality and Productivity Federation (AQPF) (Abelll and Oxbrow [27]).

2. ***European Foundation for Quality Management (EFQM)***

The European Foundation for Quality Management is a performance management framework based on four result areas (people, customers, society and key performance) and five enablers (people, policy and strategy, partnerships, processes and resources) (Buytendijk *et al* [30]).

It focuses on the results, like the Balanced Scorecard, but also addresses the drivers of success. The corporate performance management is **broader than quality management** (Buytendijk *et al* [30]).

This model is not well recognised outside Europe and the result areas are less well organised than the perspectives of the Balanced Scorecard (Buytendijk *et al* [30]).

Many of the concepts underpinning EFQM are similar to those of the KM philosophy. The EFQM model contains nine criteria against which organisations can measure themselves. **People**, **processes** and **knowledge** play a very significant part in the continuous business improvement package as some of the following nine criteria indicate:

Criterion 2: Policy and Strategy, includes the sub-criterion:

- "Policy and Strategy are based on information from performance measurement, research, learning and creativity related activities" (Abelll and Oxbrow [27]).

Criterion 3: People, includes the sub-criteria:

- "People's knowledge and competencies are identified, developed, sustained" (Abelll and Oxbrow [27]).
- "People are rewarded, recognised and cared for" (Abelll and Oxbrow [27]).

Criterion 4: Partnerships and Resources, includes the sub-criteria:

- "Technology is managed" (Abelll and Oxbrow [27]).
- "Information and knowledge are managed" (Abelll and Oxbrow [27]).

Criterion 5: Processes, includes the sub-criterion:

- "Processes are systematically managed" (Abell and Oxbrow [27]).

3. *The Six Sigma Approach*

Six Sigma is a leadership management methodology that drives **business improvement** (Smith & Fingar [14]). Six Sigma is based on the theory of variation, technically measuring performance against customer requirements. Eckes [13] maintains that Six Sigma improvement is a tried-and-tested method in helping businesses to excel and dominate their competition.

The Six Sigma philosophy not only measures performance against customer requirements, but strives for: "never-ending dissatisfaction with current performance" (Eckes [13], p. 38). Various measures are identified to measure efficiency and effectiveness.

Improvement methods are used either to improve current processes or to create new processes. Today Six Sigma is applied to various business areas traditionally thought to be devoid of process, such as marketing, business development and creative design (Smith & Fingar [14]). Six Sigma also embraces various **business performance measurement techniques** including Balanced Scorecard, Voice of the Customer (VOC), High-Performance Teams, Black Belt Teams and Dashboards (Smith & Fingar [14]). Six Sigma practitioners also aim to incorporate quality processes into live operations to control the life cycle of process improvement – Six Sigma tools are being **integrated** with various kinds of **business process management solutions** (Smith & Fingar [14]).

The new Six Sigma methods stress the alignment of goals, objectives, targets and actions, as well as the **alignment between skills, competences** and assets (Smith & Fingar [14]).

4. *ISO-series*

The ISO 9000 family of International Standards "…is concerned with 'quality management'. This means what the organisation does to enhance customer satisfaction by meeting customer and applicable regulatory requirements and continually to improve its performance in this regard" (ISO International Organisation for Standardisation [39]).

The most recent ISO developments are embodied in the ISO 9001:2000 set of standards, which is now the only ISO 9000 certification standard, from the 1994 versions of ISO 9001, ISO 9002 and ISO 9003 (ISO International Organisation for Standardisation [39]).

CMU/SEI ([38], p. 418) claims that the general concerns of ISO 9001 are encompassed by the Capability Maturity Model (for software development) and furthermore that an organisation that obtains ISO 9001 certification should at least be close to a Level 2 in maturity.

The author believes that the new ISO 9001:2000 release could be used as a valuable resource to develop an extensive Capability Maturity Model

(addressing processes that will automatically comply with the ISO 9001:2000 standards).

2.4.1.6 Total Cost of Ownership Model

This model measures the life cycle costs associated with a project or technology implementation. Tiwana [28] highlights several disadvantages of this approach - this model ignores benefits beyond pure costing, neglects strategic factors and provides little comparison with other business units or other companies within the same industry.

2.4.1.7 Activity-based Costing and Activity-based Management

These models provide insight into the costs of business activities by allocating direct and indirect costs to various steps of each activity. Though a seasoned methodology, clearly focusing on activities as the drivers of success, a negative image exists in the market due to many implementation failures in the past. The models fail to address intangible drivers and only focus on processes (Buytendijk *et al* [30]).

2.4.2 Linking Performance Measurement to Business Strategies

Most of the performance measurement models discussed in the previous section addressed the link between business strategies and performance measurement. Many of these models have been designed to cover most of the domains of management. A very limited number of models, however, includes the connection between the contribution of KM activities and business strategic objectives (Roy, del-Rey-Chamorro, van Wegen, and Steel [42]). This shortcoming will be addressed in this study, using the continuous representation mode of the Integrated Capability Maturity Model (CMMI), which provides for a strategic-driven approach by auditing only process areas that support the organisational strategy. The staged mode of CMMI, on the other hand, resembles a benchmarking approach (see section 2.6.2).

2.4.3 Measuring Knowledge Management

Though companies attempt to monitor the performance of their business processes by using a performance measurement system, these systems seldom highlight the **contribution** of KM initiatives to business processes (Roy *et al* [42]).

Business key performance areas could be improved simultaneously through a number of improvement initiatives (quality improvement, cost improvement and management improvement projects). The challenge is to measure the effectiveness of KM initiatives, isolating this measurement from the positive effects derived from other projects (Roy *et al* [42]).

This study is not aimed at measuring the effectiveness of **specific management initiatives** that are implemented in organisations. The proposed model is used rather to measure and compare the mutual maturity

level of process improvement management, and KM for a management consultation organisation.

2.4.4 Summary

Section 2.4 provided background on various business performance measurement theories and models. The performance measurement models were then related to business strategies and knowledge management, indicating the necessity for integrating these various concepts to ensure effective organisational performance measurement.

2.5 PROCESS MANAGEMENT AND PROCESS IMPROVEMENT METHODS

2.5.1 Business Process Management (BPM)

The main characteristics of Business Process Management can be summarised as follows:

- BPM leverages current 'As Is' processes by defining new 'To Be' processes and interfaces and allowing legacy systems to operate in parallel.
- BPM processes are conceptualised, deployed and changed by business people. The business-IT divide is thus closed and business is no longer delayed by IT timescales.
- BPM supports ongoing change, measurement, tracking and process improvement (Smith & Fingar [21]).

Business Process Management is replacing the re-engineering projects of the past, where processes were re-designed once-off. The re-engineering initiatives often led to organisational change and disruption during the implementation of costly business and software systems. The agility of today's business environment demands **continuous process improvement** rather than costly, once-off improvements that may be too rigid to accommodate the changing business environment (Smith [22]).

BPM is one of the strategic components of Six Sigma (see section 2.4.1.5). "It is a vehicle by which management's involvement is initiated and sustained" (Eckes [13], p. 9). According to Eckes [13], BPM consists of the following elements:

1. Creating and agreeing on strategic business objectives.
2. Creating core / sub / enabling processes. (Enabling processes are those processes that **indirectly** satisfy customer requirements, e.g. acquisition processes and payroll processes.)
3. Identifying process owners.
4. Creating and validating key measures of effectiveness and efficiency for every process (also referred to as measurement "dashboards").

5. Collecting data on agreed dashboards.

6. Creating project selection criteria.

7. Using project selection criteria for project selection.

8. Managing processes continually to achieve strategic objectives.

2.5.2 Process Improvement Initiatives and Methods

Process improvement initiatives are required to achieve the strategic objectives continually. These improvement initiatives should address one or both of the following objectives:

- Improving the **effectiveness** of the organisation: to what extent are customer or client requirements met?

- Improving the **efficiency** of organisational processes: to what extent does each process add value?

Last-mentioned objectives could be further refined by identifying measures for each high-level business process and identifying the measures of **effectiveness** (output measures of the client requirements), the measures of **internal process efficiency** (measures of cost, time, labour or value) and measures of the **process supplier's effectiveness.** The output measures of the client requirements direct the entire measurement process (Eckes [13]).

According to Smith & Fingar [14], various well-known methods support process improvement objectives, including industrial engineering, ISO certification, Six Sigma [based on Total Quality Management], Enterprise Business Architecture, Business Process Improvement (including process maturity models and audit models), Business Process Re-Engineering, Rummler-Brache Performance Improvement, Integrated Definition Function Modelling and Lean Thinking.

The exact measuring and control mechanisms that are required depend on the level of organisational throughput and product quality apparent in an organisation. Figure 3 illustrates various mechanisms that may be applicable to various organisations:

High Standard Low Throughput Nonstatistical Controls: • Checklists. • Schedules.	High Standard High Throughput Statistical Controls: • X bar and R charts. • Individual and R charts. • X bar and S charts. • Moving X bar and R charts. • Other types of statistical charts.
Low Standard Low Throughput Nonstatistical Controls: • Periodic status reviews.	Low Standard High Throughput Other types of statistical controls: • Bar charts. • Pie charts. • Pareto charts.

Figure 3: Process throughput – standardisation matrix tools (Eckes [13], p. 209)

2.5.3 Summary

Section 2.5 provided background on business process management, also relating it to business process improvement (discussed in section 2.4). Business process improvement initiatives (applying process improvement methods) were then related to performance measurement in measuring organisational effectiveness and process efficiency. The following section will indicate how maturity models and audit models support the concept of continuous improvement in an attempt to improve overall business performance.

2.6 MATURITY MODELS AND AUDIT MODELS

Maturity models stem from Watts Humphrey's philosophy that organisations had to eliminate implementation problems in a specific order if they were to create an environment conducive to **continuous improvement** (Curtis *et al* [16]). Organisations perform best if "they focus their process improvement efforts on a manageable number of process areas that requires increasingly sophisticated effort as the organisation improves" (CMMI Product Team [15]).

Maturity models provide an evolutionary path, increasing process maturity in stages. These stages are ordered, so that each stage provides a foundation for improvements in the next stage (CMU/SEI [38]). A roadmap is thus provided for continuous process improvement and is not intended to provide a quick solution for projects in trouble (CMU/SEI [38]). Maturity models, in general, apply the process management concepts of Total Quality Management (see section 2.4.1.5).

Maturity models could be used to address one or more of the following objectives:

1. Performing an **audit** regarding a specific domain of practice to assess the current organisational level of maturity in relation to a set of pre-defined criteria.

2. Defining **maturity levels** and a set of pre-defined criteria per maturity level (as specified by the author of the specific maturity model) to **benchmark** a company against similar companies.

3. Defining **capability maturity levels** and subsequent improvement objectives and practices (per level) parallel to **business strategic objectives**. The defined capability maturity levels are used as a **business performance measurement** tool, measuring certain process areas (see section 2.6.3 – the continuous representation mode of the CMMI).

Many **audit models** follow the same approach and objectives detected in maturity models. These models also provide a framework for assessing the current organisational maturity regarding a specific domain of practice. The outcome of an audit may then be used to direct improvement initiatives, such as new or adapted practices, processes and technologies.

The literature study revealed the following maturity models and audit models relevant to the following domains:

- Systems Engineering (addressed by the **CMMI** - Capability Maturity Model Integration, developed by the Software Engineering Institute of Carnegie-Mellon University (CMMI Product Team [15])).

- Software Engineering (addressed by the **CMMI**, (CMMI Product Team [15])).

- Integrated Product and Process Development (addressed by the **CMMI**, (CMMI Product Team [15])).

- Supplier Sourcing (addressed by the **CMMI**, (CMMI Product Team [15])).

- Knowledge Management (addressed by the **Knowledge Formula** of Hazlett and Gallaghers, the **Knowledge Management Maturity Model** of Siemens, **Knowledge Management Framework Assessment Exercise of KPMG,** the **KM Model** of Infosys Technologies, **IT Advisor for Knowledge Management** by Microsoft, and others (Weerdmeester, Pocaterra, & Hefke [3])).

- Workforce Management (**P-CMM** – People Capability Maturity Model of Curtis, Hefley & Miller (Curtis *et al* [16])).

Some of the models will now be discussed in more detail.

2.6.1 CMMI – Maturity Model for Integrating Various Domains

The most recent Maturity Model, developed by the Software Engineering Institute of Carnegie-Mellon University, addresses organisational processes of **various domains or disciplines**, including Systems Engineering, Software Engineering, Integrated Product and Process Development, and Supplier Sourcing. The integrated model is called CMMI (Capability Maturity Model Integration). The various disciplines differ as follows:

- **Systems Engineering:** Covers the development of total systems, which *may include software*. The focus is on transforming customer requirements and constraints into product solutions, while supporting the product solutions throughout the life of the product (CMMI Product Team [15]).

- **Software Engineering:** Covers the development of software systems (CMMI Product Team [15]).

- **Integrated Product and Process Development (IPPD):** A generic and systematic approach achieving the collaboration of relevant stakeholders throughout the life of the product to better satisfy customer needs, expectations and requirements. The processes supporting an IPPD approach are **integrated** with the other processes in the organisation (CMMI Product Team [15]).

- **Supplier Sourcing:** Used in cases where organisations require suppliers to perform functions or add modifications to products as needed by their projects (CMMI Product Team [15]).

The purpose of CMMI is to "provide guidance for improving your organisation's processes and your **ability to manage** the *development*, *acquisition*, and *maintenance* of *products or services*" (CMMI Product Team [15], p. 1). While new enterprises might wish to establish processes by using the CMMI concepts, the CMMI models are more commonly used by organisations that need to improve their current processes (CMMI Product Team [15]).

CMMI partially addresses the requirement for incorporating various different maturity models designed for different domains into one integrated model. CMU/SEI realised that the application of various multiple models that are not integrated becomes costly in terms of training, appraisals and improvement opportunities. The CMMI framework enables new disciplines to be added to CMMI so as to integrate these new disciplines with the existing ones. Interactions among process areas (of various domains) reinforce the enterprise view on process improvement (CMMI Product Team [15]).

The CMMI Product Suite is also related to 'best practices'. CMMI was developed by using a consensus-based approach to identifying the best practices in a variety of domains. The process improvement initiatives are also directly related to generic business objectives. As an example, a common business objective is to reduce the time it takes to get a product to market – this may be achieved by improving the Project Management processes to ensure on-time delivery (CMMI Product Team [15]).

CMMI currently provides one integrated framework for measuring the capability and/or maturity levels pertaining to various disciplines or domains (Systems Engineering, Software Engineering, Integrated Product and Process Development, and Supplier Sourcing). This integrated framework includes generic process area categories, namely *Process Management*, *Project Management*, *Support* and *Engineering.* The integrated framework, however, also highlights certain practices that are required for a specific discipline (these additional practices are also called 'discipline amplifications') (CMMI Product Team [15]).

The main process area categories that are common to all disciplines (Systems Engineering, Software Engineering, Integrated Product and Process Development, and Supplier Sourcing) include the following process areas (CMMI Product Team [15]):

1. Process Management process areas

- Organisational Process Focus.
- Organisational Process Definition.
- Organisational **Training** (related to organisational learning and KM).
- Organisational Process Performance (deriving quantitative objectives for quality and process performance from organisational business objectives).
- Organisational **Innovation** and Deployment.

2. Project Management process areas

- Project Planning.
- Project Monitoring and Control.
- Supplier Agreement Management.
- Integrated Project Management for IPPD (or Integrated Project Management).
- Risk Management.
- Integrated Teaming.
- Integrated Supplier Management.
- Quantitative Project Management.

3. Engineering process areas

- Requirements Development.
- Requirements Management.

- Technical Solution.
- Product Integration.
- Verification.
- Validation.

4. Support process areas

- Configuration Management.
- Process and Product Quality Assurance.
- Measurement and Analysis.
- Organisational Environment for Integration (facilitating effective integrated team behaviour, as well as stakeholder **communication and collaboration**).
- Decision Analysis and Resolution.
- Causal Analysis and Resolution.

Figure 4 provides a conceptual view of the various disciplines, process area categories and discipline amplifications.

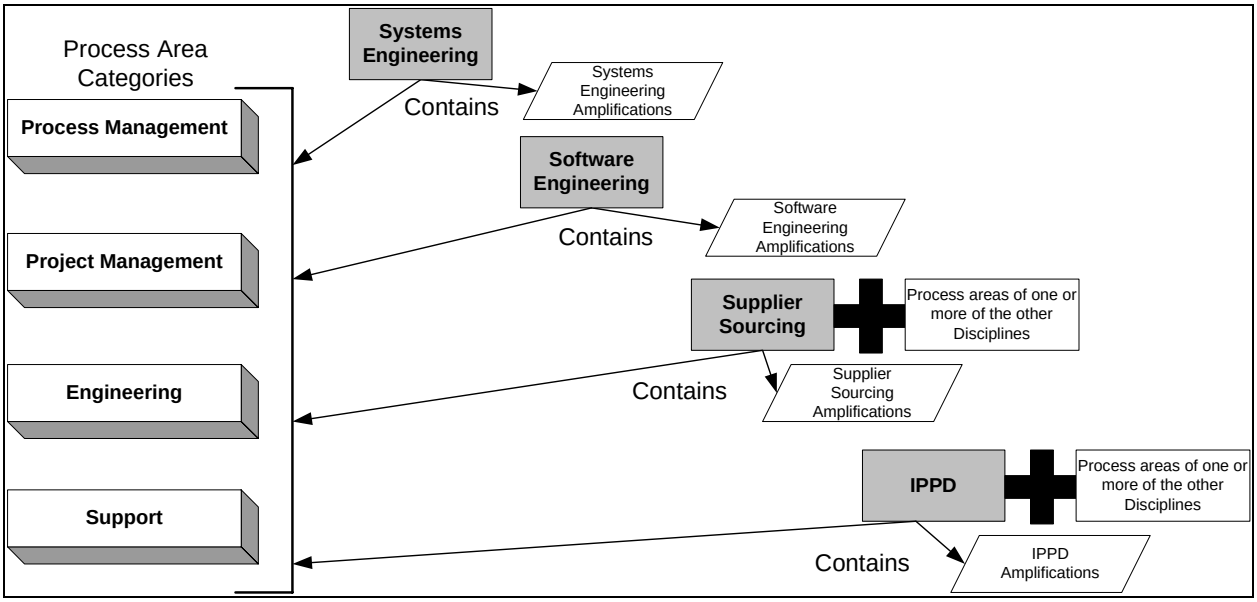


Figure 4: CMMI Process Area Categories, Disciplines and Discipline Amplifications

2.6.1.1 Continuous and Staged Model Representations

Two model representations exist: **staged** or **continuous** mode. The staged model contains **five maturity levels** (starting at level 1) and is used to deduct a single maturity rating for the *complete organisation*, which allows comparisons among organisations. The continuous model contains **six capability levels** (starting at level 0) that could be applied to *single process*

areas. This mode is used to define improvement objectives for specific process areas in accordance and parallel to strategic business objectives.

It is also possible to convert appraisal results (capability levels) obtained by following the continuous representation approach to equivalent maturity level results as used in the staged representation approach (CMMI Product Team [15]).

2.6.2 CMMI – Staged Representation

The CMMI staged representation provides a proven sequence of improvements, starting with the basic management practices and progressing through a pre-defined, proven path of successive maturity levels. Each maturity level serves as a foundation for the next. A single rating is calculated that summarises appraisal results and allows comparisons among organisations (i.e. benchmarking) (CMMI Product Team [15]).

2.6.2.1 Maturity Levels

The CMMI maturity levels define an organisation's overall maturity in terms of five progressive levels:

1: Initial: The organisation has no uniform way of performing work and processes are reinvented on each project. Managers struggle to estimate project progress, losing control over project costs, schedules and product quality. Due to the lack of standardised processes, these projects could be successful only if exceptional individuals are on board (Curtis *et al* [16]).

Immature organisations occasionally repeat proven practices. However, owing to the uncontrollable nature of delivery dates and requirement changes, team members fail to repeat best practices. The main aim of this level is thus to help organisations to remove the obstacles that keep them from repeating successful practices (Curtis *et al* [16]).

2: Managed: The main objective of this level is to enable people to repeat best practices that have been applied in the past by creating an environment of repeatability. This environment is attained by establishing control over project commitments and baselines (Curtis *et al* [16]).

3: Defined: The organisation now defines its best practices and integrates them into a common process. Best practices are now documented, integrated into a standardised process, trained and implemented by the entire organisation. A culture of adherence to professional practices and common beliefs regarding the effectiveness of these practices is cultivated (Curtis *et al* [16]).

4: Quantitatively Managed: This level of maturity is characterised by statistical performance measurement of current processes to predict future performance. Statistical improvement initiatives are based on the principle that repeatable processes should deliver the same results. Results that deviate from the expected results should be investigated and corrective action taken. Due to the manageability of processes, performance becomes

more predictable and the resulting insightful **process knowledge** may be directed towards process improvement efforts (Curtis *et al* [16]).

5: Optimising: At this level, the organisation uses its statistical process data to identify processes that may benefit most from improvement actions. This level typically includes the adjustment of current processes, deployment of new technologies and managing the change initiatives. CMMI thus supports both **linear, incremental** improvement as well as **breakthrough, quantum** improvement (Curtis *et al* [16]).

2.6.2.2 The Structural Decomposition

Figure 5 illustrates the structural decomposition of the CMMI staged representation. The various components are discussed shortly.

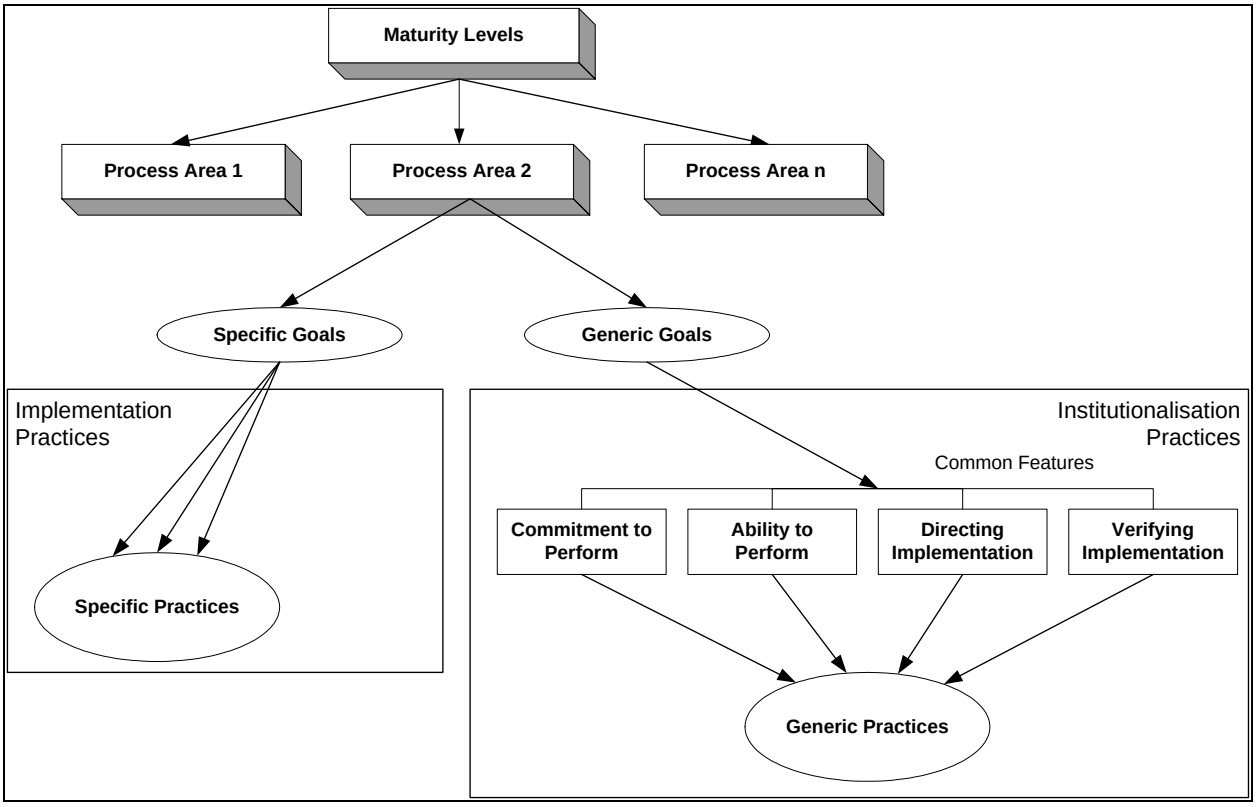


Figure 5: CMMI components for the Staged Representation (CMMI Product Team [15])

Each **maturity level** contains a predefined set of **process areas**. Each process area contains **generic** and **specific goals**, as well as **generic** and **specific practices**. Each maturity level is measured according to the process area goals (CMMI Product Team [15]).

Specific practices could also be classified as **implementation practices** and are those practices that should typically be performed to achieve the specific goals of the process area. Generic practices are classified as **institutionalisation practices** and enable the organisation to institutionalise best practices so that they are effective, repeatable, and lasting (Curtis *et al*, [16]). The generic practices (or institutionalisation practices) are further grouped into 'common feature' categories. These common features are: **Commitment to Perform** (CO), **Ability to Perform** (AB), **Directing**

Implementation (DI), and **Verifying Implementation** (VE) (CMMI Product Team [15]). The attached CD (\Reports\Institutionalisation Practices) provides further details regarding the generic or institutionalisation practices.

The various model components are also categorised as required, expected or informative. Process area goals (specific and generic) are classified as *required*, as they determine process area achievement. Specific and generic practices are classified as *expected*, as they guide individuals in implementing improvements to achieve process area goals. Supplementary information regarding goals, practices or elaborations are classified as *informative* (CMMI Product Team [15]).

The *expected* practices could differ from organisation to organisation. These practices could also be developed and improved by using Communities of Practice (see Appendix B for a definition). A Community of Practice supports people that have common professional concerns / similar issues or problems. Communities work whenever a business imperative exists to improve performance (Abell and Oxbrow [27]).

Figure 6 illustrates the set of process areas that need to be fully implemented for reaching the specific maturity level.

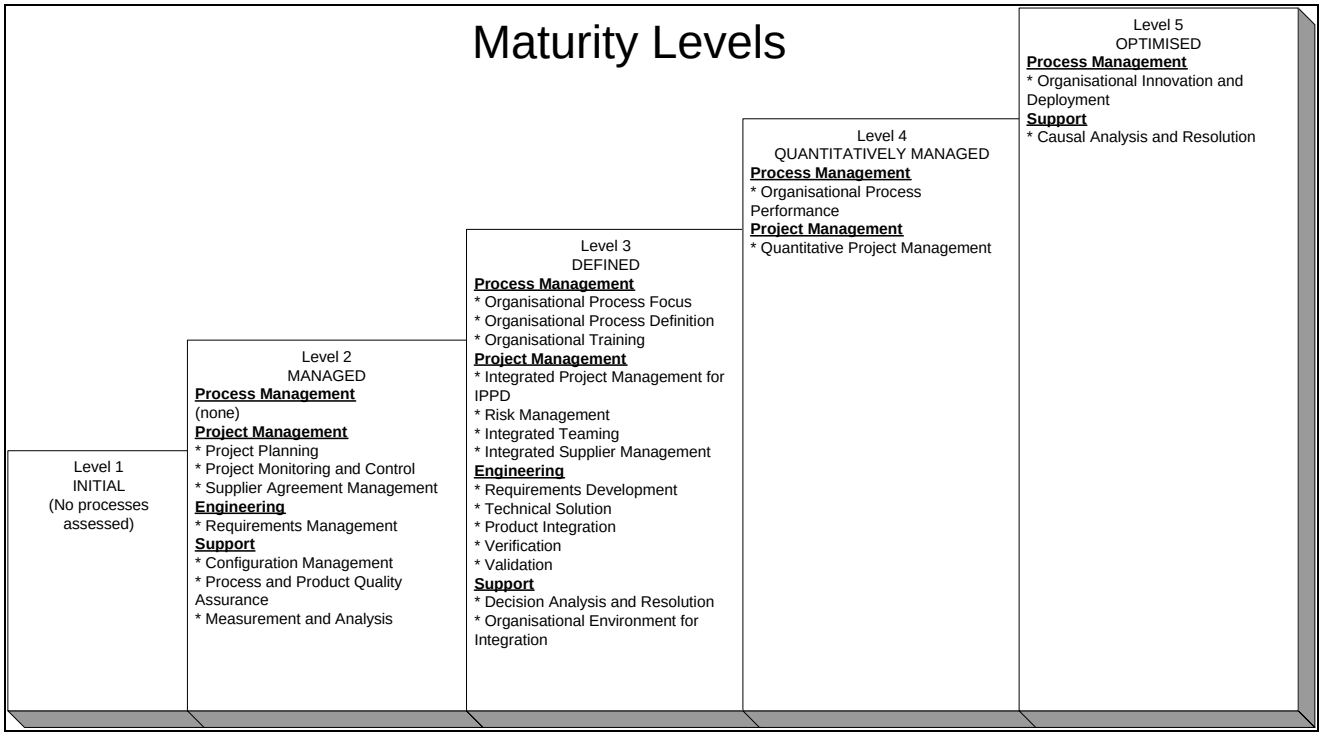


Figure 6: Process Areas per Maturity Level (CMMI Product Team [15])

2.6.3 CMMI – Continuous Representation

The continuous representation allows one to select the order of improvement that best meets the organisation's business objectives. An organisation selects certain process areas of which the individual capability levels are assessed. Certain improvement actions (per process area) are initiated, based on the assessment results. This representation also allows comparisons across and among organisations on a process area by process

area basis (CMMI Product Team [15]). Figure 7 illustrates the capability levels that are applied to a single process area.

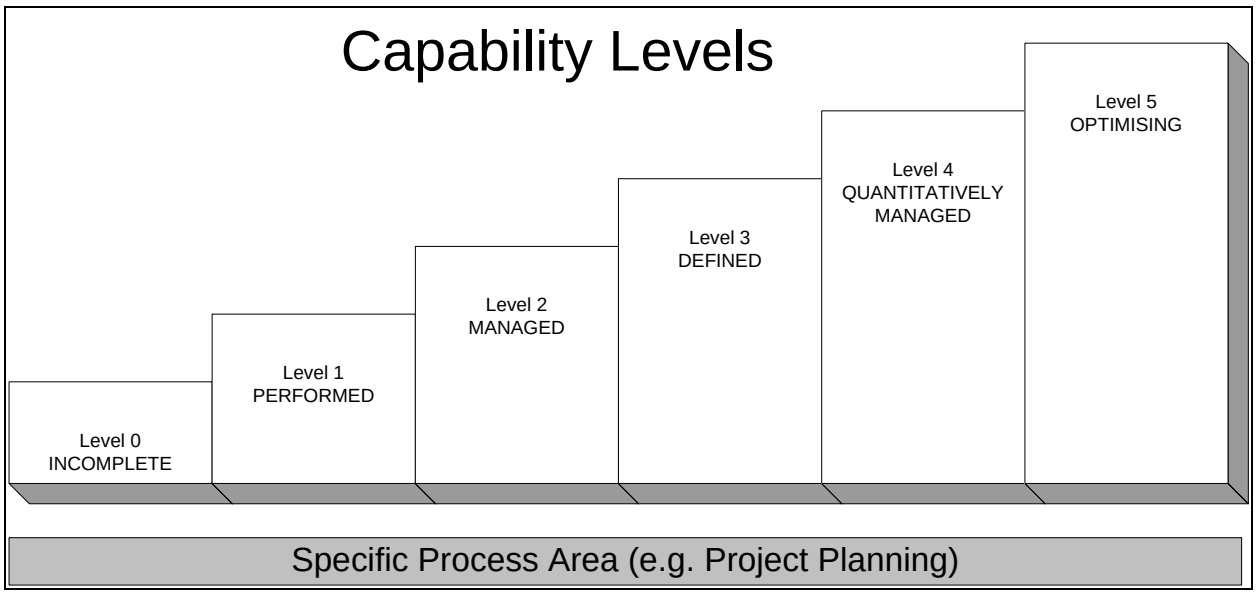


Figure 7: Capability Levels for a Single Process Area (CMMI Product Team [15])

2.6.3.1 Capability Levels

The CMMI capability levels consist of specific and generic practices for a specific process area that can systematically improve the organisation's processes associated with that process area. There are six capability levels:

0: Incomplete: An incomplete process is either not performed or partially performed. One or more of the specific goals of the process area are not satisfied (CMMI Product Team [15]).

1: Performed: A performed process satisfies all of the specific goals of the process area, thus supporting and enabling the work needed to produce identified output work products (CMMI Product Team [15]).

2: Managed: A managed process is a performed process, which has also been executed in accordance with policy, using skilled people while adequate resources to deliver outputs and involving relevant stakeholders; it is monitored, controlled, reviewed and evaluated on its conformity to its process description. (CMMI Product Team [15]).

3: Defined: A defined process is a managed process which has been tailored from the organisation's set of standard processes according to the organisation's tailoring guidelines, also contributing to the organisation's process assets in terms of work products, measures and other process-improvement information. The defined process is defined in more detail than the managed process and is performed more rigorously. The improvement information is thus easier to interpret, analyse and use (CMMI Product Team [15]).

4: Quantitatively Managed: A quantitatively managed process is a defined process that is controlled according to quantitative objectives for quality and process performance, using quantitative (statistical) techniques. Causes of

process variation are also identified and sources of variation are addressed to prevent future occurrences. The quality and process performance measures are incorporated into the organisation's measurement repository for future decision-making (CMMI Product Team [15]).

5: Optimising: An optimising process is a quantitatively managed process that has been changed to meet projected business objectives. This process focuses on continually improving the process performance through both innovative and incremental improvements (CMMI Product Team [15]).

2.6.3.2 The Structural Decomposition

Figure 8 illustrates the structural decomposition of the CMMI continuous representation. The various components are discussed briefly.

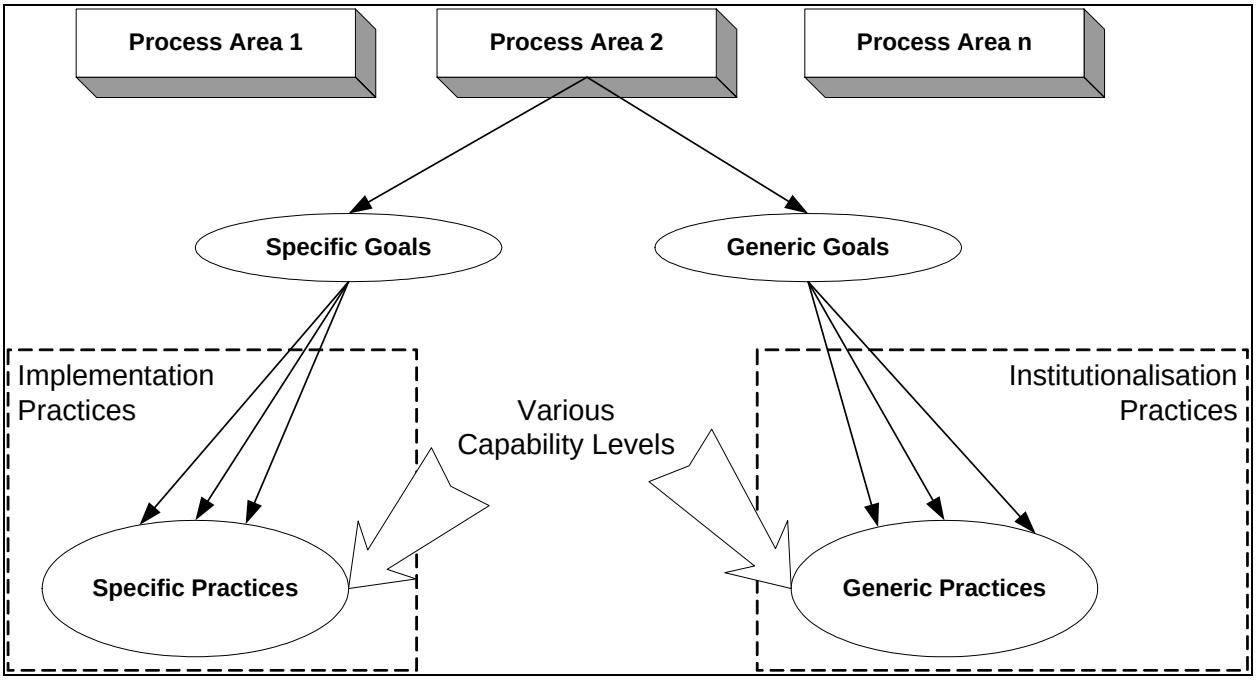


Figure 8: CMMI components for the Continuous Representation (CMMI Product Team [15])

Each **process area** contains **generic** and **specific goals**, as well as **generic** and **specific practices**. Specific practices could also be classified as **implementation practices** and are those practices that should typically be performed to achieve the specific goals of the process area. Each specific practice is associated with a **capability level** and may be further classified as a **base practice** (capability level 1) or an **advanced practice** (capability level of 2 or higher). Generic practices are classified as **institutionalisation practices** and enable the organisation to institutionalise best practices, ensuring that the processes associated with the process area will be effective, repeatable, and lasting (CMMI Product Team [15]).

The continuous representation contains generic practices for capability levels 1-5, while the staged representation only contains generic practices for maturity levels 2 and 3 (CMMI Product Team [15]). The attached CD (\Reports\Institutionalisation Practices) provides further details regarding the generic or institutionalisation practices.

2.6.4 Knowledge Management Maturity

Various KM maturity models and audit models have been designed. A few prominent models are now discussed.

2.6.4.1 Knowledge Management Framework Assessment Exercise

KPMG designed a Knowledge Management Assessment model as an assessment and benchmarking tool. The model is partly normative, which provides freedom to choose among the activities to be implemented on each of the five maturity levels. The model has been applied in a British research project, including organisations with a turnover exceeding £200 million (Weerdmeester *et al* [3]).

KPMG used four key areas of KM (people, process, content and technology) to assess organisational KM activities (Weerdmeester *et al* [3]). These areas include the following KM activities (Parlby [47], p. 23):

People Area

- "Implementing KM training / awareness (e.g. workshops or roadshows).
- Appointing knowledge officers and creating knowledge centres.
- Incentivising and rewarding knowledge working.
- Building and developing "communities of practice".
- Establishing formal KM networks (e.g. dedicated workers in discrete groups, or communities of KM practice)".

Process Area

- "Benchmarking or auditing the current situation.
- Creating a KM strategy.
- Implementing new systems for 'communities of practice'.
- Designing other KM processes."

Content

- "Creating a knowledge map.
- Implementing knowledge policies.
- Measuring intellectual capital".

Technology

- "Carrying out a knowledge system audit or assessment.
- Implementing ways to share best practice.
- Use of KM software (either dedicated or intranet or groupware software)".

The following levels apply to these four key areas of KM:

1: Knowledge Chaotic – implementing 3 or fewer of the activities stipulated above.

2: Knowledge Aware – implementing 4 or more activities from at least 2 areas.

3: Knowledge Focused – implementing 6 or more activities from at least 3 areas.

4: Knowledge Managed – implementing more than 2 activities from each area.

5: Knowledge Centric – implementing all activities from all areas.

2.6.4.2 The IT Advisor for Knowledge Management

Microsoft defines an eight-level maturity model, which involves KM progression from efficiency to effectiveness to growth. A software tool is also provided to allow individuals to score existing practices separately and consolidate the different scores (Weerdmeester *et al* [3]).

2.6.4.3 Siemens Knowledge Management Maturity Model

Siemens designed a model that incorporates both qualitative and quantitative KM maturity assessment outputs (Ehms, K. & Langen [18]).

The Siemens model assesses an organisation's overall position in KM by defining five maturity levels, based on the CMU/SEI model:

1: Initial: KM activities are ad hoc. The organisation does not describe organisational phenomena from a knowledge point of view.

2: Repeated: A few projects and activities are labelled as "knowledge management".

3: Defined: The creation, sharing and usage of knowledge are evident in standardised processes.

4: Managed: The creation, sharing and usage of knowledge are integrated, measured and improved.

5: Optimising: KM is developed continuously (Weerdmeester *et al* [3]).

Eight key areas are defined (based on the enablers of the EFQM - European Foundation for Quality Management) and extended to represent KM specific aspects (Weerdmeester *et al* [3]).

2.6.4.4 Gallager & Hazlett's Knowledge Formula

Gallagher & Hazlett [1] designed a Maturity Model based on their Knowledge Formula. The model consists of four maturity levels:

1: Knowledge-Aware.

2: Knowledge-Managed.

3: Knowledge-Enabled.

4: Knowledge-Optimised.

The four levels are supported by three main components:

1. **Infrastructure:** The extent to which business processes and related KM processes have been mapped and documented. This component also assesses the extent to which knowledge-intensive processes are supported by the use of current KM technologies such as integrated work-flow KM systems (Weerdmeester *et al* [3]).

2. **Culture:** The extent to which KM software is used, the level of user-experience with KM applications and the extent to which KM is perceived as a valuable asset in the organisation (Weerdmeester *et al* [3]).

3. **Technology:** The technological infrastructure, enabling KM technologies, and the extent to which KM applications are implemented within the user community (Weerdmeester *et al* [3]).

Note that this model recognises the importance of integrating business processes with KM processes (as indicated in the **infrastructure** component).

2.6.4.5 The Knowledge Management Model (KMM) from Infosys Technologies

The KMM of Infosys Technologies is also based on CMU/SEI's Capability Maturity Model. The KMM defines three major components (People, Process and Technology) that are used to define the characteristics of the five maturity levels. The maturity levels include:

1:Default: Dependence on individual skills and abilities.

2:Reactive: The ability to repeat certain tasks consistently.

3:Aware: Restricted data-driven decision-making, restricted ability to leverage internal expertise, but good virtual team management.

4:Convinced: The ability to leverage internal and external knowledge sources, measuring productivity benefits realised via KM initiatives, and the ability to influence quantitative decision-making regarding strategies, operations, technology and the business environment.

5:Sharing: The ability to manage organisational competence quantitatively, streamlining processes for business advantage and influencing technological and business changes (Kochikar [19]).

Certain Key Result Areas (KRAs) are addressed on each level of maturity. The model also assesses the effectiveness of the main KM life cycle stages (knowledge acquisition, knowledge sharing and knowledge reuse) on each maturity level. Virtual Teamwork has been added as a fourth dimension to assess the organisational ability to communicate and share knowledge with geographically dispersed team-members (Kochikar [19]).

2.6.4.6 The VISION Knowledge Management Maturity Model (KMMM)

Weerdmeester, Pocaterra, and Hefke [3] believe that the level of readiness to implement innovative KM solutions determines the maturity of user communities and their eagerness to experiment with innovative KM solutions, which include novel human and organisational practices. Weerdmeester *et al* [3] developed a model called 'VISION KMMM' which combines the KM technology maturity with the organisation-oriented maturity.

The purpose of the V-KMMM is to "target research towards the next generation KM technologies taking into account user needs and capabilities to participate in a common user driven research program" (Weerdmeester *et al* [3, p. 32]). V-KMMM should not be used to develop an organisation to a higher level of maturity, but rather to assess the maturity level for KM technology research.

2.6.4.7 The Knowledge Management Assessment Tool

KMAT (The Knowledge Management Assessment Tool) was developed by the American Productivity and Quality Centre, and Arthur Andersen in 1995.

A likert scale is used to assess an organisation's KM capacity in 5 KM areas: process, leadership, culture, technology and measurement (The Knowledge Management Assessment Tool [48]).

2.6.4.8 Bohn's Stages of Knowledge Growth

Bohn defined eight stages of knowledge growth (cited in Tiwana [28], p. 174). This model may be used by organisations to measure their need for KM (Table 2). The various levels have also been plotted against several process types, skill levels, quality control and other KM growth indicators (Table 3).

Stage	Name	Typical Form of Knowledge
1	Complete ignorance.	Does not exist anywhere.
2	Awareness.	Primarily tacit.
3	Measure.	Primarily written.
4	Control of the mean.	Written and embodied in hardware.
5	Process capability.	Hardware and operating manuals.
6	Process characterisation.	Empirical equations (quantitative).
7	Knowing why.	Procedures, methodologies, scientific formulas, and algorithms.
8	Complete knowledge.	Never happens, but you can always hope for it!

Table 2: Bohn's Stages of Knowledge Growth (Tiwana [28], p. 174)

Stage of Knowledge	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nature of production	Expertise based				Procedure based			
Role of workers	Everything			Problem solving			Learning and improving	
Location of knowledge	Tacit			Written and oral			In databases or software	
Nature of problem solving	Trial and error			Scientific method			Table lookup	
Natural organisation type	Organic			Mechanistic			Learning	
Suitability for automation	None							High
Ease of transfer	Low							High
Feasible product variety	High			Low			High	
Quality Control	Sorting			Statistical process control			Feed forward	

Table 3: Ranking KM Facets along Bohn's Stages of Growth (Tiwana [28], p. 175)

Hall and Andriani (cited in Tiwana [28]) provide a capability framework for positioning knowledge-related assets (Table 4). This framework is then used in combination with Bohn's Stages of Growth to assess the overall KM maturity level.

Regulatory Capability	Positional Capability
Patents	Path-dependent Capabilities
Trademarks	Reputation
Registered Designs	Value Chain Configuration
Trade Secrets	Distribution Networks
Licences	Installed Base
Proprietary Technology	Customer Base
Methodologies	Market Share
Databases	Liquidity
	Product Reputation
	Service Reputation
	Service Product Reputation
Functional Capability	**Cultural Capability**
Lead Times	Tradition or Corporate Culture of Being the Best
Accessibility of Past Knowledge	Tradition of Sharing
Innovative Capabilities	The Tradition of Co-optation
Individual and Team Skills	The Tradition of Risk Sharing
Distributor Know-How	Perception of Quality Standards
Employee Skills	Ability of Employees to Work in Teams
	Capability to Respond to Market Challenges
	Innovation
	Entrepreneurial and Intrapreneurial Drive in Employees
	Employee Initiation and Motivation

Table 4: The Capability Framework for Positioning Knowledge-Related Assets (Hall and Andriani (cited in Tiwana [28], p. 191)

2.6.4.9 Stages in Knowledge Management Evolution

Ahmed *et al* ([25] refer to four stages in KM evolution. These stages are:

1. Reactive (technical and efficiency led).

2. Mechanistic (emphasising IT, top-down driven and heavily prescriptive).

3. Organic (people-driven, emphasising communities of practice).

4. Adaptive (containing more open structures and permeable boundaries in operations and activities).

2.6.4.10 Other growth indicators

Tiwana ([28], p. 105) believes that a KM system needs to support knowledge exploitation before it can begin supporting exploration. An organisation should thus first focus on deriving additional financial and productivity gains from knowledge that already exists. Exploration could then be used to explore and identify new niches for its services and markets.

2.6.5 Organisational Learning Maturity

2.6.5.1 The People Capability Maturity Model

The People Capability Maturity Model has been developed by the University of Carnegie Mellon in an attempt to improve an organisation's workforce practices (Curtis, Hefley and Miller [16]). The P-CMM introduces stages of progressive improvement and transformation of an organisation's culture towards a **learning organisation**. This framework has been primarily designed for knowledge-intense organisations, but according to Curtis *et al* [16] almost any organisation may apply the model. The primary objective is to "improve the capability of the workforce" (Curtis *et al* [16], p. 4).

Workforce capability is defined as follows: "the level of knowledge, skills, and process abilities available for performing an organisation's business activities" (Curtis *et al* [16], p. 4).

The workforce capabilities also indicate an organisation's:

- "readiness for performing its critical business activities,
- likely results from performing these business activities, and
- potential for benefiting from investments in process improvement or advanced technology" (Curtis *et al* [16], p. 4).

Note that the above-mentioned definitions and objectives assume an integration of business activities, technology, process abilities, knowledge and process improvement.

Curtis *et al* [16] also state that P-CMM guides an organisation in selecting high-priority improvement actions based on the existing maturity of its workforce practices.

1. *Maturity Levels*

The P-CMM model includes five maturity levels:

1: Initial: Workforce practices are ad hoc and inconsistent, task responsibilities are displaced and the workforce is emotionally detached (Curtis *et al* [16]).

2: Managed: This level focuses on the establishment of workforce practices at each organisational unit. Each unit manager takes full responsibility for his/her own workforce regarding staffing, performance management, skills development, commitment co-ordination, resource provision and compensation management. This maturity level is characterised by the capability of units to meet commitments by managing and co-ordinating individual contributions into effective unit performance. This level also addresses one of the main reasons for employee churn, namely poor relations with their boss (Curtis *et al* [16]).

3: Defined: The main aim of this level is to develop an organisation-wide infrastructure regarding workforce practices, tying these practices to strategic business objectives. The workforce competencies directly contribute to the organisation's core competencies and core business activities. The workforce competencies are also **linked to process frameworks** that are established in the CMMI (Curtis *et al* [16]).

The capability in a specific workforce competency consists of the aggregated level of knowledge, skills and process abilities, also collectively referred to as competency communities. Note that these communities are very similar to Communities of Practice, used in the KM domain. The inter-dependence between business processes and competency communities is also emphasised by Curtis *et al* [16]: "The capability of an organisation's business processes is, in part, determined by the extent to which competency communities can translate their collective knowledge, skills, and process abilities into work performed".

This level is also characterised by promoting a participatory culture, enabling an organisation to gain maximum benefit from its workforce competency capabilities (Curtis *et al* [16]). Note that this culture change is similar to a knowledge sharing culture - a prerequisite for effective KM.

4: Predictable: At this level, organisations manage and exploit the capabilities created by the framework of workforce competencies in Level 3. The capability for performing work is now quantifiable and thus predictable. The most critical and strategic competency-based processes are now measured, using Six Sigma techniques. The results are used for evaluating performance and deciding on corrective actions (Curtis *et al* [16]).

Management can now trust the competency-based processes performed by competent people and these processes may be preserved as organisational

assets, which may be reused by others in the organisation (Curtis *et al* [16]). Note that this concept is similar to one of the key objectives of KM, namely knowledge reuse.

Due to the establishment of effective and quantifiable processes, a participatory environment and competent people, management is encouraged to empower workgroups and focus its attention on strategic issues (Curtis *et al* [16]).

Mastery of competency-based processes also enables integration of various different competency-based processes into a single multidisciplinary process, integrating the work of several workforce competencies (Curtis *et al* [16]).

5: Optimising: The organisation applies the quantitative results obtained in Level 4 to guide continuous improvements on individual and workgroup levels. Inputs for potential improvement to workforce practices come from various sources, e.g. lessons learned, suggestions made by the workforce or results form quantitative management activities (Curtis *et al* [16]).

The workforce aims at continuous improvement of the workforce capability through incremental advances or dramatic changes (e.g. implementing new and innovative solutions and technologies). The culture created at this level is one of continuous improvement and performance excellence (Curtis *et al* [16]). This level could only be reached if both adaptive learning (providing incremental improvement, based on past successes) and generative learning (evaluating the ways in which previous problems were solved to finding new and innovative ways of solving future problems) are pursued.

2. *The P-CMM Structural Decomposition*

Figure 9 portrays the structural elements of the P-CMM. Each component will be discussed in more detail.

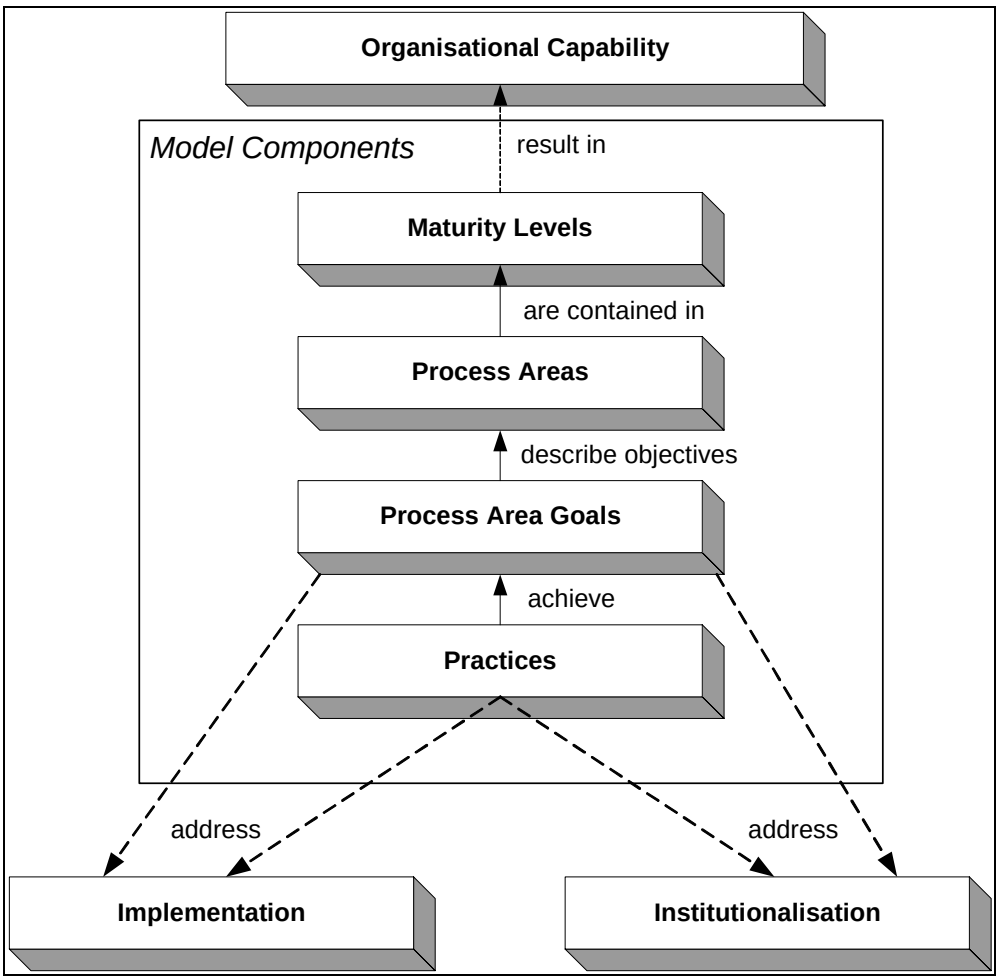


Figure 9: The P-CMM components (Curtis *et al* [16])

Each **maturity level** contains various **process areas**, which in turn contain various **process goals** and **practices**. The practices are also referred to as sub-processes or "standard, defined workforce management processes" (Curtis *et al* [16], p. 52). These practices define the activities that need to be performed to achieve a specific **goal** – they are goal-orientated (Curtis *et al* [16], p. 53).

Practices are categorised as **implementation practices** or **institutionalisation practices**:

- **Implementation practices** are those practices that are implemented for direct achievement of processes and goals.

- **Institutionalisation practices** are those practices that help institutionalise Implementation Practices. These practices are also further classified into: "**Commitment to Perform**, **Ability to Perform**, **Measurement and Analysis** and **Verifying Implementation**" (Curtis *et al* [16], p.55). The attached CD (\Reports\Institutionalisation Practices) provides further details regarding the implementation practices.

3. *Staged Culture-Changing Approach*

One of the main KM barriers experienced in most organisations is the culture of knowledge sharing (discussed in section 2.2.4).

The P-CMM indirectly addresses this barrier by introducing a staged culture-changing approach. A culture of professionalism and continuous improvement is pursued (Curtis *et al* [16]). Continuous improvement can only be attained by gaining insightful process knowledge (see capability levels 4 and 5). A culture of continuous improvement thus assumes a knowledge-sharing culture.

2.6.5.2 Buckler's Growth Model

The concept of individual learning relates to the level of people capability maturity discussed in the previous section. Buckler (cited in Ahmed *et al* [25]) defined a growth model regarding the stages in individual learning. Strong leadership is required to progress from one level of learning to the next.

These stages are:

1: Ignorance: Accepting that no one knows what they do not know.

2: Awareness: The individual becomes motivated to understand a subject or problem.

3: Understanding: Understanding develops as the depth of knowledge increases.

4: Commitment: Interest, curiosity and a high level of self-awareness lead to commitment for taking action.

5: Enactment: When individuals move to enactment, real improvements through learning start to emerge.

6: Reflection: Evaluation of actions, outcomes and theories ultimately leads to deep understanding and learning. Understanding may again lead to commitment (level 4) and enactment (level 5). A continuous cycle of learning follows.

2.6.6 Summary

Section 2.6 classified maturity models (and similar models, e.g. audit models) as business process improvement methods, which ultimately ensure business performance improvement. Various maturity models for different domains (Systems Engineering, Software Engineering, Integrated Product and Process Development, Supplier Sourcing, and Knowledge Management) were analysed to identify integration possibilities of the various models.

The CMMI (Integrated Capability Maturity Model) was discussed in detail and will be used as a framework for constructing an integrated model in section 3.3.

2.7 TECHNOLOGY – AN ENABLER

2.7.1 The Role of Technology

A new study of 100 manufacturing companies in France, Germany, the United Kingdom, and the United States indicated that IT expenditures have a minor impact on productivity unless they are supported by sound management practices (Dorgan & Dowdy [29]). The study specifically measured the use of three important management tools: lean manufacturing (cutting waste in the production process), performance management and talent management (attracting and developing highly-skilled individuals). The results of the study showed that companies that scored low in management practices gained a mere 2 percent productivity improvement after increasing computing power. However, companies displaying high scores in management practices achieved 20 percent higher productivity after improving their computing power (Dorgan and Dowdy [29]). It seems that companies should focus on **improving management practices** before investing in IT.

Recent studies (Alinen and Hoffman cited in Malhotra [52]) also found that a negative correlation exists between technical investments and business performance – the highest IT spenders typically under-performed by up to 50% compared with best-in-class peers.

The first KM adopters unfortunately also focused on exploiting technology – KM was often perceived as another IT solution. Due to immence confusion between knowledge and information, many managers spent millions of dollars on information technology initiatives, which only marginally increased improved efficiency or effectiveness of knowledge workers.

Seely-Brown (cited in Ahmed *et al* [25]) attributes these IT implementation failures to organisations' lack of understanding concerning communication and operation of knowledge workers. "Knowledge is actually created not through technology but, rather through the social processes of collaborating, sharing knowledge and building on each other's ideas" (Ahmed *et al* ([25], p. 15). Abell and Oxbrow ([27], p. 108) agree with this view: "Knowledge Management is principally about people and processes". Malhotra [52] believes that many KM system implementation failures are due to knowledge gaps between technology inputs, knowledge processes and business performance.

An urgent need exists in understanding how technologies, people, and processes together influence business performance and achievement of business strategies (Murphy cited in Malhotra [52]), p. 7)). Malhotra [52] suggests that business strategies should drive technology deployments in a strategy-pull approach in contrast with the previous Technology-Push approach.

2.7.2 Technologies that Enable Process Management

2.7.2.1 Workflow Management Systems

"Workflow is an IT technology which uses electronic systems to manage and monitor business processes. It allows the flow of work between individuals and/or departments to be defined and tracked. Although documents are often used as a medium for transporting information in a workflow system, it is mostly associated with document management where the workflow system is used to track the process of creating and reviewing and distributing documents" (Document Management Avenue [49]).

Workflow engines are used as control elements in Enterprise Application Integration products (EAI brokers). Implementation of workflow projects obtained a higher success rate than the development of application development projects (Smith & Fingar [23]). This fact is not too surprising, since the flow of work among systems, people and machines provides a logical way of designing, building, managing and operating an information technology infrastructure. It is also closer to the way business people think (Smith & Fingar [23]). From the author's perspective, workflow also naturally supports the collaboration activities taking place during knowledge exchange and transfer between employees.

Current electronic workflow models, however, fail to support the realistic and temporal structure of project tasks, their roles and responsibilities, **information flow and dependencies**. "These gaps are too often left to the user to integrate" (Mack et al [9]), which results in non-optimal integration activities.

Mack et al [9] (p. 950) claim: "What is missing is active project support: This means automatic or semiautomatic accessing, organising, and presentation of project information within the temporal context of day-to-day project management." A new information architecture is required for representing a task structure, organised in time, including project roles and responsibilities, information dependencies and flow, as well as standards for handling human interactions. (Mack et al [9]).

2.7.2.2 Business Process Management (BPM) Systems

The main purpose of BPM Systems is to integrate processes in a business and provide new process value just as relational database management systems provided new value from data (Smith & Fingar [23]).

These systems are specifically designed to address the requirements of a specific organisation. The design of processes reflects the company's goals, objectives and strategies to compete in the marketplace and how it wishes to improve its operations, products and services. The processes are also mapped to the existing IT infrastructure and various software applications that have been implemented by the organisation (Smith & Fingar [14]).

BPM Systems link systems, people, information access, information transformation, exceptions and workflow processes (Verner [20]).

These systems, however, combat **some** of the problems experienced with current workflow systems. One of the problems of using workflow systems is that different workflow vendors implement workflow in different ways, which impairs integration of the various workflow systems. Another limitation, inherent in classical workflow models, is the fixed process types that are presented by workflow systems. Some process scenarios cannot be accommodated by workflow systems. One such area is **co-ordination and negotiation between individuals and teams**. Workflow management systems ineffectively support change management processes and product life cycle management (Smith & Fingar [23]). Workflow-based solutions that do support life cycle management infrequently provide an end-to-end coverage and therefore also **hamper process improvement** over time (Smith & Fingar [23]).

BPM Systems consider various different types of processes (such as workflow, e-mail and supply chain) as different manifestations of the same underlying semantic (Smith & Fingar [23]). Pi-Calculus is a new technology engine that is supported by generic BPM System protocols that have been defined for various process-participants (e.g. activities, tasks, resources, task handlers, task lists and directories) (Smith & Fingar [23]).

Smith & Fingar [23] believe that BPM Systems will be used as an IT platform for developing the next generation of **enterprise resource planning systems**, **document management**, **workflow**, content and **knowledge management**.

2.7.2.3 Enterprise Application Integration (EAI)

“Application integration is about gluing together many applications so they work as if they were one” (Wong, cited in Firstcoastcreative.com [50]).

EAI allows organisations to link various different business applications (built in-house or packaged) into one system, enabling process and data sharing across the company and beyond (including customers and partners).

Various technologies (e.g. middleware solutions) have been used in the past to enable integration between different systems. These technologies accomplished point-to-point integration and often needed changes in existing applications or their data structures as business processes change.

EAI technologies address changes in the business process environment by focusing on process-level integration. One-to-one integration (used by previous technologies) is replaced by one central hub. Process flows and rules definitions are configured outside the applications themselves, which minimises the complexity associated with adding or upgrading applications.

An EAI solution usually contains three technology layers: a message service, a message broker, and a business process modeller. The process modeller contains the configuration of all business processes, logic and rules. The message broker applies these rules during the formatting and routing of messages, while the message service performs the actual delivery of messages to target applications. By using process modelling the integration

of various applications is configured, rather than programmed (Firstcoastcreative.com [50]).

2.7.3 Technologies that Enable Knowledge Management

Technology's most important role in KM is to broaden the reach and increase the speed of knowledge transfer (Tiwana [28]). In addition, technology plays the following three roles:

- Facilitating communication.
- Providing an infrastructure for storing codified and explicated knowledge.
- Assisting with mapping distributed parts of tacit and explicit knowledge to maintain their interdependencies (Tiwana [28]).

Communication and information technologies primarily facilitate codification, storage and retrieval of content. These technologies make it easier for people to work together irrespective of their geographic location. Electronic networks give access to experts worldwide, while teams can work together without being at the same location (Ahmed *et al* ([25]).

Mack, Ravin and Byrd [9] believe that KM Systems may have a major social and cultural-shaping role: "Bulletin boards, frequently accessed documents, highlighted news and success stories may shape the corporate culture and values, giving recognition and acknowledgment to successful employees, while creating models for others" (Mack et al [9] (p. 929)).

2.7.3.1 Minimum Technology Requirements

Even though technology is only seen as an enabler for managing knowledge, most companies considering KM "are expected to have high-speed networks already in place" (Tiwana [28], p. 252).

Tiwana [28] also specified a minimum set of components to support a KM System:

- TCP/IP Connectivity throughout the organisation.
- Web Server.
- A POP3/SMTP or MAIL server.
- A Virtual Private Network to support access and connectivity.
- Support for streaming audio and video on the central server(s) (Tiwana [28], p. 162).

2.7.3.2 Applicable Technologies

Different technologies could be applied to support the knowledge-management and -conversion processes. Tiwana ([28], p. 165) believes that "knowledge and expertise existing in organisations generates more value

when it is rapidly applied than when it is accumulated in systems and software". Knowledge **integration** is thus more powerful and causes fewer delays than **transferring** knowledge and expertise.

The following section classifies some useful technologies supporting KM according to the different knowledge conversion quadrants identified by Nonaka [5] (see Table 1).

Tacit to Tacit

Groupware: Used to assist individuals to work together in teams or groups in sharing experiences. Groupware includes: online meetings, video conferencing, audio conferencing, text-based conferencing, synchronous communication and chat (Marwick [8]).

Community Systems: Used to find persons with common interests to join a community for sharing information (Marwick [8]).

Expertise Location Systems: Used to get advice from experts who are willing to share their knowledge (Marwick [8]).

Video Conferencing and Multimedia: Video conferencing enables people to share knowledge by exchanging full-motion video and audio across a distributed network. A multimedia clip could convey a complex operation that would otherwise be difficult to convey with pictures and words (Tiwana [28]).

Virtual shared spaces: These tools promote knowledge sharing, creation and transfer. Examples are virtual meetings (***Web conferencing***) and Web-based, real-time, distributed document collaboration (Tiwana [28]).

Tacit to Explicit

Collaboration Systems and Groupware: These systems could be used to share mental models by articulating these models through dialogue. Specialised brainstorming applications and workflow systems are also included in this category (Marwick [8]).

Digital whiteboards: Information, notes or ideas generated during meetings or brainstorming sessions are captured on electronic whiteboards and distributed, printed, exchanged or e-mailed to participants or interested parties (Tiwana [28]).

Newsgroups / forums: Used by a group of participants willing to give advice to other participants. IBM uses an Internal Company Forum to contribute knowledge in response to a request for help. All questions and answers are gathered in a repository / archive and may be consulted by any group member who requires similar help (Marwick [8]).

Expert Systems: Used to supply expertise knowledge electronically. Expert systems "capture and reproduce the knowledge of an expert problem solver or decision maker and then simulate the 'thinking' of that expert" (Whitten and Bentley [12], p. 12).

Explicit to Explicit

Marwick [8] claims that this form of knowledge conversion is the best supported by Information Technology.

Knowledge Capturing Systems: These include systems that capture electronic documents that are easy to share via e-mail, the Web or a document management system. Other forms of knowledge capture include digital audio and video recordings, though search-capabilities are still limited to the transcription abilities of automatic speech recognition technologies (Marwick [8]).

Search Technologies: Search engines are used to retrieve documentation using pre-indexing or natural language analysis. Results may be ranked according to specific criteria (e.g. documents with several citations or references appearing on top of the returned list). Many attempts are made to improve the precision of the search results by encoding knowledge of the domain being searched (Marwick [8]).

Taxonomies, Categorisation / Classification Technologies: These are used to create categories (automatically and/or manually) and relate different documents to one another by placing them in the same category. This usually helps users to interpret documents in a specific context (Marwick [8]).

Project Management Tools: Though project management tools are limited in creating knowledge, these tools provide a good basis for storing and organising documents, records and notes. (Tiwana [28]).

Directories: Intranets are the primary platform for creating directories of skills. These directories serve as pointers in finding employees that may be knowledgeable on specific subjects or projects. The ‘pointer’ approach builds a bridge between the knowledge requester and the knowledge source (Ahmed *et al* [25]).

Portals, Meta-Data, Document Management Systems: Portals provide a convenient location for the storage of meta-data about documents in their domain. Portals are usually a combination of various technologies such as capturing and gathering, categorisation and raxonomies (including taxonomy maintenance features) and searching (Marwick [8]). Document management systems make huge amounts of documents (including electronic forms, specifications and correspondence) available through the Web (Tiwana [28]).

Intranets and Extranets: Intranets are used to support knowledge access and exchange within organisational units. Extranets support knowledge access and exchange between organisations.

Data Warehouses / Knowledge Repositories: Repositories are used to store and enable access to organisation data, information and knowledge. Usually these repositories are devoid of context, so significant user interpretation is required. ***Data mining tools*** are often used to extract

data from repositories. By interpreting the results, users may gain new knowledge (Ahmed et al [25]).

Summarisation: Document summaries allow users to avoid reading a complete document if it is not relevant to their current tasks (Marwick [8]).

Explicit to Tacit

Technology that supports this type of knowledge conversion should, in addition to information retrieval, facilitate the understanding and use of the information. Technologies (e.g. ***Searches*** and ***Classifications***), that assist users in discovering relationships between documents and concepts, help users to explore an information space and eventually deduct new tacit knowledge from it.

This knowledge conversion category also includes technologies that apply to the formation of tacit knowledge through learning (e.g. ***distance learning*** and ***online-education***).

In addition to the above-mentioned technologies, Tiwana [28] claims that various intelligence tools should also be included: ***case-based reasoning***, ***decision support systems***, ***fuzzy logic systems***, ***genetic algorithms***, ***collaborative filtering***, ***neural networks*** and ***rule-based systems***.

Mack et al [9] believe that the digital knowledge workplace of the future will require a more intelligent and task-oriented infrastructure than the one enabled by previously-mentioned technologies. The knowledge workplace will support tasks directly, as well as refer to specific project roles and responsibilities.

2.7.4 An Optimal Knowledge Management Technology Mix

A study performed by Breu and Smith (cited in Bahra [26], p. 121) revealed perceived effectiveness of technology applications in knowledge exploitation. In the past, e-mail, management information systems and shared databases were ranked as the top three technologies enabling knowledge exploitation. A future perspective reveals the following top ten effective knowledge exploitation applications:

Top ten effective applications	Future (%)
Internet	47.8
Intranet	35.3
E-mail	31.0
Shared databases	27.7
Customer Relationship Management (CRM) Software	26.1
Desktop Video Conferencing	23.9
Management Information System (MIS)	17.9
Extranet	14.7

Top ten effective applications	Future (%)
Enterprise Resource Planning (ERP) Systems	13.6
Document Management	10.9

Table 5: Breu and Smith (cited in Bahra [26], p. 121)

Workflow management featured as number nine in the past. The future perspective indicates that workflow management will not even feature as one of the top-ten applications. This may be due to the fact that workflow management systems are too rigid and restrict free-flow knowledge sharing. The complexity and ambiguity of knowledge require rich technology applications "that are capable of supporting the management and sharing of complex content as it is incorporated in people's experiences, expertise and understanding of the business context" (Bahra [26], p. 121).

A comparative analysis on the role of technology for supporting knowledge exploitation was performed by Breu and Smith (cited in Bahra [26]). The study indicated that CRM (Customer Relationship Management) software and desktop video conferencing feature prominently in high-performance organisations, while e-mail plays an inferior role. Average-performing organisations, in contrast, rely primarily on e-mail, internet and intranet technologies.

Even though certain trends exist, selection of an optimal mix of technologies depends on various internal and external organisational variables. The success of utilising KM technology is also significantly influenced by various qualitative variables. These include:

- The extent to which current organisational mechanisms for finding, creating, packaging, applying and reusing knowledge are balanced with the constraints of the **current organisational culture** (Mack *et al* [9]).

- The **trust** that users may have **in the digital community**. Users will only contribute knowledge and insights via technology solutions when they value their digital community (Tiwana [28]).

- The level of management support. Tiwana [28] believes that KM initiatives will only gain management support for sustained funding if these initiatives build on **existing systems**. A KM system should not be implemented as a stand-alone system, but rather be integrated with the existing systems and architectures. Figure 10 illustrates how KM applications need to integrate with current system architectural components. The shaded blocks indicate components that may need adjustment to accommodate KM applications.

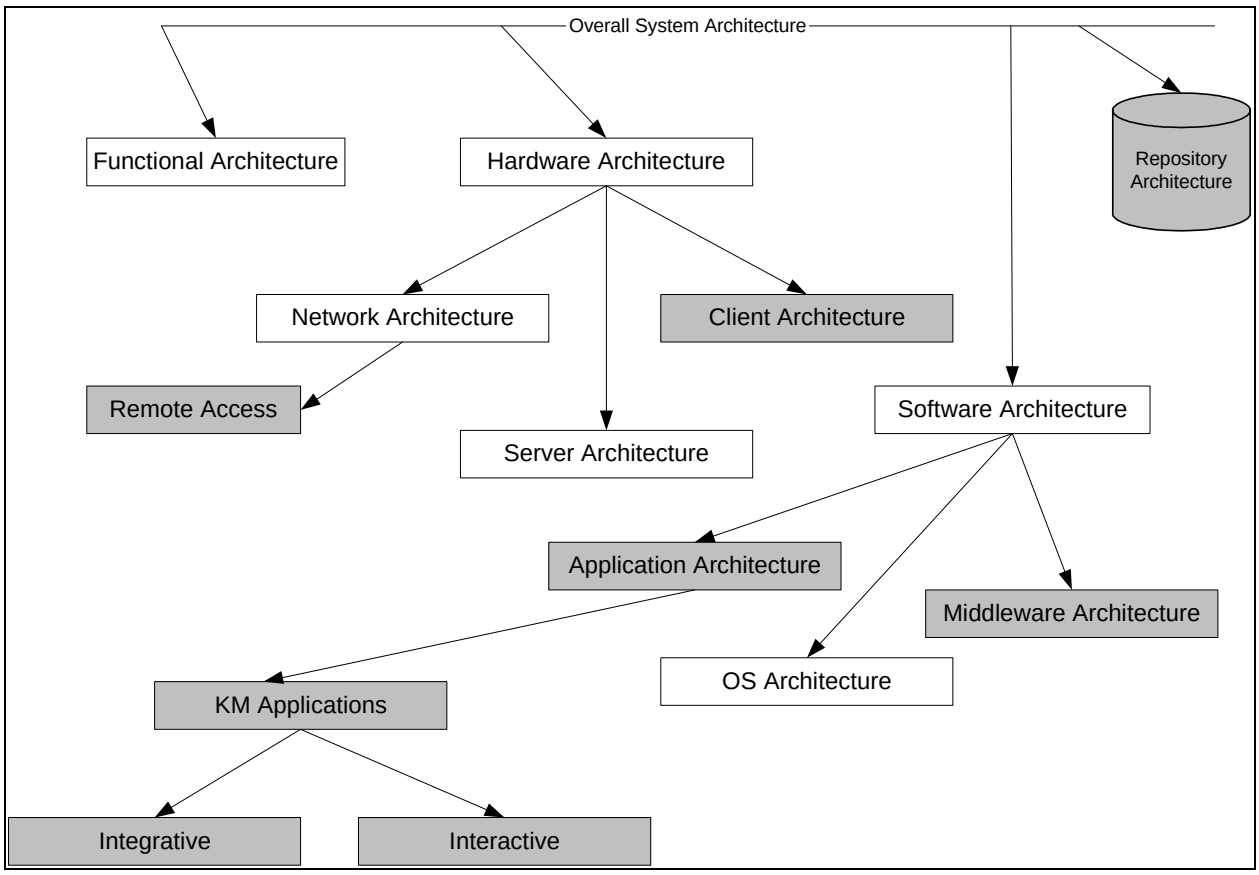


Figure 10: KM System integration with current systems and architectures (Tiwana [28], p. 235)

2.7.5 Summary

Section 2.7 quoted various literature in supporting the proposition that technology is only an enabler for managing processes and knowledge effectively. Relevant technologies that are enablers in process improvement management and KM were discussed subsequently, and the selection of an optimal technology mix was debated.

2.8 REQUIREMENT FOR A BLENDED MODEL

Ahmed *et al* [25] believe that effective KM systems can only be developed by following a holistic view. Success is derived from integrating various elements: e.g. employees, process systems, technology and leadership.

Rich and Duchessi [35] also believe that a systems perspective is required to address the predominant KM issues for organisations. These issues are:

(1) What is the **dynamic behaviour** of a specific organisation's knowledge?

(2) What **policies are required** to ensure positive growth or organisational knowledge, also ensuring financial success?

Rich and Duchessi [35] designed various cause-and-effect models to indicate the delicate relationships and interactions between various components,

such as staff, experience, workload and organisational knowledge. The following two scenarios are included as examples:

- An investment in KM increases the available knowledge in the organisation. The increase in knowledge increases productivity, which in turn increases revenue from KM efforts (Rich & Duchessi [35]).

- A consulting firm's policies, and the effect they have on individuals, determine the time allocations between KM activities and direct revenue-generating activities of the firm. A policy decision is required to redirect sources away from revenue-generating tasks to ensure attendance to KM activities. This change in policy could have the following cause-effect relationship: individuals are motivated to contribute to KM activities, which increases the amount of personal knowledge transferred to organisational knowledge or personal knowledge (networking with other individuals), which then increases personal knowledge (as other individuals assimilate the transferred knowledge), which again raises productivity (Rich & Duchessi [35]).

The cause-and-effect relationships and dynamic interactions between these various components establish the outcomes (positive or negative) of the KM system.

The author proposes that significant cause-and-effect relationships and close interaction exist between organisational process improvement management and KM. The following section highlights some of these interactions that were discovered in literature.

2.8.1 Process Improvement Management and Knowledge Management Interactions

Ahmed *et al* ([25], p. 23) define a collective objective for organisational learning and KM:

> "…to create a motivated and energised work environment that supports the continuous creation, collection, use and reuse of both personal and organisation knowledge in the pursuit of business success. Central to this equation are two fundamental assets: people (whose knowledge resides in skill, expertise, experience intuition, etc.) and organisations (whose knowledge is embedded within its culture, processes and systems)".

Dewey (cited in Ahmed *et al* ([25], p. 17) said:

> "All learning is a continuous process of discovering insights, inventing new possibilities for action, producing the actions and observing the consequences leading to insights".

These definitions indicate that individual learning and experience may be internalised and transferred as knowledge to other individuals, organisational processes or systems. The assimilated knowledge may then be applied to current processes for continuous process improvement or lead to new insights, inventions or possibilities. The never-ending learning process could be amplified throughout the organisation through KM, which facilitates rapid

organisational learning, process improvement and ultimately improved business performance.

Learning and knowledge (obtained during the execution or improvement of business processes) mutually reinforce each other – the act of learning provides knowledge and understanding, which eventually feed further learning (Ahmed *et al* ([25]). The learning process in turn facilitates process improvement.

The intertwined objectives found in process improvement management, and knowledge management also become apparent in Slocum, McGill and Lei's (cited in Ahmed *et al* ([25]) identified learning strategies, which are employed by leading companies. These strategies are:

- Developing a strategic **intent to learn**.
- Committing to continuous experimentation (practised during **process improvement** initiatives).
- **Learning from successes and failures** (following a problem-solving approach in analysing negative process measures).

2.8.2 Using Maturity Models for Domain Integration

The CMMI and P-CMM both address organisational factors, such as size, organisational culture, nature of workforce, the business environment and business objectives. These practices provide guidance regarding the developing of organisational processes without prescribing how these practices should be implemented. Organisations have freedom to specify suitable processes, while still abiding by the minimum set of CMM requirements (Curtis *et al* [16]).

Maturity models are also technology-independent – they do not enforce **specific** technologies or software solutions, but rather support the idea of pragmatism, starting with what you have and then incrementally improving it. These models could be applied as a benchmarking tool, comparing various similar organisations with each other. Maturity models could also be used as an assessment and performance management tool, measuring general performance levels of an organisation against its strategic objectives.

Furthermore, these models could be used to assess software systems in terms of KPA (Key Performance Area) Requirements of a **specific domain**. As an example, Türethen and Demirörs [24] assessed the Oracle HRMS (Human Resource Management System) functional reach against the P-CMM KPA Requirements. The assessment exercise revealed some gaps in the current Oracle Human Resource Management System regarding some of the required processes. These gaps could be filled by customising the current HRMS or via workarounds (Türethen & Demirörs [24]). The study performed by Türethen & Demirörs [24] highlights one of the problems experienced with IT Solutions – one IT solution will only partially address KPA practices.

Ahmed et al [25]) warn that quality management standards such as ISO 9000 can create a culture of 'conformance' where "changes to processes and new ideas are discouraged, and would be criticised by auditing procedures" (Ahmed et al [25], p. 89). The CMM Process models (as encapsulated in CMMI) contrary to ISO-models encourage **process improvement** and **innovation** rather than process stagnancy.

George Box (cited in CMU/SEI [38], p. 13) recognised the **major deficiency** in the first capability maturity model, designed for software projects: "…the CMM is not an exhaustive description of the software process. It is not comprehensive; it only touches on other, non-process factors, such as people and technology, that affect the success of software projects." Though CMU/SEI attempted to integrate various business process domains with an integrated capability maturity model (CMMI), this model is still restricted in terms of non-process factors.

The previous section emphasised the need to integrate process improvement management, and KM, due to the intricate relationships between these various domains. These interrelationships are also obvious in the domain-specific maturity models. As an example, Bohn's Stages of Knowledge Growth closely resemble that of the staged representation of the Integrated Capability Maturity Model. The objective is to progress a company from a state of art (depending on a few knowledgeable individuals and their tacit, subjective knowledge) to one of science (providing a repeatable methodology capable of handling variations) (Tiwana [28]).

The Siemens model (KMMM) also integrates KM activities with current business processes. Knowledge is used:

- as a process
- supporting a process
- influencing the sequence or selection of activities in a process
- influencing process improvement efforts and innovations (Ehms & Langen [18]).

According to Tiwana [28] KM systems should support collaboration, knowledge sharing, learning and continuous improvement. Conversely, continuous process improvement models (such as CMMI) require KM for successful implementation.

2.8.3 Using Maturity Models for Project Phase Integration

2.8.3.1 Capability Maturity Model Deficiencies

The author detected another deficiency in process capability maturity models. If these models are to be applied in management consultancy organisations, whose main activity is the management of projects, one needs to evaluate the extent to which these models address the various project management phases found in projects. P-CMM supports processes on an organisational level. CMMI strongly supports the project planning phase, and to a lesser extent the execution phase and closure phase. The project definition phase

and transitions between the project definition phase and other phases are also neglected.

Organisations need to transfer knowledge obtained and explicated during the project definition phase (usually explicated in a proposal and contract) to subsequent phases. Tasks and deliverables need to correlate with the initial commitments made in the project definition phase. Any anomalies may require proposal re-evaluation or contract extensions.

Another shortcoming has been identified: the lack of project execution or implementation processes. CMMI specifically addresses Software **Engineering**, Systems **Engineering**, Integrated Product and Process **Development** and Supplier Sourcing. Planning, engineering and development processes are emphasised rather than implementation processes.

2.8.3.2 Addressing Deficiencies

The author believes that current CMMI process areas may be applied to various project management phases, if they are interpreted correctly. The SEI team defined various informative components (e.g. notes, elaborations and discipline amplifications) to guide the appraiser in interpreting process areas, goals and practices. Likewise, one could use additional informative components to provide certain project management phase interpretations. Practices and sub-practices should also be added to ensure efficient phase transitions and phase synchronisation.

An additional process area category and process areas could be added to address the project execution phase. This process area category will be relevant to all CMMI disciplines (Software Engineering, Systems Engineering, Integrated Product and Process Development and Supplier Sourcing).

2.8.4 Requirement for a New Model

Maier and Remus [43] performed an empirical study to investigate the use of KM Systems in the 500 largest German companies and the top 50 banking and insurance companies. They found that process orientation was not focused in most of the KM activities in these organisations, despite the fact that most organisations had already implemented process management programmes in the past.

Ahmed [25] states that many companies fail to integrate the various types of processes, including operational, behavioural (communication and individual learning), and managerial processes. These companies usually focus their attention on individual operational processes, consequently delivering sub-optimal results.

It is proposed that various maturity models be synthesised into a single model to address the interrelationships and interactivity of closely-related domains (process improvement management, knowledge, and learning management) for management consultancy organisations. The aim is to

improve the effectiveness of the current stand-alone domain models by utilising their synergistic capabilities.

The new model needs to be defined in terms of the existing models, identifying possible overlaps and deficiencies, while applying the existing models to the project management context of management consultancy organisations. Figure 11 portrays a framework for analysis:

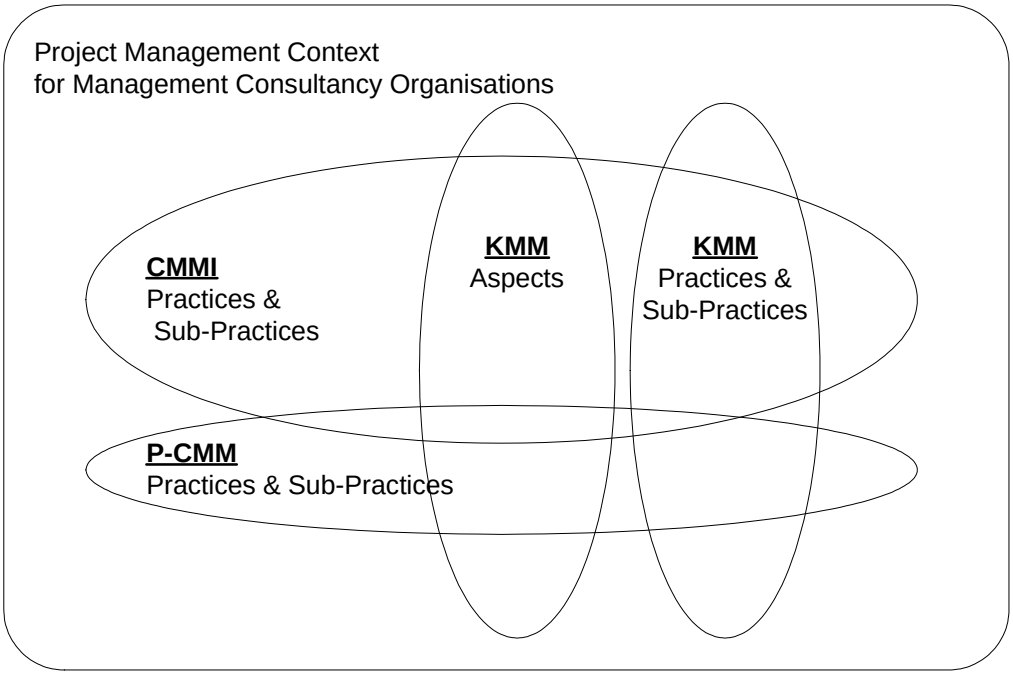


Figure 11: Context for Analysing Model Overlaps and Deficiencies

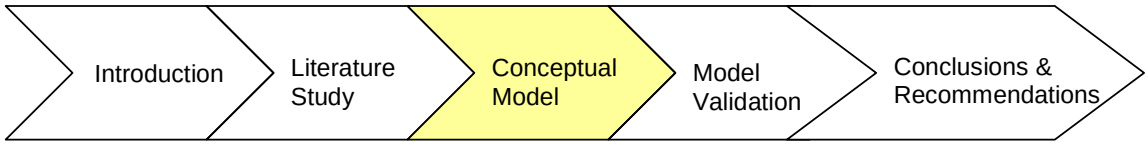
2.8.5 Summary

Section 2.8 motivated the requirement for an integrated model, based on the close interaction between process improvement management and KM. The advantages and disadvantages of using maturity models for domain integration (process improvement management and KM) and usefulness in terms of project management phase integration were also discussed.

2.9 CHAPTER SUMMARY

Chapter 2 addressed most of the research questions, including detailed analyses of various maturity models. The requirement for integrating process improvement management and knowledge management in an attempt to improve overall business performance of management consultancy organisations is motivated. Analyses of various maturity models posed the opportunity of using maturity models as a vehicle for integrating highly interactive domains. The design of such an integrated maturity model is discussed in the next chapter.

3. CONCEPTUAL MODEL



3.1 INTRODUCTION

The purpose of this chapter is to design an integrated process improvement management / KM maturity model for management consultancy organisations by integrating overlapping concepts and addressing deficiencies found in current models.

At the outset, a model building approach is defined by re-defining the maturity levels of a blended model and delineating the model construction process for designing detail elements of the blended model. The model construction process is then followed, which produces the main deliverable of this thesis: the blended model (see Figure 12).

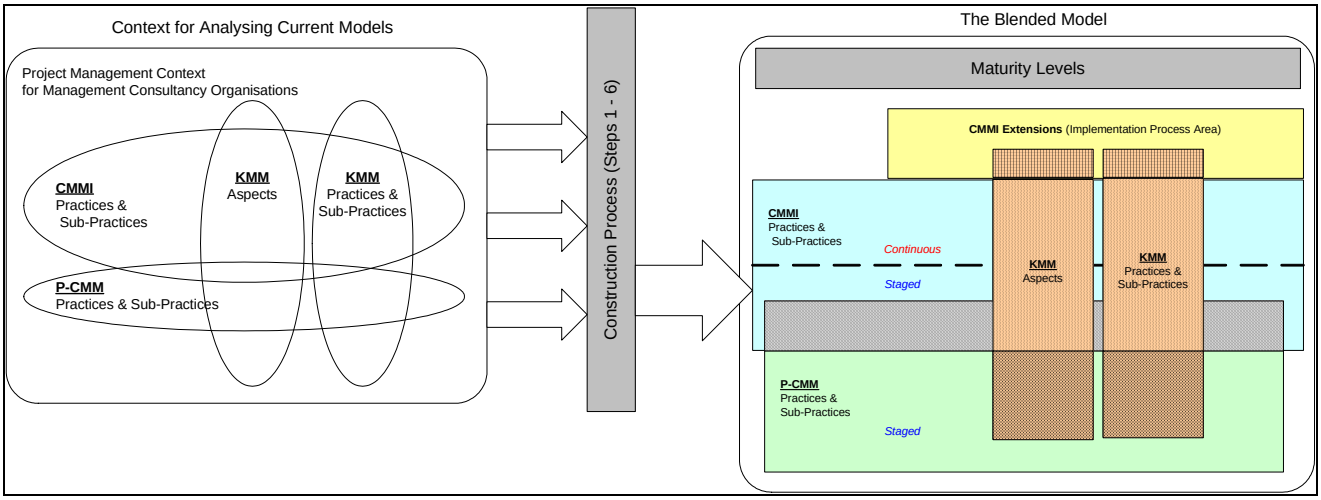


Figure 12: Constructing a Blended Model

The blended model is constructed by using model components of the following existing reconcilable models:

- CMMI: Capability Maturity Model Integration (CMMI Product Team [15]).
- P-CMM: People Capability Maturity Model (Curtis *et al* [16]).
- Knowledge Management Framework Assessment Model of KPMG (Parlby [47]).
- Siemens Knowledge Management Maturity Model (Weerdmeester *et al* [3]).
- KMM from Infosys Technologies (Kochikar [19]).

3.2 MODEL BUILDING APPROACH

As a starting point, the P-CMM mentions the integration possibilities with CMMI. Various P-CMM Process Areas support the main CMMI support process areas; consequently the CMMI has been used to construct the basic framework in terms of process areas.

3.2.1 Blended Model Maturity Levels

The CMMI Maturity Level descriptions will be used. The various levels will be reinterpreted in the context of the new, blended approach. Table 6 maps other maturity model descriptions according to the CMMI description in terms of their intent and maturity level objectives.

CMMI	P-CMM	KPMG Model	Siemens Model	Infosys Technologies Model
Initial	Initial	Knowledge Chaotic	Initial	Default
Managed	Managed	Knowledge Aware	Repeated	Reactive
Defined	Defined	Knowledge Focused	Defined	Aware
Quantitatively Managed	Predictable	Knowledge Managed	Managed	Convinced
Optimising	Optimising	Knowledge Centric	Optimising	Sharing

Table 6: Maturity Level Map

The following maturity level definitions will be used:

Initial: The organisation has no uniform way of performing work – processes are reinvented on each project. Managers struggle to estimate project progress, control costs, schedules (including task responsibilities) or product quality. No standardised processes or practices are followed and project members do not reuse or improve previous project experiences or artefacts. These projects could only be successful if exceptional individuals are on board. There is a strong dependence on individual skills, abilities and tacit knowledge, rather than sharing and building on previous organisational experience and knowledge.

Managed: The organisation creates an environment of repeatability – the ability to repeat tasks consistently. This environment is attained by establishing control over project commitments, baselines and workforce practices on a project and organisational unit level.

Defined: The organisation defines its best practices and integrates them into a common process. Best practices (also regarding KM) are documented, integrated into a standardised process, trained and implemented by the entire organisation. Workforce competencies (aggregated knowledge, skills and process abilities) are linked to the defined processes and knowledge

usage is evident in the standardised processes. Standardised processes and practices also encourage/reward knowledge working/sharing (e.g. adapting compensating systems, technical infrastructure, and appointment of knowledge officers). A participatory and knowledge-sharing culture is nurtured, enabling an organisation to gain maximum benefit from its workforce competencies and process implementation experiences. This level is characterised by the implementation of various KM techniques (e.g. communities of practice, knowledge maps and storytelling).

Quantitatively Managed: The current process performance, the capability for performing work and the actual creation, usage and sharing of internal and external knowledge sources are quantifiable. This quantification may be used to predict future performance, identify deviations from expected results and initiate corrective action. Established processes can now be trusted and may be preserved as organisational assets, which may be reused by others in the organisation. Management now starts to utilise the insightful process knowledge to direct its attention to strategic issues and improvement initiatives.

Optimising: The organisation uses its statistical process data (in combination with its strategic objectives) to identify processes that may benefit most from improvement actions. This may lead to linear, incremental process improvement initiatives as well as breakthrough, quantum improvement initiatives. The culture created on this level is one of continuous improvement, learning and performance excellence.

3.2.2 Blended Model Construction Process

The purpose is to demonstrate the close interaction and integration of managing process improvement and managing knowledge (embedded in competency-based processes) and measure their mutual maturity level. This is attained by identifying processes, goals and practices from various maturity models, analysing and extending these to a set of processes, goals and practices that would demonstrate and test the domain integration and mutual maturity level. The model should also address all project management phases that are present in management consultancy organisations.

The following model construction process was followed:

1. Identify and analyse all process area categories, process areas, goals and practices of various process / people / knowledge management maturity models.

2. Graphically demonstrate the interaction of CMMI and P-CMM process areas, overlapping processes as well as embedded KM practices.

3. Discuss the process areas, goals and practices and how they demonstrate KM practices for management consultation organisations.

4. Define process-overlaps between CMMI and P-CMM and KM models.

5. Demonstrate how CMMI process areas address various project management phases and define additional process areas, practices, and informative components to address current model deficiencies.

6. Construct a reduced model (the blended model) that will be validated in practice.

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Identify and analyse process area categories, process areas, goals and practices.	Demonstrate CMMI, P-CMM and KM interaction.	Discuss process areas, goals, practices of CMMI and P-CMM.	Define CMMI, P-CMM and KM overlaps.	Define additional informative components and process areas to address project management phase perspectives.	Define the Blended Model.

3.3 BLENDED MODEL CONSTRUCTION

This section provides details regarding the execution of the model construction steps.

3.3.1 Step 1: Identifying and Analysing Process Area Categories, Process Areas, Goals and Practices

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Identify and analyse process area categories, process areas, goals and practices.	Demonstrate CMMI, P-CMM and KM interaction.	Discuss process areas, goals, practices of CMMI and P-CMM.	Define CMMI, P-CMM and KM overlaps.	Define additional informative components and process areas to address project management phase perspectives.	Define the Blended Model.

A set of process area categories, process areas, goals and practices for capability levels 1 to 3 and maturity levels 1 to 5 from various models have been identified and included in a database (part of the Blended Model Appraisal Tool). Specific practices have also been further detailed to show sub-practices. Note that an additional process area category was added to the CMMI framework (called 'Workforce Management Process Areas'). This process area includes the P-CMM process areas. Refer to CMMI Product Team [6], CMMI Product Team [15] and Curtis *et al* [16] for a complete set of goals, practices, sub-practices and notes per process area.

3.3.2 Step 2: Demonstrating CMMI, P-CMM and Knowledge Management Interaction

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Identify and analyse process area categories, process areas, goals and practices.	Demonstrate CMMI, P-CMM and KM interaction.	Discuss process areas, goals, practices of CMMI and P-CMM.	Define CMMI, P-CMM and KM overlaps.	Define additional informative components and process areas to address project management phase perspectives.	Define the Blended Model.

The complete set of CMMI and P-CMM processes have been portrayed on a single diagram (Figure 13). Data flows and process interactions are also depicted according to models that have been constructed and documented by the CMMI Product Team [15] and Curtis *et al* [16].

The diagram also illustrates overlapping process areas that are discussed in the next step. Processes containing more than 2 KM sub-practices are marked with the symbol: 

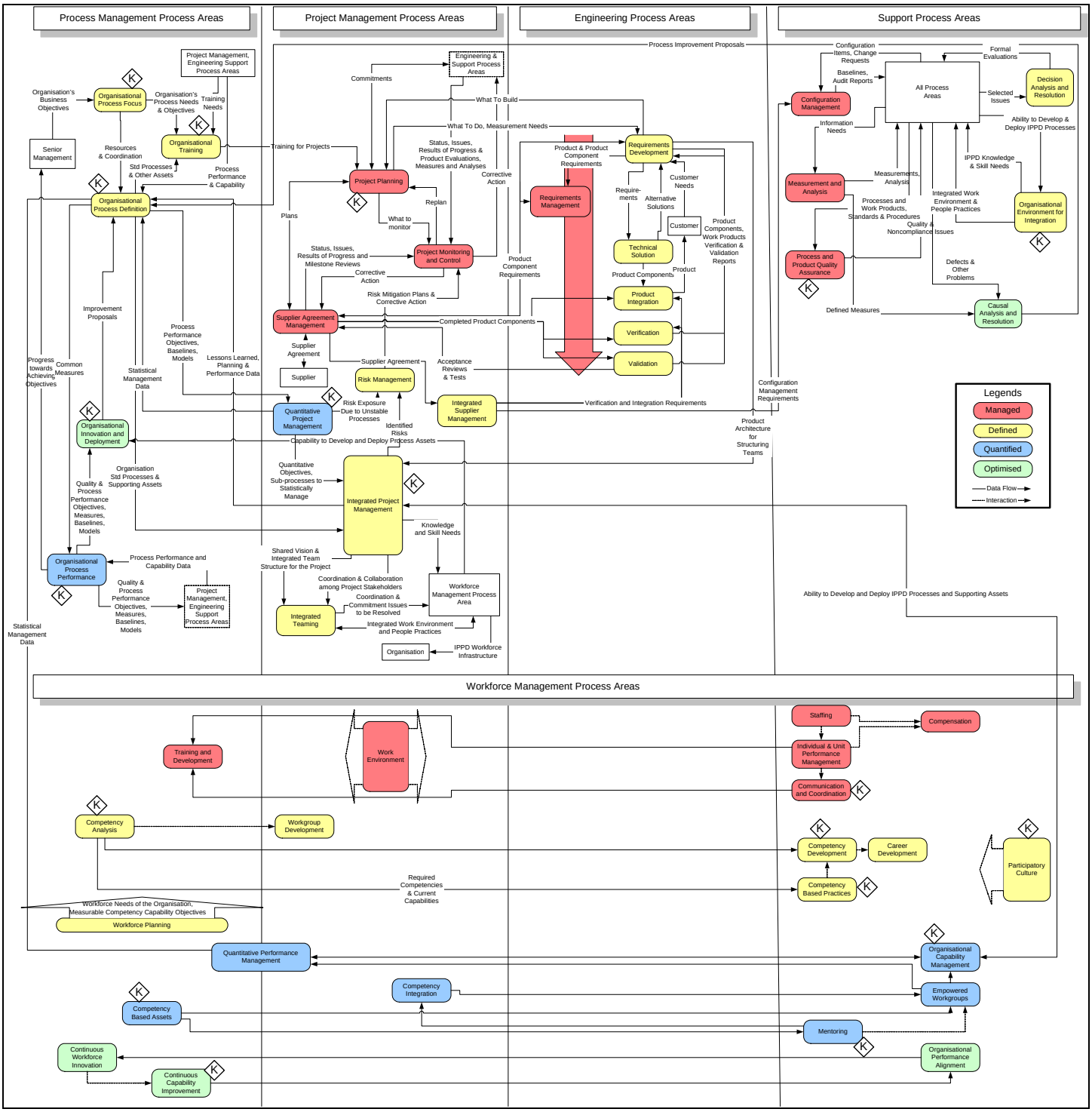


Figure 13: CMMI, P-CMM, and KM Interaction and Integration

3.3.3 Step 3: Discussing Process Areas, Goals and Practices of CMMI and P-CMM

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Identify and analyse process area categories, process areas, goals and practices.	Demonstrate CMMI, P-CMM and KM interaction.	Discuss process areas, goals, practices of CMMI and P-CMM.	Define CMMI, P-CMM and KM overlaps.	Define additional informative components and process areas to address project management phase perspectives.	Define the Blended Model.

The following section describes each CMMI and P-CMM process area (appearing on Figure 13) in short, highlighting specific KM aspects that are addressed and discussing process relevancy in terms of management consultancy organisations.

3.3.3.1 Process Management

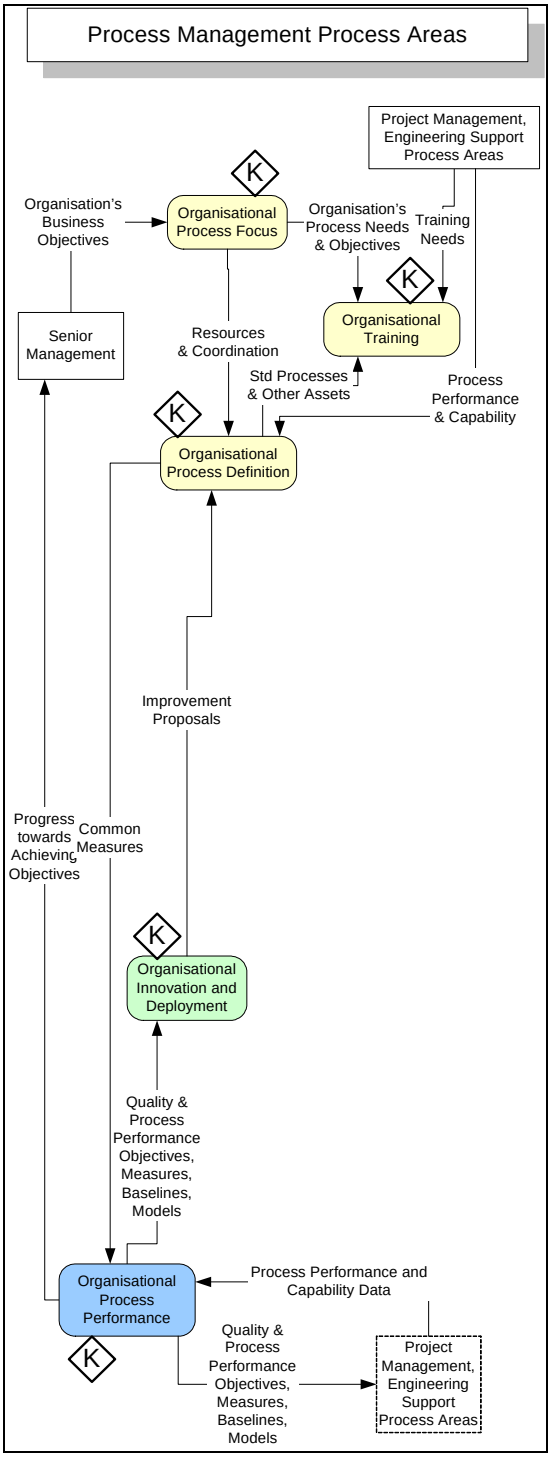


Figure 14: Process Management Process Areas

1. Organisational Process Focus: The purpose is to plan and implement organisational process improvement based on understanding the current strengths and weaknesses of the organisation's processes and process assets. Candidate improvements to organisational processes are initiated by various sources (e.g. measurement of processes, lessons learned, process appraisal results, benchmarking against other organisations, and knowledge shared on successful improvement initiatives in organisational units). Various sub-practices could be classified as typical KM practices (CMMI Product Team [15]).

2. Organisational Process Definition: The organisation's process asset library supports consistent process performance across the organisation as well as KM aspects such as organisational learning and process improvement by allowing the sharing of best practices and lessons learned across the organisation (CMMI Product Team [15]).

3. Organisational Training: The purpose of organisational training is to develop the skills and knowledge of people to ensure that they perform their roles efficiently and effectively. Skills and knowledge may be technical, organisational, or contextual. Technical skills pertain to the ability to use tools, equipment, materials, data, and processes that are required by a process or project. Organisational skills are related to behaviour within the employee's organisation structure, role and responsibilities, and general operating principles and methods. Contextual skills are the self-management, communication and interpersonal abilities required to perform in the organisational and social context of the project (CMMI Product Team [15]).

   This process focuses on maintaining and improving the knowledge capability (embedded in knowledge workers) of the organisation.

4. Organisational Process Performance: Process performance is a measure of the actual results achieved by following a process. Performance is measured according to the pre-defined process measures (e.g. effort, cycle time, and defect removal effectiveness) and product measures (e.g. reliability and defect density) (CMMI Product Team [15]).

   The pre-defined measures could also include KM measures (e.g. number of business problems solved due to knowledge sharing, and number of innovations in products, ideas and processes). The expected process performance can be used in establishing the project's quality and process-performance objectives, which may be used as a baseline for actual project performance measurements. Each quantitatively managed project also provides actual performance results, which become part of the baseline data for the organisational process assets.

5. Organisational Innovation and Deployment: The purpose of this process is to select and deploy incremental and innovative improvements (proven and unproven ideas) that visibly improve the organisation's processes and technologies. The improvements support the organisation's quality and process-performance objectives (e.g. improved product quality, increased productivity, greater customer satisfaction and shorter development or production time) as derived from the organisation's business objectives (CMMI Product Team [15]).

   This process requires various knowledge-inputs to analyse, evaluate, and select improvement and innovation proposals, deploying the selected proposals to improve overall organisational performance. Organisational learning takes place by updating organisational processes with accepted process improvements and applying / deploying the improved processes in future projects.

3.3.3.2 Project Management

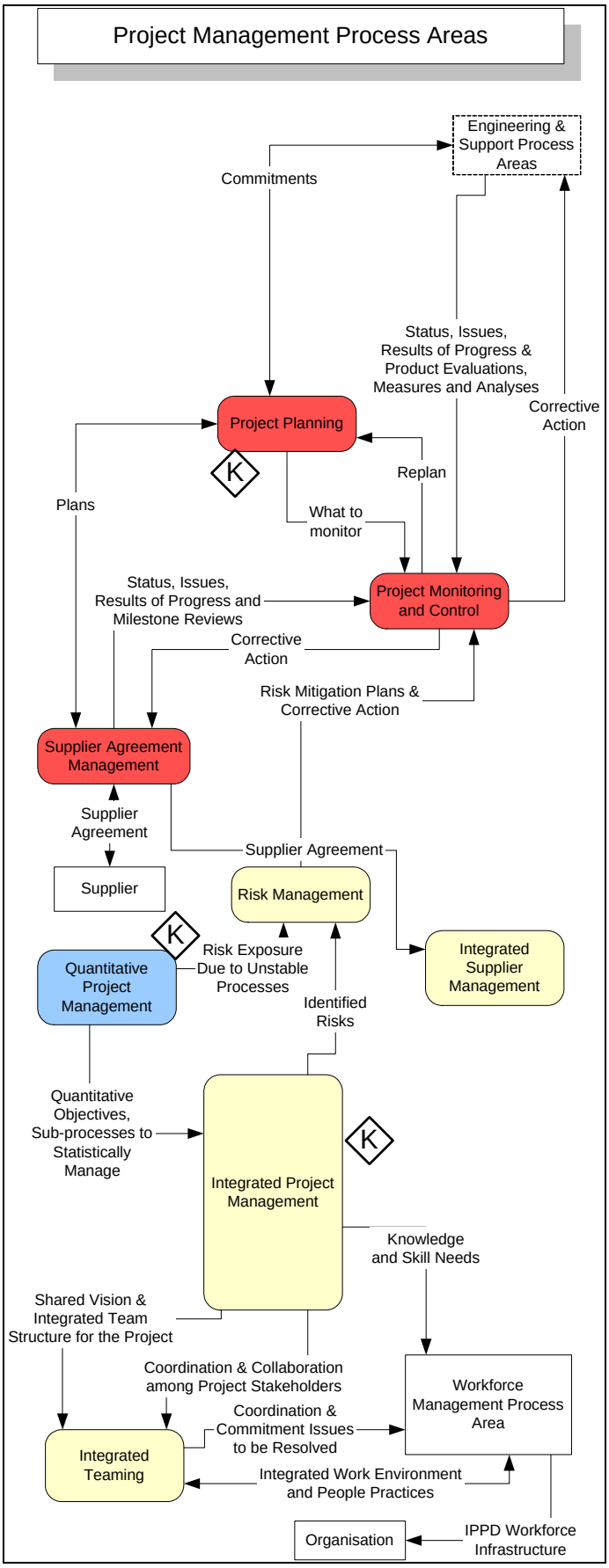


Figure 15: Project Management Process Areas

Though this process area category usually refers to the management of a funded project, a subset of the same practices may also be applied to project proposals. Project proposal activities should also be based on a set of standard processes that need to be measured and improved.

1. Project Planning: The purpose is to establish and maintain plans that define project activities, which are also the main operational activities of management consultancy organisations. Project planning includes estimating work tasks, determining required resources, negotiating commitments, producing a schedule, and identifying project risks. The project plan provides the basis for performing and controlling project activities that address the commitments to the project's customer (CMMI Product Team [15]).

   Project planning is a generic management consultancy process and provides a baseline for project organising / staffing / directing / co-ordinating / reporting / budgeting. This process could be used to demonstrate effective knowledge transfer and KM practices that should be embedded within a typical management consultancy process.

2. Project Monitoring and Control: The aim is to understand the project's progress and to initiate corrective actions if the project's performance deviates from the plan (CMMI Product Team [15]).

   Project monitoring and control require continuous feedback from various project tasks to ensure early detection of problems and efficient collaboration for resolving the identified problems.

3. Supplier Agreement Management: This process entails the management of product acquisitions from suppliers for which a formal agreement exists. The products acquired include those delivered to the project's customer as well as significant products (or components) delivered to the consultant (e.g. development tools and test environments) (CMMI Product Team [15]).

4. Integrated Project Management for IPPD: This process establishes and manages the project and involvement of relevant stakeholders according to an integrated and defined process, as well as the establishment of a shared vision for the project and in a team structure for integrated teams. Co-ordination and collaboration between various relevant stakeholders are ensured (CMMI Product Team [15]).

   This process incorporates tailoring of standard processes to reduce variability among projects and enable the sharing of process assets, best practices and lessons learned (gathered during the implementation of previous projects).

5. Risk Management: The aim is to identify potential problems before they occur and to plan risk-handling activities to mitigate any adverse impacts of these risks (CMMI Product Team [15]).

The process involves the collaboration and involvement of relevant stakeholders and requires strong leadership from all relevant stakeholders to create an environment conducive to sharing risks.

6. Integrated Teaming: The purpose is to form and sustain an integrated team for the development of work products. This process includes the provision of skills and expertise to accomplish team tasks, collaborating with other stakeholders and teams (internally and externally) to share knowledge, sharing a common understanding of the team's tasks and objectives and conducting these in accordance with established operating principles (CMMI Product Team [15]).

   This process is closely integrated with the process 'Integrated Project Management for IPPD' and incorporates many KM and people practices.

7. Integrated Supplier Management: The purpose is to proactively identify sources of products that may be used to satisfy the project's requirements and to actively manage suppliers while maintaining a co-operative project-supplier relationship. This process also includes the evaluation of various supplier products, monitoring supplier processes and revising supplier agreements. The process ties in with the practices identified in the process 'Supplier Agreement Management', but specifically emphasises a co-operative relationship with suppliers in cases where suppliers perform functions that are critical to the success of the project. Integrated supplier management is not required for projects using off-the-shelf items that are generally available and not modified for a specific project (CMMI Product Team [15]).

   This process is not necessarily a generic management consultancy process and need not always be included in a project.

8. Quantitative Project Management: The purpose is to quantitatively (statistically) manage the project's defined processes to achieve the project-specified quality and process-performance objectives. The defined processes are a set of sub-processes that are based on the organisation's set of standard processes (CMMI Product Team [15]).

   This process could also be extended to quantitatively manage the project's defined processes to achieve KM specific objectives that have been defined in the process area 'Organisational Process Performance'.

3.3.3.3 Engineering

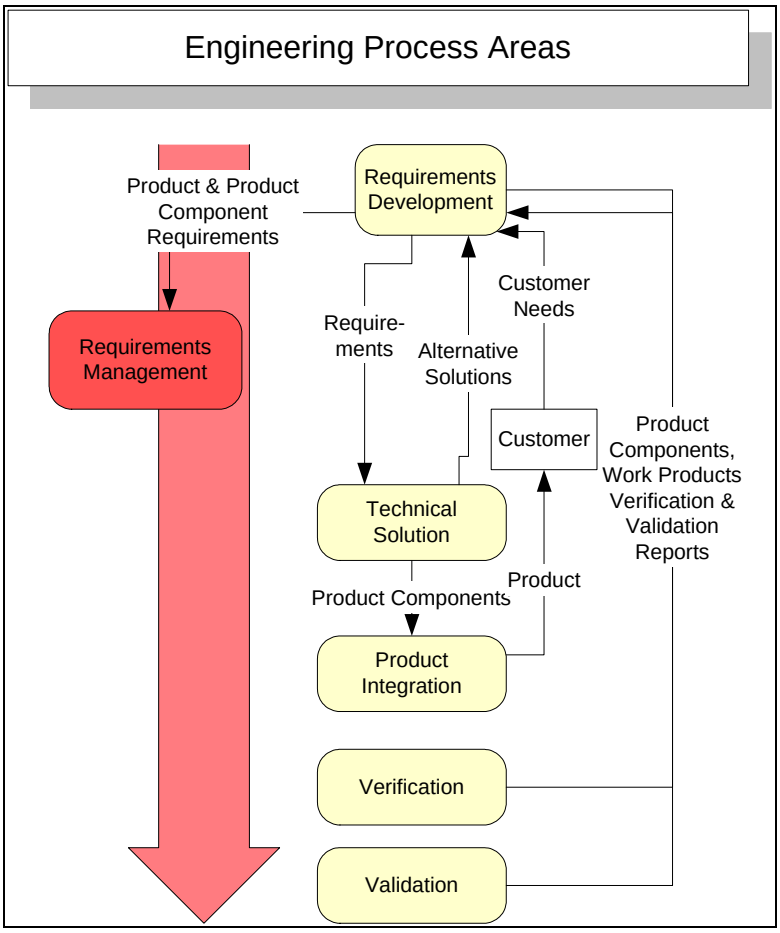


Figure 16: Engineering Process Areas

1. Requirements Development: The purpose is to produce and analyse customer, product, and product-component requirements (CMMI Product Team [15]).

   This process may be executed during the project proposal phase as well as the project execution phase. All management consultants need to address customer requirements. A high level of communication, collaboration, expertise and knowledge sharing is required in collecting requirements. These customer requirements may also include physical products and product-component requirements, but not necessarily.

2. Requirements Management: The purpose is to manage the requirements of the project's products and product components, and identify inconsistencies between the requirements and the actual project products. This process also includes the documentation of requirement changes and maintaining traceability between source requirements and product / product-component requirements (CMMI Product Team [15]).

   This process is a prerequisite for knowledge reuse. Requirements that are adequately managed and updated provide accessibility and traceability for reuse.

3. Technical Solution: This process entails the design, development and implementation of solutions according to requirements. The solutions, designs, and implementations include products, product components, and product-related life cycle processes or services that are appropriate (CMMI Product Team [15]).

   All management consultants need to present a solution to a customer problem (which could be in the form of a proposal or a physical product). A high level of communication, collaboration, expertise and knowledge sharing is required in designing the solution. Knowledge and code from previous projects should be reused to exploit previously-obtained knowledge assets.

4. Product Integration: This process entails the assembly of the product from product components, ensuring that the integrated product functions properly, and is delivered (CMMI Product Team [15]).

   This process is not necessarily a generic management consultancy process, as physical products or product components might not necessarily be part of the problem solution.

5. Verification: This process ensures that requirements for selected work products are met (CMMI Product Team [15]).

6. Validation: Validation is used to demonstrate that a product or product component fulfils its intended use when placed in its intended environment. Whereas verification ensures that "you built it right", validation ensures "you built the right thing" (CMMI Product Team [15]).

3.3.3.4 Support

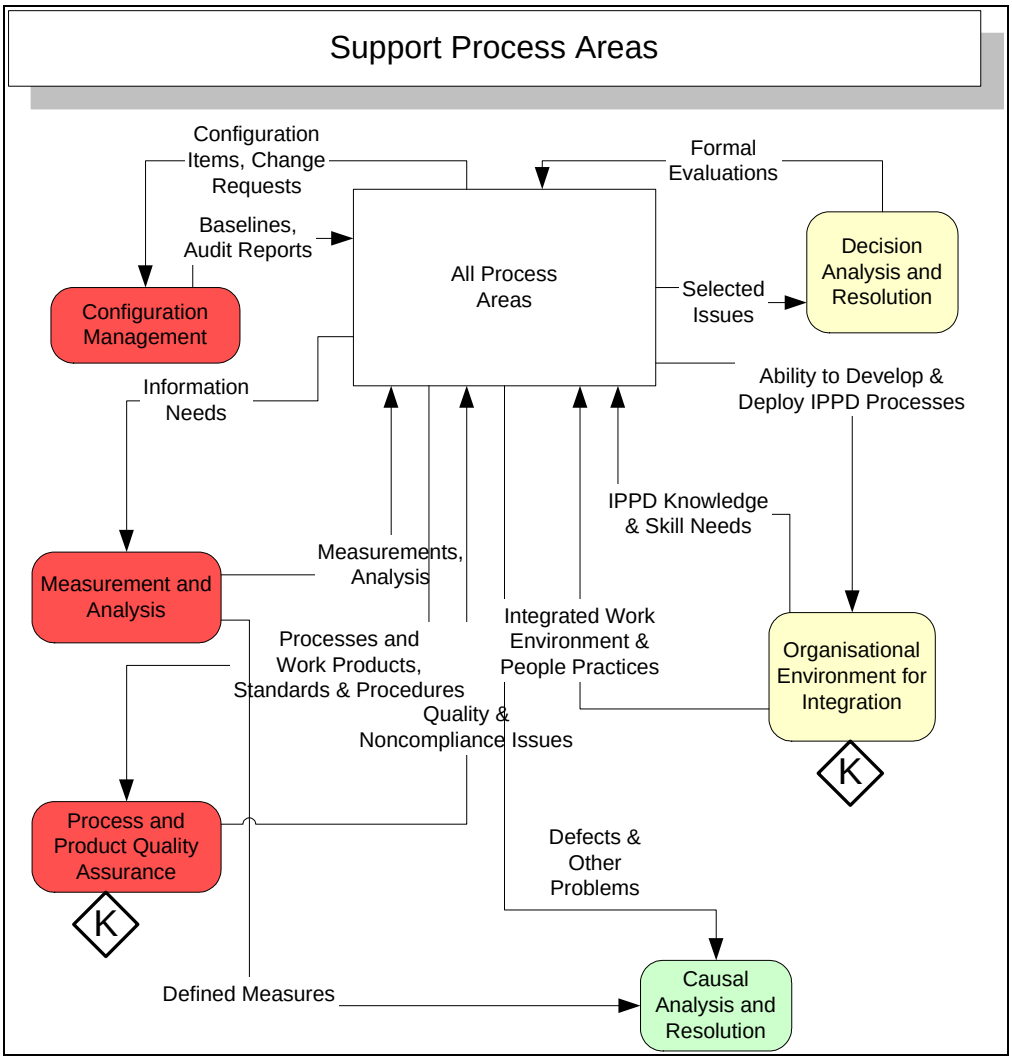


Figure 17: Support Process Areas

1. Configuration Management: This process is used to establish and maintain the integrity of work products using configuration identification (of selected work products that compose the baselines), configuration control, configuration status accounting (to developers, end users and customers) and configuration audits. Examples of work products that may be placed under configuration control include: plans, requirements, process descriptions, standards, reuse libraries, design data, code, compilers and product technical publications (CMMI Product Team [15]).

   This process enables many KM processes by ensuring accessibility to specific versions of organisation work products such as standards, procedures, and reuse libraries.

2. Process and Product Quality Assurance: This process provides staff and management with objective insight into processes and associated work products by evaluating performed processes, work products and services against the applicable process descriptions, standards and procedures. Non-compliance issues are also addressed. This process differs from the 'Verification' process area in that practices ensure that planned processes

are implemented, rather than ensuring that requirements are satisfied (CMMI Product Team [15]).

Due to the evaluative nature of this process, lessons could be learned from implemented projects and processes could be improved (for future use in products and services).

3. Measurement and Analysis: The purpose is to develop and sustain a measurement capability that is used to support management information needs. This process includes specifying the objectives of measurement and analysis that are aligned with identified information and knowledge needs. Measures, data collection and storage mechanisms, analysis techniques and reporting mechanisms are specified and implemented (CMMI Product Team [15]).

   This process facilitates the management of information and knowledge. It enables individuals to make informed decisions and take appropriate corrective action.

4. Decision Analysis and Resolution: The purpose is to analyse possible decisions using a formal evaluation process. The evaluation process requires knowledge and experience in selecting evaluation criteria / methods / alternative solutions, performing the evaluation, and selecting a recommended solution (CMMI Product Team [15]).

   The evaluation process is used extensively in management consulting organisations and in various project phases. The recommended alternative (accompanied by documentation of the criteria, methods, alternatives and recommended solution) may provide a valuable record and be useful to other similar projects or issues.

5. Causal Analysis and Resolution: The purpose is to identify causes of defects and other problems and take action to prevent their reccurrence. Causal analysis is primarily used to communicate lessons learned from projects. These activities may also provide a mechanism for evaluating the processes of projects at the local level and looking for improvements that can be implemented. Effective improvements may then be extended to the organisational level (CMMI Product Team [15]).

6. Organisational Environment for Integration: The purpose is to provide an IPPD (Integrated Product and Process Development) infrastructure and manage people for integration and performance (CMMI Product Team [15]).

   Many of the practices that are addressed in this process area are extended in the ‘Workforce Management Process Areas’, which originated from P-CMM.

3.3.3.5 Workforce Management

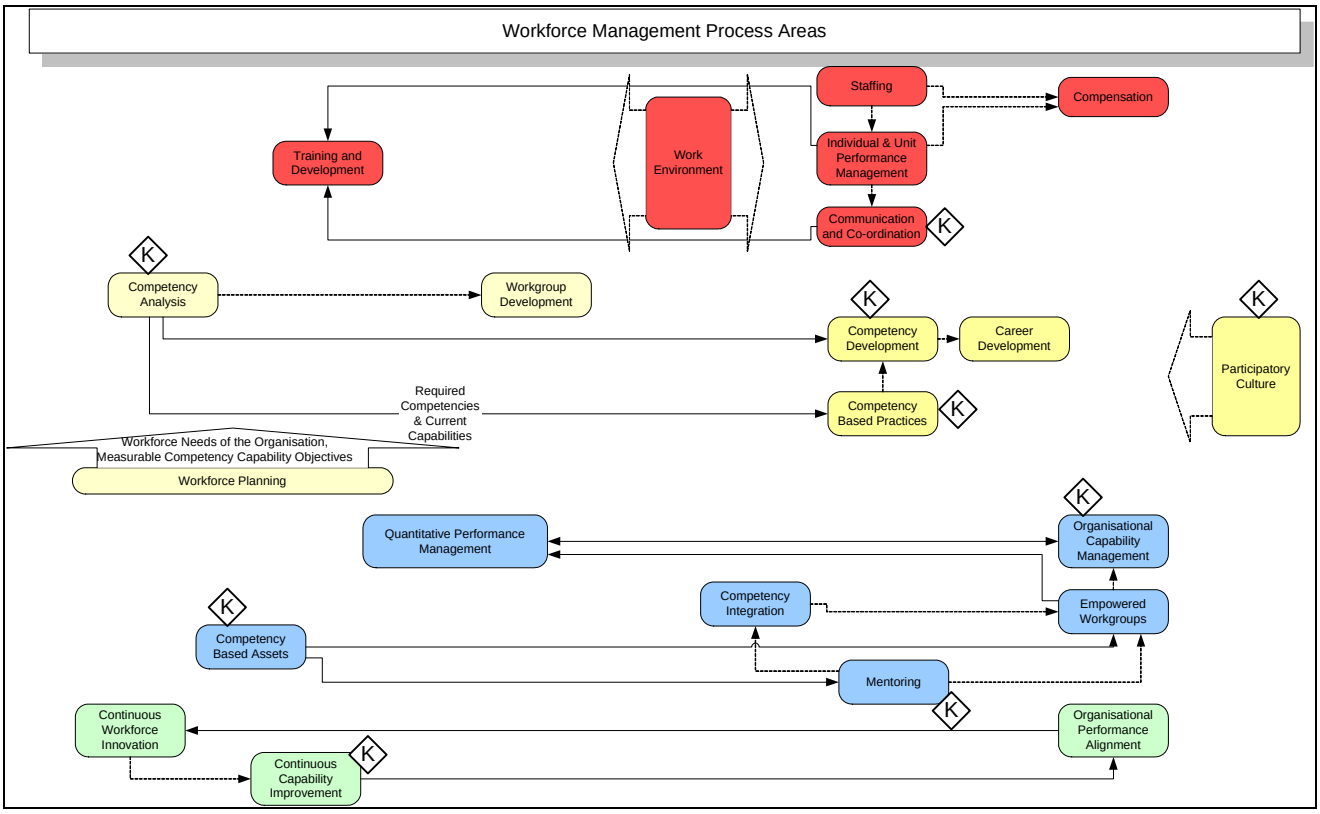


Figure 18: Workforce Management Process Areas

This process area category addresses the required environment and management of people to exploit the collaborative environment. The category also addresses suitable workplace resources to maximise the productivity of people and facilitate integrated teams, and organisational and standard processes which culturally enable a work environment that promotes and rewards teams as well as individual excellence (CMMI Product Team [15]).

1. Work Environment: The purpose of this process area is to focus on the resources provided for performing work, as well as the physical conditions under which the work is performed. Resources and environmental conditions affect the workforce's ability to perform work efficiently. An inefficient working environment impedes efficiency in knowledge-intense environments (Curtis et al, [16]).

2. Staffing: One of the primary sources of knowledge in an organisation is the employees. This process area involves processes related to recruiting, selecting among candidates for open positions, entering or leaving the organisation, transitioning into new positions and balancing the workload with available resources (Curtis *et al*, [16]).

   This process area enables the replenishment of knowledge assets and is a prerequisite for performing any advanced competency development and containment practices.

3. Individual and Unit Performance Management: The process of managing performance is initiated by defining measurable objectives for unit

performance, which forms a framework for defining individual performance objectives. These performance objectives should also include KM performance objectives (Curtis et al, [16]).

The recognition and reward strategy of the organisation should also reinforce those skills and behaviours (e.g. knowledge sharing behaviours) that the organisation values.

4. Communication and Co-ordination: This process establishes timely communication across the organisation, ensuring that the workforce has the skills to share information and co-ordinate its activities efficiently (Curtis *et al*, [16]).

   Increasing the flow of information provides a foundation for higher maturity level processes (e.g. establishing a knowledge-sharing and participatory culture, and creating empowered workgroups).

5. Compensation: A compensation system is required to motivate and reward skills and behaviours that the organisation considers to be vital to its success (Curtis *et al*, [16]).

   The organisation could also use the compensation system to reward knowledge development and containment behaviours. According to P-CMM, such compensation practices are only visible in higher maturity levels (see process areas 'Competency-Based Practices', 'Competency Integration', 'Empowered Workgroups', and 'Continuous Workforce Innovation').

6. Training and Development: The purpose of this process is to ensure that individuals are equipped with skills to perform their assignments and are provided with relevant development opportunities (Curtis *et al*, [16]).

   The acquired skills are in effect added to the organisation's knowledge and skill capability and ultimately the ability to perform. References to skilled individuals are also required to ensure effective reuse of current knowledge and skills and to enable the higher-level process area, namely 'Integrated Project Management'.

7. Participatory Culture: This process is required to create an environment that ensures the flow of information within the organisation, incorporating knowledge of individuals into decision-making processes and gaining their support for commitments. The process exploits the full capacity of the workforce to make informed decisions that affect the performance of business activities. Competency-based information, knowledge and experience are also captured and made available to other individuals or workgroups that require the information (Curtis *et al*, [16]).

   The participatory culture ties in with a knowledge-sharing culture, which is a prerequisite for effective KM in an organisation.

8. Workforce Planning: The purpose is to identify the current and future workforce competency needs, based on anticipated future developments in the business, its products, markets, technologies, services and

business processes. Action plans are compiled for developing those required competencies on a unit and organisational level. The competency development plans are also integrated into a strategic workforce plan that sets long-term objectives for workforce activities (Curtis *et al*, [16]).

This process requires information about the current competency capabilities (skills, knowledge and process abilities) in the organisation prior to the replenishment and development of new competencies. This information could be obtained during information audits, knowledge audits and a competency analysis (discussed next).

9. Competency Analysis: This process is used to identify the workforce competencies (knowledge, skills, and process abilities) required to perform the organisation's business activities and to develop and use these abilities as a standard set of workforce practices. Resource profiles are also compiled to indicate the organisation's level of capability in each of its workforce competencies (Curtis *et al*, [16]).

   Information audits and knowledge audits could be used as additional mechanisms for analysing workforce competencies and resource profiles.

10. Competency-Based Practices: The purpose of this process is to revisit workforce practices (on the 'managed level') to ensure that they are based on developing the competencies of the workforce. The organisation and its units, for instance, adjust their recruiting practices to satisfy the requirements for workforce competencies identified in the strategic workforce plan. Staffing decisions are now also based on the competency capabilities required in the new position and in possible future positions. Performance objectives now need to contribute to long-term development in workforce competencies and the compensation strategy and practices are structured to motivate development in the organisation's workforce competencies (Curtis *et al*, [16]).

    This process thus uses the information about the current knowledge, skills and process capabilities within the company and future or strategic competency requirements to adjust current workforce practices.

11. Competency Development: This process enhances the capability of the workforce to perform its assigned tasks and responsibilities. Development activities raise the level of knowledge, skill, and process ability in the organisation's current and anticipated workforce competencies. The organisation utilises the experience accumulated in its workforce to share workforce competency practices in competency communities (based on the concept of communities of practice) (Curtis *et al*, [16]).

    The sharing of best practices using communities of practices is a key KM practice.

12. Workgroup Development: This process is used to organise work, methods and procedures within a group of people that performs a set of highly interdependent tasks to achieve shared objectives (Curtis *et al*, [16]).

Some KM aspects are also addressed, such as capturing lessons learned about products, processes or workforce practices when disbanding a workgroup (usually during the finalisation of a project).

13. Career Development: The purpose of this process is to ensure that individuals are provided with opportunities to develop workforce competencies that enable them to achieve their career objectives. Graduated career opportunities (an arrangement of positions or work responsibilities that requires increasing levels of capability in certain workforce competencies) and promotion criteria are defined to encourage growth in the organisation's workforce competencies (Curtis *et al*, [16]).

    This process encourages individuals to pursue development of skills and knowledge that the organisation requires in the future.

14. Competency-Based Assets: This process is used to capture and distribute the knowledge, experience, and artefacts developed during the execution of competency-based processes for reuse by other members of the competency community and enhancing performance and capability. This process area includes many aspects of KM and learning organisations. The competency-based assets are also incorporated into competency development activities and mentoring programmes (Curtis *et al*, [16]).

15. Mentoring: This process is used to transfer the lessons of greater experience (knowledge transfer) in a workforce competency to other individuals and workgroups to improve their capability. Mentoring is also executed on the defined level of maturity but in an informal way, without defining the specific content that had to be transferred. At the quantitatively managed level, the mentors are guided by defined content of knowledge, skills, and process abilities that need to be transferred. Mentors thus make use of and deploy competency-based assets. The defined content ensures that guiding mentors achieve consistent competency development results with individuals or workgroups in an advanced form of competency development (Curtis *et al*, [16]).

16. Competency Integration: This process area aims at integrating various interdependent workforce competency-based processes into seamless, multidisciplinary processes. At the defined level of maturity, individuals use defined interfaces between their separate, competency-based processes to manage mutual dependencies. At the quantitatively managed level, the various competency-based processes are more closely integrated to provide for tightly interconnected interactions among different competency communities and aid in problem-solving regarding products, services and work dependencies. Current workforce practices and activities (e.g. staffing, performance management, compensation, and arranging the work environment) are also adapted to support multidisciplinary, integrated processes (Curtis *et al*, [16]). This process area improves the efficiency of knowledge transfer.

17. Empowered Workgroups: The purpose is to grant workgroups authority for determining how to conduct their business activities most effectively and holding members accountable as an empowered workgroup for achieving work results. Empowered workgroups also accept increasing

responsibility for performing some of the workforce practices such as recruiting, selection, performance management, reward, training, development, and compensation activities that are appropriate to the function and structure of the empowered workgroup (Curtis *et al*, [16]). This process area improves the efficiency of knowledge transfer.

18. Quantitative Performance Management: This process is used to define quantitative performance objectives for achieving organisational business objectives. Measurable performance objectives are also defined for those competency-based processes that most contribute to achieving the organisational objectives. These competency-based performance objectives are then used to quantitatively manage the competency-based processes during the execution of day-to-day activities (Curtis *et al*, [16]).

19. Organisational Capability Management: This process quantifies and manages the capability of the workforce by assessing the quantitative level of knowledge, skills and process abilities for critical workforce competencies in the organisation. The organisation also determines the quantitative impact that competency development and other workforce activities have on the capability of each of its workforce competencies. The capability of competency-based processes is established and workforce practices are continuously studied to determine their impact on the achievement of the organisation's performance objectives (Curtis *et al*, [16]).

    This process area thus establishes the required level of knowledge (embedded in competency-based processes) and uses the actual measured levels to suggest changes in workforce practices to improve overall organisational performance (Curtis *et al*, [16]).

20. Continuous Workforce Innovation: This process involves the identification, evaluation and implementation of improved or innovative workforce practices and technologies. These could, for instance, include new recruiting and selection techniques, creative compensation schemes, new methods for developing knowledge and skills, alternative career choices, and new ways of organising the workforce. A procedure is also developed for proposing improvements to workforce activities. Innovations are tested and deployed across the organisation, evaluated quantitatively and communicated to the workforce (Curtis et al, [16]).

21. Continuous Capability Improvement: The organisation establishes a framework for continuously improving personal work processes and workgroup operating processes. Recommendations from improvements in personal work processes and workgroup operating processes are also reviewed within competency communities to determine if they should be incorporated into current competency-based processes. The organisation also adapts its workforce practices to support continual improvement (Curtis *et al*, [16]).

    This process demonstrates the use of competency communities (similar to communities of practice) for suggesting improvements in personal work processes and workgroup operating processes.

22. Organisational Performance Alignment: The aim of this process is to align performance results across individuals, workgroups and units with organisational performance and business objectives. Practices in the process convey a picture of performance within the organisation and how the integration of various business activities is affected by workforce practices and activities. This allows management to use workforce practices and activities strategically to achieve organisational business objectives (Curtis et al, [16]).

3.3.4 Step 4: Defining CMMI, P-CMM and Knowledge Management Overlaps

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Identify and analyse process area categories, process areas, goals and practices.	Demonstrate CMMI, P-CMM and KM interaction.	Discuss process areas, goals, practices of CMMI and P-CMM.	Define CMMI, P-CMM and KM overlaps.	Define additional informative components and process areas to address project management phase perspectives.	Define the Blended Model.

3.3.4.1 Knowledge Management Overlaps with CMMI and P-CMM

During the analysis it was discovered that KM practices and sub-practices are already included in the set of CMMI and P-CMM practices and sub-practices. The blended model should indicate those practices and sub-practices that may also be classified as KM practices and sub-practices (see attached CD: \Reports\KM Sub-Practices – a report from BMAT displaying all KM practices that are embedded in the CMMI and P-CMM).

The current CMMI and P-CMM models do not address the execution of primary KM processes (e.g. finding knowledge, creating new knowledge, packaging or assembling knowledge, applying or using existing knowledge, and reusing or leveraging knowledge previously obtained). Each CMMI and P-CMM practice needs to be evaluated in terms of the effectiveness of the primary KM processes that are used in executing a certain practice. The blended model will require a **KM Aspect** element, which will allow an appraiser to evaluate each CMMI and P-CMM practice and sub-practice in terms of the effectiveness of their applied KM processes.

3.3.4.2 CMMI and P-CMM Process Overlaps

During an analysis of the original process areas, goals and practices, it was found that many practices in the workforce management process area category are also found in the process management process area category and project management process area category. The workforce management process area (stemming from P-CMM) usually addresses only the improvement and management of workforce practices, which is a sub-set of the total set of organisational practices. CMMI, in contrast, tends to focus on operational practices. Table 1 is used to discuss the overlapping practices briefly.

CMMI Process Area	P-CMM Process Area	Overlap
Process Management		
Organisational Process Definition (Defined Level)	Competency Analysis (Defined Level)	CMMI: Establishing an organisational process asset library (including the support environment / criteria for including and referencing items), the process tailoring criteria and a measurement repository. P-CMM: The workforce competencies required to perform the organisation's business activities are identified. The knowledge, skills, and process abilities are identified for performing the various workforce competencies. The workforce processes used within each workforce competency are established and maintained according to a documented procedure. The defined workforce competencies could be seen as prerequisites for performing the organisation's business processes and should be part of the process asset library.
	Competency-Based Assets (Quantitatively Managed Level)	P-CMM: Practices define the methods and mechanisms for capturing and distributing knowledge and experience obtained during the execution of competency-based processes. CMMI refers to an asset library used as a mechanism. P-CMM, though, emphasises competency communities as knowledge-distributing mechanism.
Organisational Training (Defined Level)	Training and development (Managed Level)	CMMI: Practices focus on maintaining and improving the knowledge capability of the organisation by establishing the strategic training requirements and tactical plan, providing the necessary training, updating training records and assessing the effectiveness of the training. The required roles and skills required for performing the organisation's standard processes are assessed. P-CMM: Practices ensure that individuals receive timely training to perform their assignments according to the unit's training plan. Note that the practices do not cover the strategic training requirements as in CMMI.
	Competency Analysis (Defined Level)	P-CMM: Practices identify the workforce competencies that are required to perform the organisation's business activities (which include the organisation's standard processes addressed in CMMI).
	Workforce Planning (Defined Level)	P-CMM: Practices identify the current and future (strategic) competency needs, which are used to compile strategic workforce plans. This is similar to the assessment of strategic training requirements in CMMI.

CMMI Process Area	P-CMM Process Area	Overlap
Organisational Process Performance (Quantitatively Managed Level)	Quantitative Performance Management (Quantitatively Managed Level) Organisational Capability Management (Quantitatively Managed Level)	CMMI: Performance measures, baselines and models are established. P-CMM: Measurable performance and baselines are identified for competency-based processes that most contribute to accomplishing business activities and objectives. The performance baselines are thus only a sub-set of those defined in CMMI. P-CMM: Progress in developing the capability of critical workforce competencies is managed quantitatively. The organisation also develops quantitative models of capability in its critical workforce competencies for use in workforce planning and management.
Organisational Innovation and Deployment (Optimised Level)	Continuous Workforce Innovation (Optimised Level) Continuous Capability Improvement (Optimised Level)	CMMI: Incremental and innovative improvements are selected and deployed for improving the organisational processes and technologies. P-CMM: The organisation establishes and maintains mechanisms for supporting continuous improvement of its workforce practices and technologies. Innovative workforce practices and technologies are also identified, evaluated and deployed. These innovations are a sub-set (covering only workforce practices innovations) of the total set of organisational process innovations (in CMMI). P-CMM: The organisation establishes a framework for continuously improving personal work processes and workgroup operating processes. Opportunities for improving the capability and performance of competency-based processes are evaluated and selected, and improvement recommendations are implemented. The organisation also adapts its workforce practices to support continual improvement.
Project Management		
Integrated Project Management for IPPD (Defined Level)	Workgroup Development (Defined Level)	CMMI: Practices include the establishment of a project's defined process that is built on standard processes, the co-ordination of stakeholders, managing task and stakeholder dependencies and the organisation of integrated teams. P-CMM: Similar practices are evident. Workgroups are established to optimise performance of interdependent work, standard processes are tailored, mechanisms are created for collaboration and communication and certain workforce practices (e.g. staffing and performance management) are adapted for efficient workgroup performance.

CMMI Process Area	P-CMM Process Area	Overlap
	Competency Integration (Quantitatively Managed Level)	P-CMM: The practices aim at integrating various independent workforce competency-based processes into multidisciplinary processes (such as integrated project management processes).
Integrated Teaming (Defined Level)	Workgroup Development (Defined Level)	CMMI: Practices include the establishment of team composition, identification of required knowledge and skills, and governing the team operation (in terms of a team charter, team roles and responsibilities, operating procedures, and establishing interfaces between teams). P-CMM: Similar practices are evident. Practices include the establishment of team composition and allocating work to these teams, identification of procedures that should be used, team roles that need to be performed, skills that are required to function as a workgroup and interfaces that are required to co-ordinate work activities.
Quantitative Project Management (Quantitatively Managed Level)	Quantitative Performance Management (Quantitatively Managed Level)	CMMI: The practices aim at managing the project's defined processes to achieve project-specified quality and process-performance objectives that are based on the organisation's objectives for quality- and process performance. P-CMM: The practices are based on performance objectives that are defined for those competency-based processes that contribute most to achieving organisational business performance objectives. The focus is thus different than the CMMI-focus (which is more project-based). In CMMI, however, the project-specific performance objectives are also derived from the organisational business performance objectives. The various project-specific, quality / process performance objectives, and competency-based process performance objectives thus need to be based on the same organisational business performance objectives.
Support		
Organisational Environment for Integration (Defined Level)		CMMI: Practices include the provision of an integrated IPPD infrastructure in terms of a shared vision, integrated work environment (tools and resources) and the identification of IPPD skill requirements. Leadership mechanisms are also created, as well as mechanisms to balance team and home organisation responsibilities. P-CMM: Practices include the identification of

CMMI Process Area	P-CMM Process Area	Overlap
	Work Environment (Managed Level) Competency Analysis (Defined Level)	physical resource requirements. Note that the practices only address one element within the CMMI process area. P-CMM: Practices include the identification of workforce competencies (skills, knowledge and process abilities) to perform the organisation's business activities. Many of the other Workforce Management Process Area practices also aid in creating a competency capability for an integrated organisational environment.

Table 7: Process Overlaps between CMMI and P-CMM

3.3.5 Step 5: Defining Additional Informative Components and Process Areas to Address Project Management Phase Perspectives

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Identify and analyse process area categories, process areas, goals and practices.	Demonstrate CMMI, P-CMM and KM interaction.	Discuss process areas, goals, practices of CMMI and P-CMM.	Define CMMI, P-CMM and KM overlaps.	Define additional informative components and process areas to address project management phase perspectives.	Define the Blended Model.

In consultancy organisations, the tasks that are performed in the first two phases (see Figure 1) differ from one project to the next. Consultants develop and compile proposals based on specific tender requirements, which include tasks from both the definition and planning phases. Practices that are incorporated into various process areas could thus be implemented either during the definition or planning phases. One should, though, ensure that the commitments generated from the definition phase are synchronised with commitments made during the planning phase and executed in subsequent phases.

The specific and generic goals and practices, that have been defined for CMMI process areas, are performed during different project management phases. Table 8 demonstrates the primary focus of the specific and generic practices and required extensions for synchronising the different project management phases. Additional process areas (and their specific and generic goals and practices) are also required to address project management phase deficiencies. Note that workforce management process areas (originating from P-CMM) have not been included, as these process areas do not focus on a specific project management phase, but rather address organisational-level practices.

Various identifiers have been used to categorise the type of extension that is required.


Extending the 'Project Planning' process area.


Defining content of added process areas.


Extending generic practices.

Process Area	Project Management Phase			
	Definition	**Planning**	**Manage Execution**	**Closing Down**
SPECIFIC PRACTICES PER PROCESS AREA				
Process Management Process Areas				
Organisational Process Focus	CMMI: Organisational Level			
Organisational Process Definition	CMMI: Organisational Level			
Organisational Training	CMMI: Organisational Level			
Organisational Process Performance	CMMI: Organisational Level			
Organisational Innovation and Deployment	CMMI: Organisational Level			
Project Management Process Areas				
Project Planning	CMMI, Extended	CMMI		
Project Monitoring and Control			CMMI	
Supplier Agreement Management			CMMI	
Integrated Project Management for IPPD			CMMI	
Risk Management			CMMI	
Integrated Teaming			CMMI	
Integrated Supplier Management			CMMI	
Quantitative Project Management			CMMI	
Engineering Process Areas				
Requirements Development			CMMI	
Requirements Management			CMMI	
Technical Solution			CMMI	
Product Integration			CMMI	
Verification			CMMI	
Validation			CMMI	

Process Area	Project Management Phase			
	Definition	**Planning**	**Manage Execution**	**Closing Down**
Implementation Process Areas				
Process and Product Transition			Added	
Process and Product Training			Added	
Post-Implementation Support			Added	
Support Process Areas				
Configuration Management	CMMI			
Process and Product Quality Assurance	CMMI			
Measurement and Analysis			CMMI	
Decision Analysis and Resolution			CMMI	
Causal Analysis and Resolution			CMMI	
Organisational Environment for Integration		CMMI		
GENERIC PRACTICES for the Generic Goal INSTITUTIONALISE A MANAGED PROCESS (relevant to every Process Area)				
GP 2.1 Establish an Organisational Policy	CMMI: Organisational Level			
GP 2.2 Plan the Process	Extended	CMMI		
GP 2.3 Provide Resources			CMMI, Extended	
GP 2.4 Assign Responsibility	Extended	CMMI		
GP 2.5 Train People	CMMI: Organisational Level			
GP 2.6 Manage Configurations	CMMI: Organisational Level			
GP 2.7 Identify and Involve Relevant Stakeholders	Extended	CMMI	CMMI	
GP 2.8 Monitor and Control the Process			CMMI, Extended	
GP 2.9 Objectively Evaluate Adherence			CMMI, Extended	
GP 2.10 Review Status			CMMI	

Process Area	Project Management Phase			
	Definition	Planning	Manage Execution	Closing Down
with Higher Level Management				
GP 3.1 Establish a Defined Process	Extended	CMMI		
GP 3.2 Collect Improvement Information				CMMI
GP 4.1 Establish Quantitative Objectives for the Process	Extended	CMMI		
GP 4.2 Stabilise Sub-process Performance			CMMI	
GP 5.1 Ensure Continuous Process Improvement	CMMI: Organisational Level			
GP 5.2 Correct Root Causes of Problems	CMMI: Organisational Level			

Table 8: Additions Required regarding Current Maturity Models

The required extensions and additions will now be discussed.

3.3.5.1 Extending the Project Planning Process Area

This process currently focuses on the establishment and maintenance of a project plan that should control the execution of the project. The process area is also applicable to the definition phase of the project.

Informative components have been added to the relevant headings to apply this process area to both the definition phase and planning phase (discussed in the following paragraph). Additional practices and sub-practices have also been added to ensure synchronisation of commitments between the definition and planning phases. These additions have been added to the Blended Model Assessment Tool (BMAT).

Introductory Notes

Added Note: The term “project plan” should be interpreted as the client-approved project plan, which could be delivered as part of a project proposal during the project definition phase or presented to the client during the project planning phase.

Added Note: Project planning collectively refers to those activities that are performed during the project definition phase (compiling a proposal) and the project planning phase (performing detailed planning).

SP 1.3 Define Project Life Cycle

Added Note: The project life cycle could be defined in the project definition phase or the project planning phase.

3.3.5.2 Defining the Content of the Implementation Process Areas

An additional category ('Implementation' process areas) has been added to the model. The content of the 'Implementation' process areas is defined according to the template designed by the SEI team. Practices were defined in accordance with the Custom Development Methodology (Oracle, [56]) and personal experience. Details are available on the attached CD (\Reports\Implementation PA).

3.3.5.3 Extending Generic Practices

Certain generic practices should be interpreted in the context of both the project definition phase and project planning phases. The following additional informative components highlight this perspective.

GP 2.2 Plan the Process

Added Note: The plan for performing the specific process area may be documented during the project definition phase (as part of the project proposal) and/or documented during the project planning phase. Ensure that planned commitments between the project definition phase and project planning phase are synchronised.

GP 2.3 Provide Resources

Added Note: Resources should be provided in accordance with commitments made in the project definition phase and project planning phase.

GP 2.4 Assign Responsibility

Added Note: Responsibility and authority for performing the specific process area could be assigned during either or both the project definition phase (as stipulated in the project proposal) and the project planning phase. Changes to resources (committed in the project proposal) should be negotiated with the client.

GP 2.7 Identify and Involve Relevant Stakeholders

Added Note: The relevant stakeholders could be identified in either or both the project definition phase and the project planning phase. During the execution phase, identified stakeholders should be involved according to the contracted plan.

GP 2.8 Monitor and Control the Process

Added Note: The process area should be monitored against the initial planning of the process area. The initial planning of the process area could be defined during either or both the project definition phase (documented in the project proposal) and the project planning phase. Corrective action should be taken if deviations are detected.

GP 2.9 Objectively Evaluate Adherence

Added Note: The specific process area should be objectively evaluated against its process description, standards, and procedures as defined during either or both the project definition phase (documented in the project proposal) and the project planning phase. Non-compliances should be addressed.

GP 3.1 Establish a Defined Process

Added Note: The description of the process that is tailored from the organisation's set of standard processes could be defined in either or both the project definition phase (documented in the project proposal) and the project planning phase. The contractor may be forced to use a set of processes according to a client-preferred methodology.

GP 4.1 Establish Quantitative Objectives for the Process

Added Note: Quantitative objectives could be established during either or both the project definition phase (documented in the project proposal) and the project planning phase.

3.3.6 Step 6: Defining the Blended Model

Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Identify and analyse process area categories, process areas, goals and practices.	Demonstrate CMMI, P-CMM and KM interaction.	Discuss process areas, goals, practices of CMMI and P-CMM.	Define CMMI, P-CMM and KM overlaps.	Define additional informative components and process areas to address project management phase perspectives.	Define the Blended Model.

The blended model is a process improvement model that:

- Reuses existing maturity models of various integrated domains (process improvement, knowledge management and people management).
- Defines overlaps between the existing models.
- Defines CMMI extensions that need to address all project management phases and their interactions.

Figure 19 portrays the conceptual blended model.

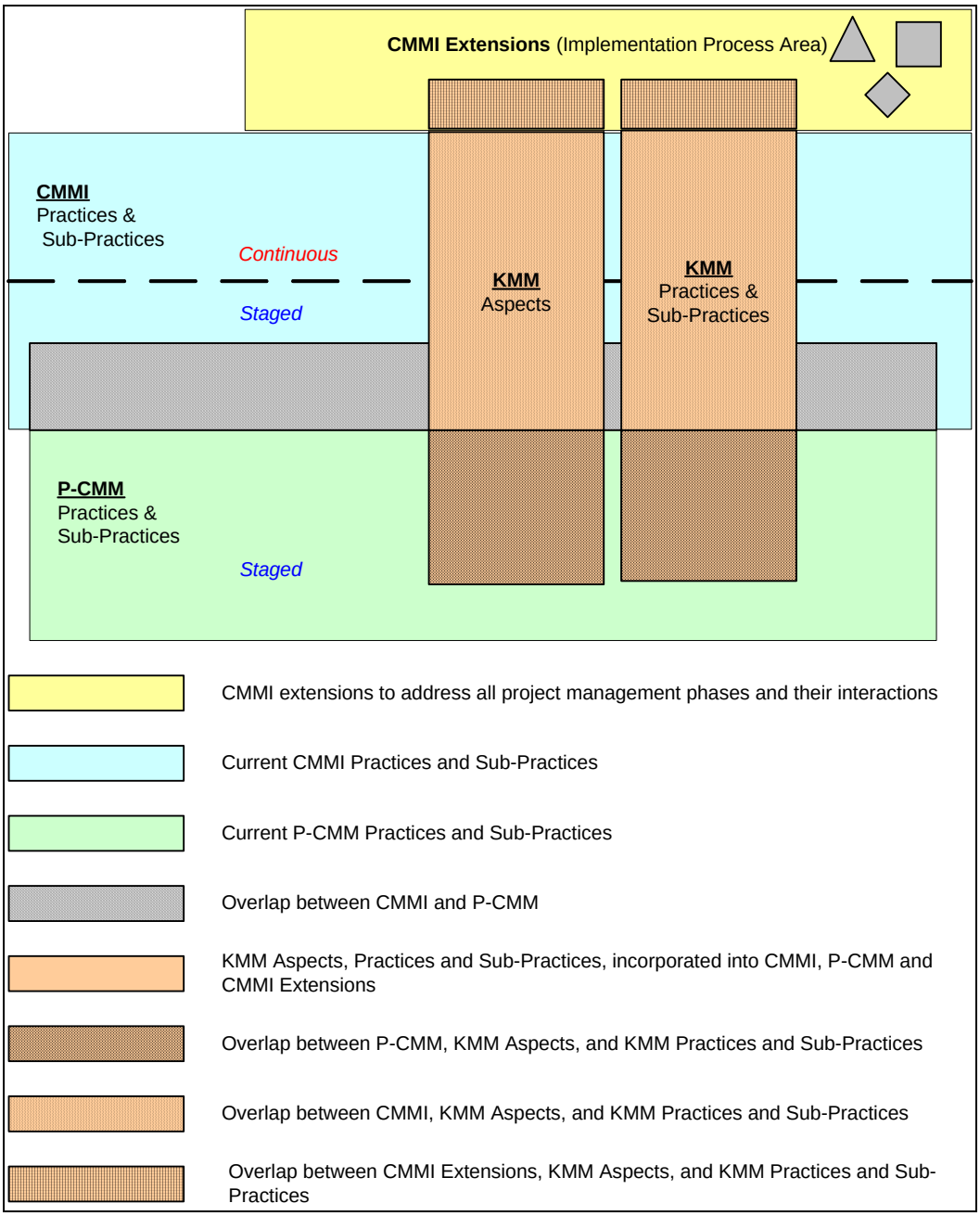


Figure 19: Conceptual Blended Model

According to Curtis *et al* ([16]), the P-CMM could be easily implemented with other capability maturity models. Maturity growth on one model does not require or restrict maturity growth on the other; consequently the various maturity levels need not be synchronised. Maturity growth on either model will, however, assist in *accelerating maturity growth* on the other (Curtis *et al,* [16]).

The challenge for an organisation initiating an improvement programme containing both CMMI and P-CMM components is to integrate an improvement strategy that allows improvements guided by one model to support improvements guided by the other model. At the same time, the organisation should balance the amount of change being undertaken with the day-to-day operational activities (Curtis *et al*, [16]).

Some of the current KM maturity models do not indicate a specific sequence of implementing KM practices. The Knowledge Management Framework Assessment Model of KPMG, for instance, only grades an organisation based on the number of KM practices implemented. The advantage of a blended model is the classification of processes and practices according to maturity levels that require increasingly sophisticated effort, providing an evolutionary improvement path for organisations.

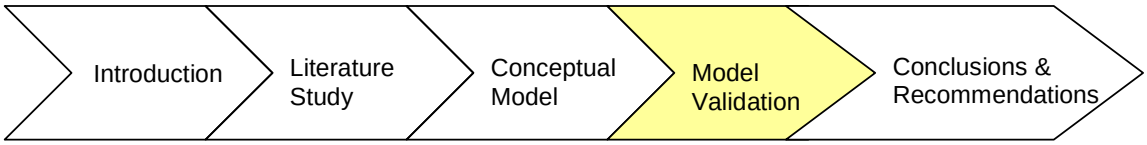
Most of the KM maturity models also assess the use of technology and infrastructure in supporting KM processes. The CMMI and P-CMM models do not prescribe the level or type of technology that should be used. During the appraisal process of specific practices with regards to required KM processes and practices, the appraisal data will refer to current technologies that are applied in enabling the KM processes and practices. The effectiveness of these technologies are then reviewed during the generation of appraisal results.

The current CMMI model incorporates both staged and continuous representations, allowing the measurement of both organisational maturity and capability. Unfortunately P-CMM only incorporates a staged representation. This constraint will also apply to the P-CMM part of the Blended Model.

3.4 CHAPTER SUMMARY

Chapter 3 provided an approach for defining an integrated maturity model. The defined approach was then followed in designing the detailed elements of an integrated maturity model, addressing process improvement management, knowledge management and workforce capability management. The approach also addresses a project management environment, which is characteristic of management consultancy organisations. To evaluate the usefulness of the newly-built model, a real-world validation exercise is required. The next chapter aims at performing a partial validation of the newly-built model at a South African management consultancy organisation.

4. MODEL VALIDATION



4.1 INTRODUCTION

The purpose of this chapter is to define a strategy for validating the model that has been constructed in Chapter 3, and to conduct the actual appraisal at a management consultancy organisation.

This includes model validation constraints and strategy (using a Class C appraisal for model validation), defining the appraisal methodology, and selecting the instruments and tools for conducting the appraisal. The requirements for a custom-built tool is also discussed briefly, referring to Appendix A for detailed designs.

A plan is compiled for conducting the appraisal (defining the selected project, appraisal team and schedule).The rationale that was used, in characterising the sub-practices while processing the appraisal data, is also defined. The appraisal data are finally summarised and interpreted.

4.2 VALIDATION STRATEGY

4.2.1 A Case Study for Validation

The blended model has been partially validated at a management consultancy organisation – Waymark. The purpose of the validation is to demonstrate the appraisal process and simultaneous appraisal of KM practices and aspects while appraising selected CMMI Process Areas.

Due to restricted resources and appraisal requirements posed by the organisation, a complete maturity level appraisal was not feasible. The organisation stated the following appraisal objectives and constraints:

- The model should be used as part of an extensive quality improvement programme.
- The focus should be on the appraisal of projects, rather than an organisational unit.
- Only certain process areas for certain projects should be appraised in accordance with business strategic objectives.
- Appraisal of these process areas should be used in identifying ‘best practices’ or ‘pockets of excellence’ in completed projects.
- Appraisal of the process areas should highlight current deficiencies, which will be used in identifying improvement opportunities.

- The appraisal results should be used to plan improvements for the execution of the Firearms project.

4.2.2 Constraints regarding Model Validation

Due to the organisational requirement of appraising only selected process areas and specific projects, a staged representation (measuring the overall organisational maturity regarding the integrated domains) will not be feasible. A continuous representation would be more appropriate. Though CMMI does provide both representations (staged and continuous), P-CMM only provides a staged representation.

The following strategy will thus be followed in validating the blended model:

> Use of a **continuous representation** for selected operational process areas, measuring against a capability level 3 (Defined), using CMMI.

Figure 20 portrays the scope of the validation exercise in terms of the complete blended model.

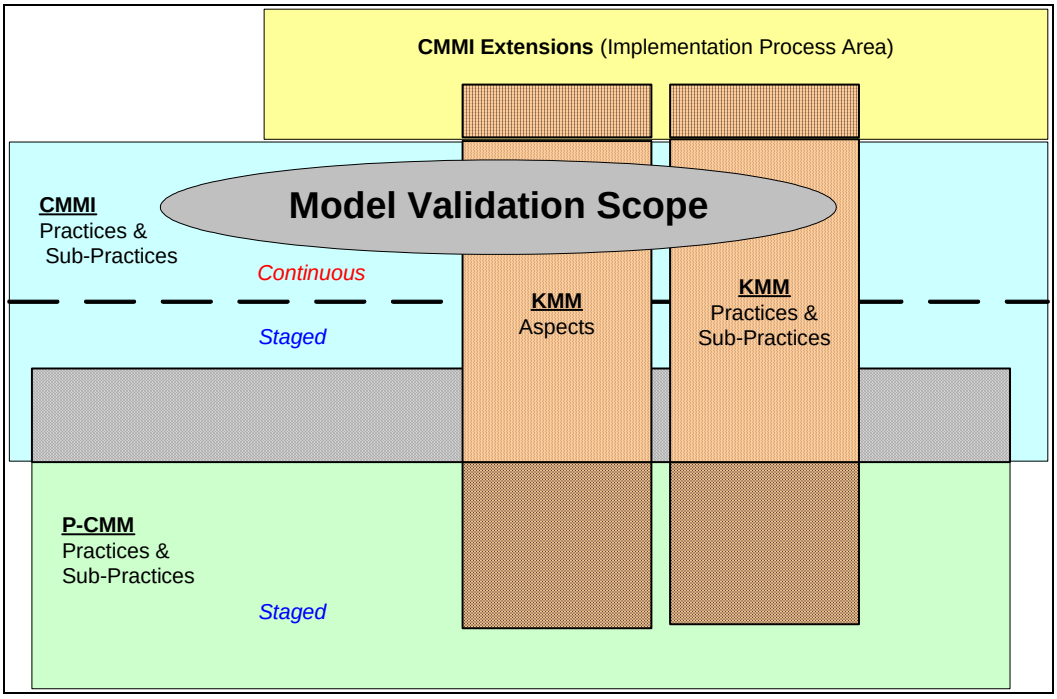


Figure 20: Model Validation Scope

4.2.3 Appraisal Strategy

The Software Engineering Institute compiled an Appraisal Requirements for CMMI (ACR) document that contains the criteria for developing, defining, and using appraisal methods on CMMI Products (CMMI Product Team [15]). Table 9 presents the characteristics of different classes of appraisal methods. The detailed requirements for each appraisal method class are available in the Appraisal Requirements for CMMI (CMMI Product Team [54]).

Characteristics	Class A	Class B	Class C
Amount of Objective Evidence Gathered (relative)	High (all 3 sources required)	Medium (at least 2 sources required, 1 must be an interview)	Low (only 1 source required)
Ratings Generated	Yes	No	No
Resource Needs (relative)	High	Medium	Low
Team Size (relative)	Large	Medium	Small
Validation and team consensus	Required	Required	Not Required
Appraisal Team Leader Requirements	Lead appraiser	Lead appraiser or person trained and experienced	Person trained and experienced.

Table 9: Characteristics of CMMI Appraisal Method Classes (CMMI Project Team, [54])

Class A methods are the only methods that are suitable for providing ratings for benchmarking. Class B methods are recommended for initial assessments in organisations that are just beginning to use CMMI models for process improvement activities. Class C methods are used when the periodic self-assessments are required for specific projects and organisational support groups (CMMI Project Team, [54]).

The Software Engineering Institute also compiled a method for performing CMMI appraisals, called the Standard CMMI Appraisal Method for Process Improvement (SCAMPI). This method was originally designed to provide benchmark quality ratings relative to CMMI models and supports the Appraisal Requirements for CMMI (ARC) for a Class A appraisal. The SCAMPI method could also be used in combination with the ACR document in performing a Class B or Class C appraisal.

The author, in consultation with the client, initially planned to perform a Class B appraisal. The following Class B appraisal requirements, however, could not be met, due to a lack of resource availability:

- Gathering objective evidence data from 2 separate sources for each observation.
- Using an appraisal team to verify the validity of observations and findings.

The appraisal results would thus comply only with Class C appraisal requirements. Further corroboration and validation of objective evidence and observations would be required to promote the appraisal to a Class B level appraisal.

4.3 VALIDATION METHODOLOGY

SCAMPI will be used in combination with the ACR document in performing a Class C appraisal. The method consists of three phases and eleven processes, as detailed in Table 10 and discussed briefly.

Phase	Process
1: Plan and Prepare for the Appraisal	1.1 Analyse Requirements
	1.2 Develop Appraisal Plan
	1.3 Select and Prepare Team
	1.4 Obtain and Analyse Initial Objective Evidence
	1.5 Prepare for Collection of Objective Evidence
2: Conduct Appraisal	2.1 Examine Objective Evidence
	2.2 Verify and Validate Objective Evidence
	2.3 Document Objective Evidence
	2.4 Generate Appraisal Results
3: Report Results	3.1 Deliver Appraisal Results
	3.2 Package and Archive Appraisal Assets

Table 10: SCAMPI Phases and Processes (Members of the Assessment Method Integrated Team [53], p I-4)

4.3.1 Plan and Prepare for Appraisal

This phase includes the analysis of the sponsor's objectives and requirements. The scope within the blended model (and included process areas) are defined and agreed to. This provides the basis for estimating personnel time commitments and overall costs to the appraised organisation.

Members of the appraised organisation prepare objective evidence, which consists of qualitative and quantitative information, statements and artefacts applicable to an item, service or process element. These are gathered by using a specific instrument (see Section 4.4). The appraisal team then verifies and validates the objective evidence provided by the appraised organisation relative to the referenced model (Members of the Assessment Method Integrated Team [53]).

4.3.2 Conduct the Appraisal

The appraisal team collects data from the appraised organisation to judge the extent to which the model is implemented. This implies the collection of data

and information on all the model practices for each process is appraised within the organisational unit.

A Class C appraisal only requires practice-level ratings and team consensus as illustrated in Figure 21:

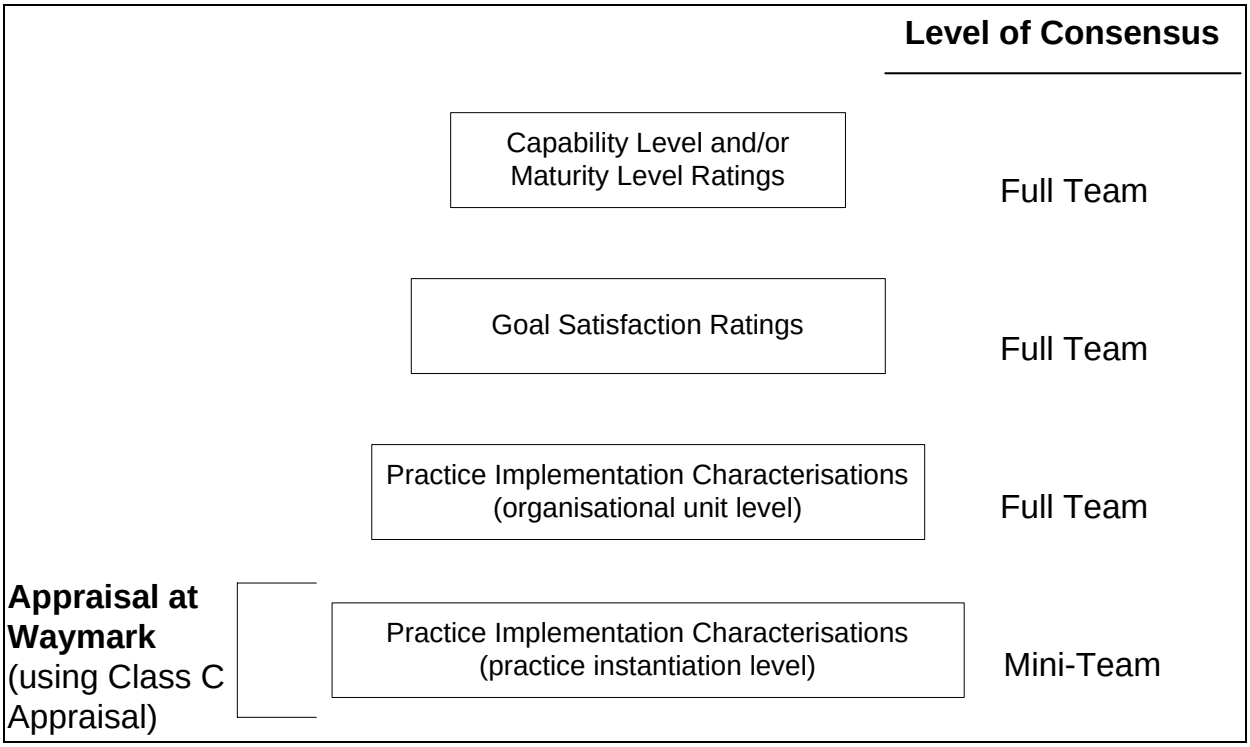


Figure 21: SCAMPI Rating Process (Members of the Assessment Method Integrated Team [53], p I-27)

On practice instantiation level (See Figure 21), observations are made, based on the objective evidence collected. Each practice should be characterised as Fully Implemented (FI), Largely Implemented (LI), Partially Implemented (PI) or Not Implemented (NI).

The author adapted the appraisal method by performing characterisations on a sub-practice level, rather than on a practice level. Preliminary practice categorisations are then generated programmatically for validation by the appraisal team. A sub-practice may also be characterised as 'Not Applicable', as sub-practices are informative components (not expected components), while practices cannot be classified as 'Not Applicable'.

4.3.3 Report Results

The appraisal team provides the findings and ratings as appraisal results to the appraised organisation. The appraisal results also become part of the appraisal record of the organisation. For the purposes of this study, the results are also included in this document.

4.4 APPRAISAL INSTRUMENTS

SCAMPI V1.1 relies on the collecting of objective evidence via instruments (questionnaires or surveys), presentations (delivered to the appraisal team to

describe organisational processes), documents (reflecting one or more practices) and interviews (with those implementing or using processes within the organisational unit). These data sources are fed into an information-processing engine, which is transformed for appraisal purposes. The appraisal team reads and interprets the transformed data and creates preliminary findings, which are validated before they become final findings. (Members of the Assessment Method Integrated Team [53]).

The objective evidence may be classified into three categories:

- **Direct Artefacts:** Tangible outputs that resulted from direct implementation of a specific or generic practice (e.g. deliverable products, documents and training materials).
- **Indirect Artefacts:** Artefacts that resulted from performing a specific or generic practice that substantiates its implementation (e.g. meeting minutes, status reports, review results and performance measures).
- **Affirmations:** Oral or written statements supporting the implementation of a specific or generic practice (e.g. questionnaire responses, presentations and interviews).

4.5 TOOLS

SEI has already developed a tool for performing SCAMPI Class A appraisals. The tool is called Tracker. This tool is built on an Access-database and supports the staged representation of CMMI. The tool, however, could not be adapted to include additional practices and aspects from other maturity models (e.g. the P-CMM and KM maturity models).

As the main objective of the appraisal at Waymark (from an organisational perspective) was to initiate a continuous improvement cycle, a tool was required for enabling continued in-house appraisal and improvement and to accommodate additional practices and KM aspects. A tool was developed to facilitate the appraisals process performed at Waymark. This tool (called BMAT – Blended Model Appraisal Tool) will be discussed next.

4.5.1 Tool Scope

The database of the Blended Model Appraisal Tool (BMAT) currently supports both appraisal representations (staged and continuous). The database also supports both appraisal targets (appraising a single project or appraising an organisational unit). Screens and reports have been developed in support of the appraisal requirements for Waymark – appraising a single project using the continuous representation. The populated goals, practices and sub-practices address capability levels 1 to 3 and maturity levels 1 to 5.The scope is also portrayed in Figure 22.

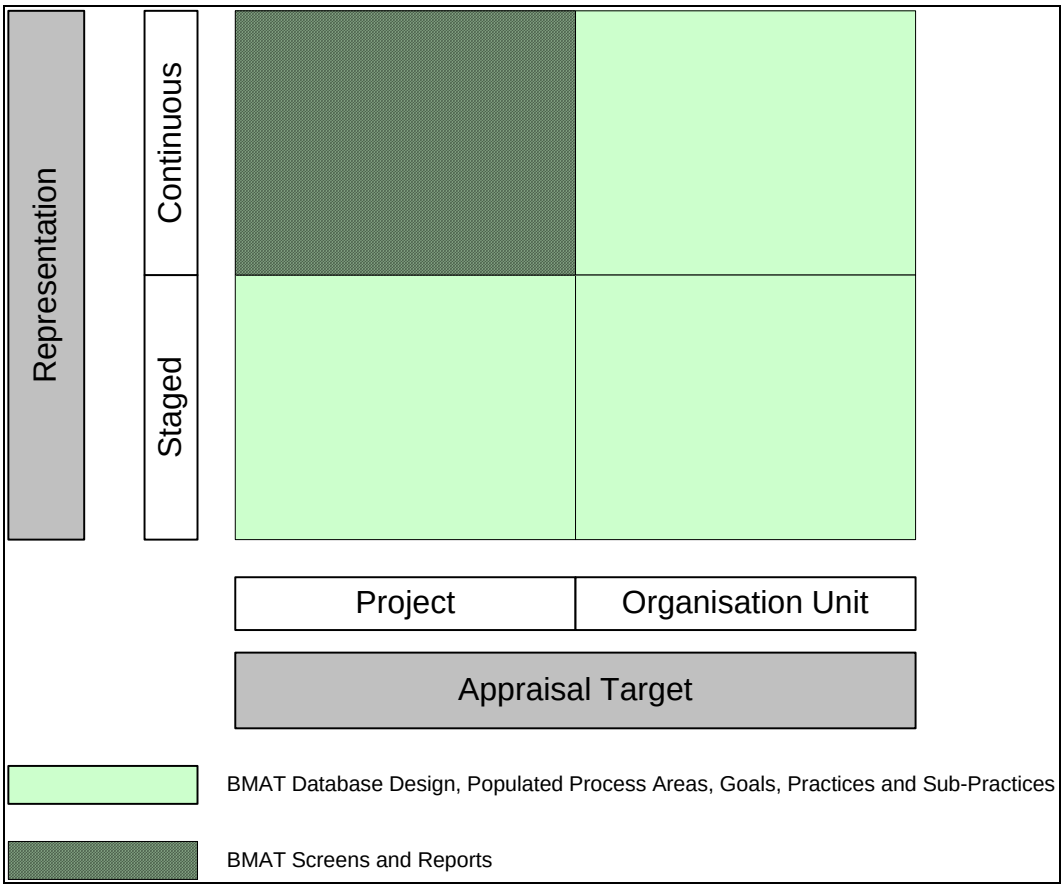


Figure 22: Scope of BMAT

The tool does not re-create all descriptive components included in the various maturity models, but rather facilitates the appraisal process. Components such as notes, referenced work products, related process areas and amplifications for certain disciplines have thus been excluded. The original maturity model documentation should still be consulted for detailed notes and references during the appraisal process.

The following primary requirements have been implemented:

- Storing structural elements (e.g. CMMI and P-CMM process areas and a hierarchy of expected and informative components).
- Providing a hierarchy of appraisal levels (capability levels 1 to 3 and maturity levels 1 to 5).
- Providing the ability to appraise specific projects against various appraisal models (CMMI, Blended) for a continuous model representation.
- Highlighting overlapping Process Areas.
- Providing different appraisal events and the ability to reuse objective evidence for an original appraisal in a follow-up appraisal.

- Providing mechanisms for collecting objective evidence and references to electronic/manual files that serve as objective evidence (direct / indirect / affirmations).

- Providing mechanisms for registering appraisal results for sub-practice appraisals as well as appraisal of the KM process embedded in the sub-practice.

- Providing mechanisms for adding best practices that are not listed as part of the CMMI and P-CMM models.

- Providing appraisal results for sub-practices as well as the required KM processes.

This tool will thus also serve as a repository of best practices, pointing to projects where these practices have been successfully implemented. New employees could visit the repository of best practices, viewing objective evidence that has been linked to appraised projects. The high-level process, modular/functional components, database design components, screens and reports have been included in Appendix A.

4.6 RESTRICTIONS

Although the author used SCAMPI as an appraisal framework, the author is a self-trained appraiser, rather than a qualified SEI-trained lead appraiser.

4.7 THE APPRAISAL PLAN AND DATA GATHERING PROCESS

4.7.1 Organisational Projects Appraised

Waymark required the appraisal of the following projects:

- Firearms Project (FCS) – only the proposal part.

- Voter Registration Project in Tanzania – complete life cycle.

- First National Bank Project – complete life cycle.

- Department of Trade and Industry Project – complete life cycle.

Due to resource restrictions, this document only includes appraisal of the Voter Registration project.

4.7.2 The Appraisal Team

Role	Person(s)
Project Sponsor	HMD (Hennie Meeding)
Appraiser	MDV (Marné de Vries)
Objective Evidence Provider –	HMD (Hennie Meeding), HVW

Role	Person(s)
CMMI Processes	(Hennie vd Walt), NEL (Nick Erleigh), FDA (Fernando D'Almeida), ESC (Ernie), LBK (Liana Beukes).
Validators	Complete team.

Table 11: Role Descriptions

4.7.3 Initial Appraisal Scope

Process areas have been selected in consultation with the appraised organisation. These are:

1. Project Planning
2. Project Monitoring and Control
3. Integrated Project Management for IPPD
4. Integrated Teaming
5. Requirements Development
6. Requirements Management
7. Technical Solution
8. Product Integration
9. Verification
10. Validation
11. Process and Product Quality Assurance

4.7.4 Adapted Appraisal Scope

The appraisal scope had to be adapted, due to the unavailability of resources. The following process areas were appraised for the Voters Registration project:

Project Management Process Areas

- Project Planning

Engineering Process Areas

- Requirements Development
- Requirements Management
- Technical Solution

- Product Integration
- Verification

For the purpose of this study, the set of appraised process areas was sufficient to demonstrate the following:

- The appraisal process, using an appraisal method.
- Appraising KM aspects and processes that are embedded in the blended model.
- Appraising the project management phase extensions (integrating the project definition phase and project planning phase) that were made to the base practices of the project planning process area.
- Appraising the project management phase extensions (integrating the project definition phase and project planning phase) that were made to the generic practices with regard to the generic goal, 'Institutionalise a Managed Process'.

4.7.5 The Appraisal Schedule

Figure 23 illustrates the original appraisal schedule:

Activity	Task	Deliverables	Responsible	Feb(1)	Feb(2)	Feb(3)	Feb(4)	Mar(1)	Mar(2)
Plan and Prepare for the Appraisal									
	Analyse Requirements	Adapted / Refined Blended Model	MDV, Team						
		Validated Model	MDV, Promotor, Team						
	Develop Appraisal Plan	Updated Appraisal Schedule	HMD, MDV						
	Select and Prepare Team	Selected Team	HMD, MDV						
	Obtain Initial Objective Evidence	Initial Objective Evidence	HVW, NEL, FDA, ESC						
	Analyse Objective Evidence		MDV						
	Collect additional Objective Evidence	Complete set of Objective Evidence	HVW, NEL, FDA, ESC						
Conduct Appraisal									
	Examine Objective Evidence		MDV						
	Verify and Validate Objective Evidence		MDV, Team						
	Document Objective Evidence	Evidence-Practice Mapping	MDV						
	Generate Appraisal Results	Practice-Level Ratings	MDV						
Report Results									
	Deliver Appraisal Results	Documented Appraisal	MDV						
	Package and Archive Appraisal Assets	Recorded Appraisal	To be decided						

Figure 23: The Original Appraisal Schedule

4.8 APPRAISAL PROCESSING

BMAT was used to record the objective evidence and a preliminary characterisation of each sub-practice.

The following rationale was used in characterising the sub-practices:

Characterisisation	Rationale Used
Fully Implemented	Direct evidence is available AND implementation of the sub-practice was verified during an interview.
Largely Implemented	No direct evidence is available BUT

Characterisisation	Rationale Used
	implementation of the sub-practice was verified during an interview. OR Direct evidence is available to support implementation of a large part of the sub-practice.
Partially Implemented	The interviewee confirmed that the sub-practice was only partially implemented, not necessarily providing evidence.
Not Implemented	No evidence was found that the sub-practice was implemented AND the interviewee confirmed that the sub-practice was not implemented at all.
Not Applicable	A sub-practice may not be applicable in the context of the project that is appraised. This may be due to the fact that the sub-practice is not required by the client, thus not having sponsorship for its execution.

Table 12: The Rationale for Characterising Sub-Practices

The following rationale was used in characterising the KM processes:

Characterisisation	Rationale Used
Efficient	The knowledge worker could easily search and find the necessary **input** data / information / knowledge for executing the practice. AND The newly-created data / information / knowledge are explicated as an **output** that could easily be searched/accessed and reused by other individuals that require the data / information / knowledge. Note that the newly-created data / information / knowledge need not necessarily be explicated (documented). Judgement is necessary to decide whether explication would facilitate their reuse in other practices or processes.
Workable	The knowledge worker has problems in finding the necessary **input** data / information / knowledge for executing the practice. AND/OR

Characterisisation	Rationale Used
	The newly created data / information / knowledge are explicated as **output**, but are not necessarily available for easy access and reuse by other team members. Explicated data / information / knowledge are usually stored on a local PC (not accessible to other project team members).
Inefficient	The knowledge worker has problems in finding the necessary **input** data / information / knowledge for executing the practice. AND/OR The newly-created data / information / knowledge are not explicated as an **output** that could easily be searched/accessed and reused by other individuals that require the data / information / knowledge. Judgement should be used to determine if explicated data / information / knowledge would really be required by other processes / practices. If not, the KM aspect should be characterised as 'Workable'.
Not Applicable	This characterisation is the default characterisation if the appraised sub-practice has not been implemented.

Table 13: Rationale for Characterising KM Processes

4.9 APPRAISAL RESULTS

BMAT was used in calculating the appraisal results on various levels: practice level, goal level and process area level. Detailed reports are provided on the attached CD (\Reports\Appraisal Result Report).

BMAT provides the ability to generate results based on the selected capability level. Though an organisation needs to specify the required capability level upfront (e.g. capability level 3), it is possible to generate results against a lower capability level (e.g. capability levels 1 and 2) by using the same set of appraisal data.

The following summarised results were obtained for capability levels 1, 2 and 3. The results for appraising sub-practices are summarised in Table 14.

Process Area	Result – Level 1	Result – Level 2	Result – Level 3
Product Integration	2.14	2.10	2.13
Requirements Development	2.44	2.59	2.75
Requirements Management	2.08	2.61	2.61
Technical Solution	1.88	1.97	2.09
Verification	3.04	3.01	3.10
Project Planning	1.97	2.20	2.20

Table 14: Summarised Results – Appraising Sub-Practices

The results are based on characterising sub-practices according to the following values:

1: Fully Implemented

2: Largely Implemented

3: Partially Implemented

4: Not Implemented

Table 14 also applies the following colour-coding indicated in Table 15.

Values larger than 3	Red	Process areas should receive high priority for improvement.
Values between 2 and 3	Blue	Process areas should receive medium priority for improvement.
Values smaller than 2	Black	Process areas should receive low priority for improvement.

Table 15: Colour-Coding for Appraising Sub-Practices

As can be expected, results seem to deteriorate if measured against higher capability levels. The reason is that more sub-practices are added to each capability level, making it more difficult to achieve full-implementation of all sub-practices. The reports provided on the attached CD (\Reports\Appraisal Result Report) could be used to identify the specific practices that need to be improved.

Note that some of the results seem to improve if measured against higher capability levels (e.g. Product Integration). This is the result of adding more sub-practices at higher capability levels, while the added sub-practices achieve good results, which improves the overall average.

The results for appraising KM processes for sub-practices are summarised per process area in Table 16. A detail report is available on the attached CD (\Reports\KM Appraisal Result Report).

Process Area	Result – Level 1	Result – Level 2	Result – Level 3
Product Integration	1.60	2.17	2.23
Requirements Development	2.13	2.31	2.31
Requirements Management	2.61	2.48	2.48
Technical Solution	2.27	2.39	2.34
Verification	2.50	2.75	2.78
Project Planning	1.62	1.63	1.63

Table 16: Summarised Results – Appraising KM Processes

The results are based on characterising sub-practices according to the following values:

1: KM Effective

2: KM Workable

3: KM Inefficient

Table 16 also applies colour-coding indicated in Table 17.

Values larger than 2.5	Red	Process areas should receive high priority for improvement regarding embedded KM processes.
Values between 2 and 2.5.	Blue	Process areas should receive medium priority for improvement regarding KM processes.
Values smaller than 2.5	Black	Process areas should receive low priority for improvement regarding KM processes.

Table 17: Colour-Coding for Appraising KM Processes

4.10 RESULTS INTERPRETATION

The results highlighted different process areas at different capability levels that should be targeted for improvement (especially Verification). The appraisal results also indicated that the company is not following the predetermined growth path that is mandated by the continuous representation of the maturity model. The company may, for instance,

perform better on a higher capability level for certain process areas (Product Integration and Verification). The addition of certain practices thus improves the overall average for some of the appraised process areas.

On a capability level 1, none of the process areas scored a total average of 1 (Fully Implemented). Even though the company requested an appraisal against a capability level 3, the results indicate the necessity of first improving practices that are required for a capability level 1.

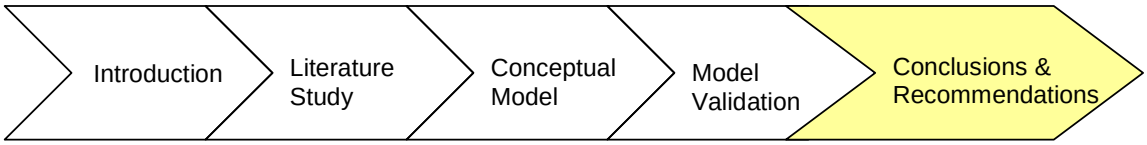
The results for appraising KM processes also revealed process areas that should be targeted for KM improvement (especially Verification).

4.11 CHAPTER SUMMARY

Chapter 4 provided an approach for validating the newly-built model at a management consultancy organisation. The validation strategy includes the selection of an appraisal strategy, methodology, instruments and a custom-built tool.

The validation approach was followed in compiling a detailed plan for conducting an appraisal at a management consultancy organisation. Appraisal data were collected during the appraisal exercise, using a certain rationale in processing the appraisal data. The processed results revealed process areas that should be targeted for improvement at the appraised company.

5. CONCLUSIONS AND RECOMMENDATIONS



5.1 CONCLUSIONS

The study demonstrated the integration possibilities of the following domains: process improvement / knowledge / workforce-capability management. An informal content analysis confirmed the necessity of integrating process improvement and knowledge management efforts to leverage organisational performance.

Various maturity models (from process improvement, knowledge management and workforce capability management domains) were investigated and evaluated for suitability in management consultancy organisations. Deficiencies were identified and a new, blended model was designed and constructed, which combined current maturity models and their required extensions.

The blended model was partially validated at a management consultancy organisation using the custom-built appraisal tool (BMAT) in performing the appraisal. Results were obtained, which highlighted organisational process areas (especially Verification) that require immediate practice and KM improvement efforts. Even though the company requested an appraisal against a capability level 3, the results indicated the necessity of first improving practices that are required for a capability level 1.

The new, blended model (and its validation) demonstrated the feasibility of integrating the various domains as proposed in the problem statement.

5.2 RECOMMENDATIONS

5.2.1 Model Recommendations

Model validation was limited to a selected set of process areas that was measured against a **capability level** 3, using a continuous model representation. Validation of the complete blended model would also require appraisal against a specific **maturity level**, using a staged model representation.

It is recommended that further empirical research is performed in addressing the following:

- Measuring and comparing the maturity levels of the synthesised domains (process-improvement / knowledge / workforce-capability management) for multiple consultancy organisations.

- Measuring and comparing the capability levels of project management process areas for multiple consultancy organisations.

Though staged representation of maturity models provides a classification of processes and practices according to maturity levels that require increasingly sophisticated effort, this may also pose certain limitations. The validated organisation, for instance, indicated that it would gain more value from an appraisal exercise, if process areas were selected according to its strategic objectives. Only certain process areas were thus selected, using the continuous representation of CMMI to perform the appraisal. A company may thus require a different growth path than that dictated by the staged representation of the blended model. Further research would be required to investigate the possibility of tailoring the blended model in accordance with an organisation's strategic objectives.

5.2.2 Tool Recommendations

Regarding the custom-built appraisal tool (BMAT), the following restrictions could be addressed in a next version:

- Basic structural elements (e.g. CMMI and P-CMM process areas and a hierarchy of expected and informative components) are provided. Components such as notes, referenced work products, related process areas and amplifications for certain disciplines have been excluded and should be included in the next version.

- The hierarchy of appraisal levels is limited to capability levels 1 to 3 (instead of 1 to 5). The next version should incorporate all levels.

- The database supports both appraisal targets (appraising a single project or appraising an organisational unit). Screens and reports have, however, been developed in support of the appraisal requirements for Waymark – appraising a single project using the continuous representation. The next version should incorporate screens and reports for both appraisal targets, also having the option to use either the staged or continuous representation approach.

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University of Pretoria, etd De Vries, M (2006)

APPENDIX A

1. PROCESS FLOW

As mentioned earlier in the document, the Blended Model Appraisal Tool (BMAT) will primarily support appraisal processes. The high-level processes that will be followed, are depicted in Figure 24.

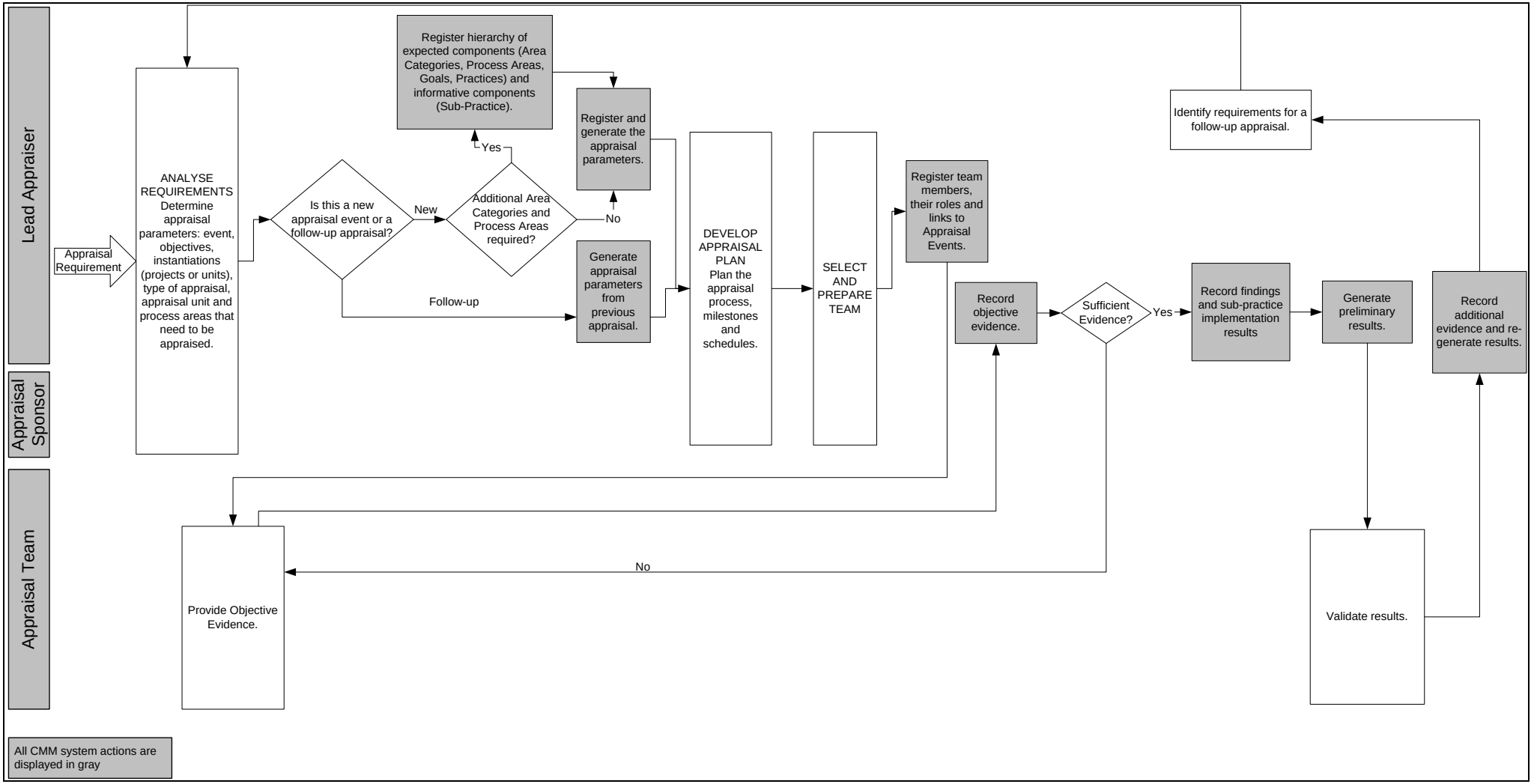


Figure 24: High-level Appraisal Processes

2. MODULAR COMPONENTS

Figure 25 depicts the functional decomposition of BMAT.

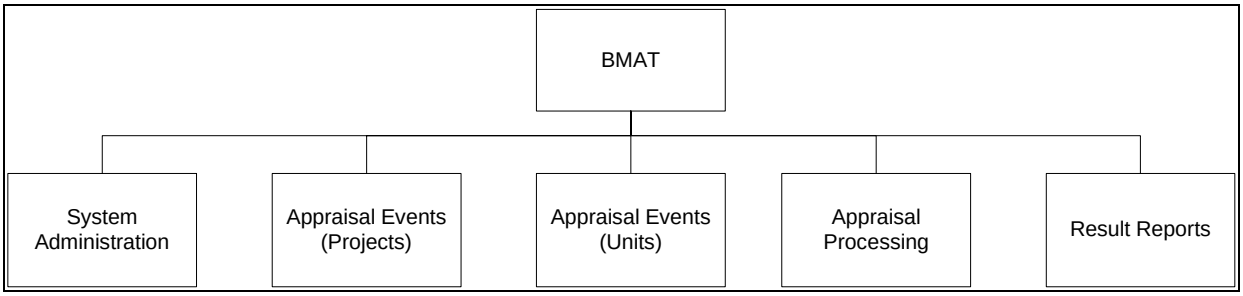


Figure 25: Modular System Components

3. DATABASE COMPONENTS

Table 18 delineates the system table definitions. This is followed by a diagram (Figure 26) portraying the system tables and relationships between these tables.

Table	Description
Appraisal_Event	Used to register an appraisal exercise that has been approved by an organisation and receives sponsorship.
Area_Category	A logical categorisation of process areas.
Company	The organisation for which an appraisal is performed.
Common Feature	Categorising Practices into the following set: Commitment to Perform (CO), Ability to Perform (AB), Directing Implementation (DI), Verifying Implementation (VE) and Measurement & Analysis.
Detail	Additional information regarding sub-practices.
Event_Member	Used to record the appraisal team members that has been assigned to a specific appraisal event for assistance.
Goal	Used to group a set of related practices that would accomplish a single goal if all these practices were implemented. Goals may be specific or generic. Generic goals may be applicable to more than one process area. See the definition of 'PA_Goal'.
Member	Used to record details of members. This entity could later be extended to incorporate an access control module.
Origin	Used to register the origin of an area category,

Table	Description
	process area, goal, practice or sub-practice. Most of the structural components originate from the CMMI model and P-CMM model. Some components also stem from various KM maturity models, while others have been added to address all project management phases.
PA_Event	Used to identify process sreas that will be included for a specific appraisal event and specific appraised units (e.g. an organisational unit or contracted project). This entity is also used to record appraisal results in terms of the capability maturity level of the appraised process area.
PA_Goal	A specific or generic goal that is applicable to a process area. See the definition of 'Goal'.
Person	Used to store data on any person that acts as an appraisal team member of provides appraisal evidence.
Practice	A process / routine / procedure that should be performed by the appraised company during an appraisal exercise.
Primary_Role	Used to record the specific roles that may be fulfilled during the appraisal event. Examples are: Lead Appraiser, Project Sponsor, Team Validator.
Process_Area	Used to group a set of related practices that support goals in a specific process domain. Examples of process areas include: Project Planning, Project Monitoring and Control, and Requirements Development.
Process_Overlap	Used to indicate the overlap of certain process areas to appraise overlapping process areas conjointly.
Project	Used to store information about the Projects that are appraised. Also see 'Sample_Project'.
Sample_Project	A list of projects that are used during the appraisal of an organisational unit. A sample of projects are used as a source for gathering objective evidence.
SPractice_Appraisal	Used to register preliminary appraisal results based on the accumulated objective evidence. Each sub-practice is characterised as either Fully Implemented, Largely Implemented, Partially Implemented or Not Implemented. A Sub-Practice that has not been

Table	Description
	implemented may ALSO be classified as Not Applicable, which should be supported by a reason.
SPractice_Evidence	The sub-practice appraisals are based on various sources of objective evidence. This entity is used to record the sources of evidence. Note that different classes of appraisals require different types of sources.
Sub_Practice	A process / routine / procedure that should be performed by the appraised company. The sub-practice should be performed as part of a practice and is used to provide more details regarding the execution of its parent practice. During appraisal, a sub-practice only provides informative details regarding the parent practice and need not be demonstrated per se by the appraised organisation.
Unit	The unit that is appraised during the appraisal of a specific Process Area. A sample of projects will be required in appraising a single organisational unit.

Table 18: Table Definitions

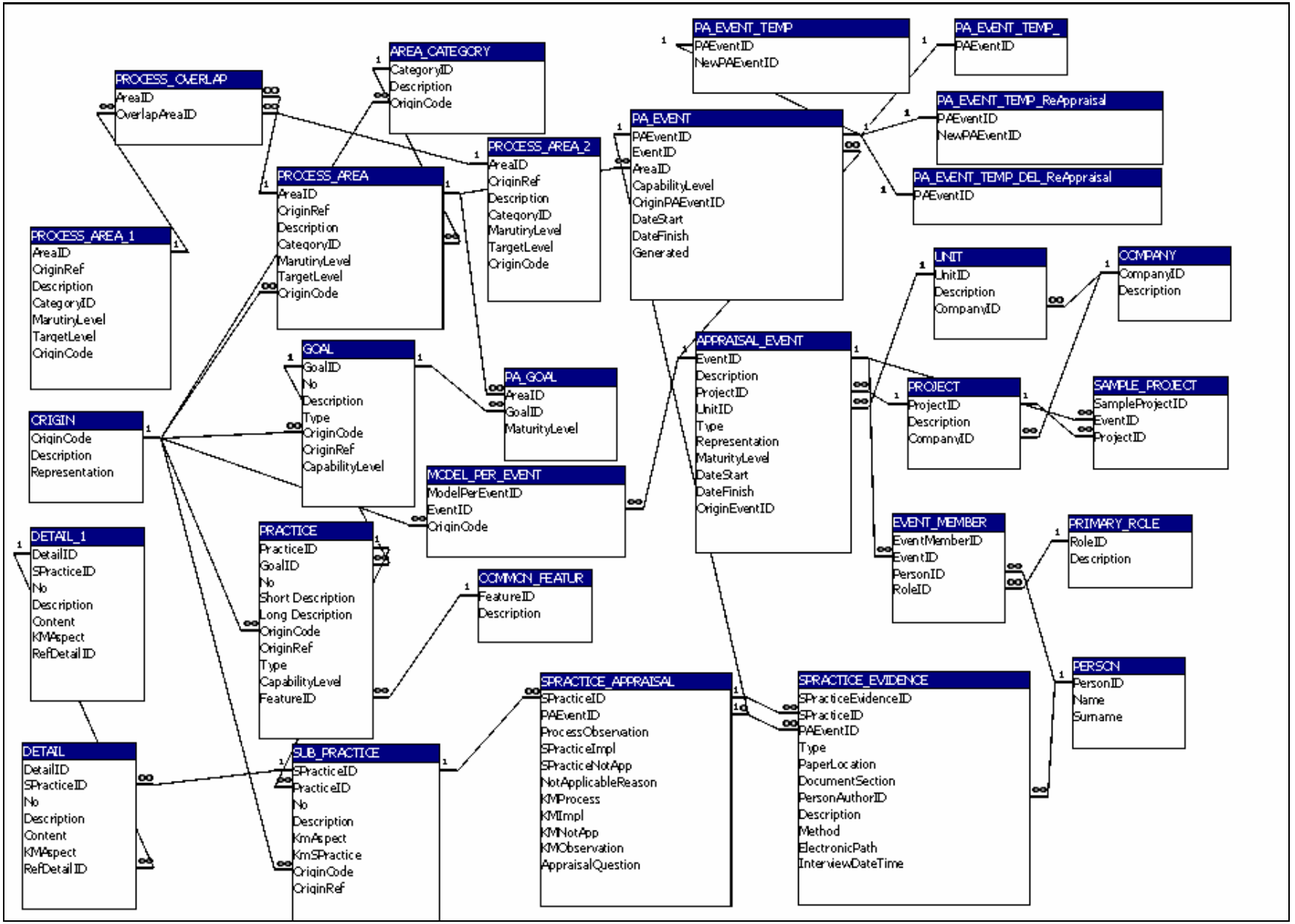


Figure 26: Physical Data Model

4. BUILT-IN RULES AND PROGRAM LOGIC

4.1 APPRAISAL REQUIREMENTS

Various different appraisal classes have different levels of appraisal requirements. The following requirements/rules have been incorporated in BMAT.

4.1.1 Practice and Sub-Practice Categorisations

Sub-practices may be categorised as either Fully Implemented (value = 1), Largely Implemented (value = 2), Partially Implemented (value = 3) or Not Implemented (value = 4). If a sub-practice has been categorised as Not Implemented, the sub-practice may also be classified as Not Applicable. Sub-practices are informative components, rather than expected components and may thus not be applicable to a specific project or organisational unit. If a sub-practice is classified as Not Applicable, the result of the specific sub-practice will not be incorporated in the calculation of summarised appraisal results.

4.1.2 KM Categorisations

Sub-practices may be categorised as either KM-Effective, KM-Workable or KM-Inefficient. A sub-practice may also be classified as Not Applicable regarding the KM appraisal. This may be due to the fact that the sub-practice has been classified as Not Applicable during sub-practice appraisal or if the sub-practice was classified as 'Not Implemented'.

4.1.3 Appraisal Based on Sub-Practices

Appraisal results will be calculated based on the appraisal of sub-practices. Each practice should thus have at least one sub-practice, even if the sub-practice is exactly the same as the practice.

4.1.4 Generic Goal Reuse

Generic goals and practices are applied to various different process areas in both the staged and continuous representations. The following rules have been incorporated in BMAT:

- For a staged representation – each process area specifies its own generic goals and practices and the maturity level to which they are applicable. As an example, the process area 'Configuration Management' (required for a maturity level 2) specifies the generic goal 'Institutionalise a Managed Process' as a requirement for a maturity level 2 rating. If an organisation targets a maturity level 3 rating, this same process requires an additional generic goal, namely 'Institutionalise a Defined Process'.

- For a continuous representation – generic goals and processes are specified for each capability level, independent of relevant process areas.

Abovementioned rules have been applied as follows:

- For a staged approach – generic goals (per process area) are classified according to its maturity level if the maturity level for a generic goal is different (higher) than the linked PROCESS_AREA.MaturityLevel. This maturity level value is stored in PA_GOAL.MaturityLevel).

- For a continuous approach - generic goals are classified according to its capability level (see table 'GOAL').

4.2 APPRAISAL RE-EVALUATION

BMAT will facilitate the re-evaluation of an appraisal event by generating a set of sub-practice appraisal records from a previous event. This will allow the appraiser to view appraisal results from a previous appraisal, edit sub-practice appraisal results based on additional objective evidence and view practice-level, goal-level and process area-level appraisal results.

BMAT will thus provide the ability to manage various follow-up appraisal events against an original appraisal event. One should thus be able to view appraisal progress for specific process areas.

4.3 APPRAISAL RESULTS

4.3.1 Calculating Appraisal Results

Sub-Practices are manually categorised according to the Appraisal Requirements for CMMI (ACR). The categorisation values that are stored in the database is then used to calculate a categorisation value (an average categorisation value) per practice, per goal, and per process area.

5. USER INTERFACE

5.1 MAIN MENU

The Main Menu provides the main interface to various screens and reports as portrayed in Figure 27.

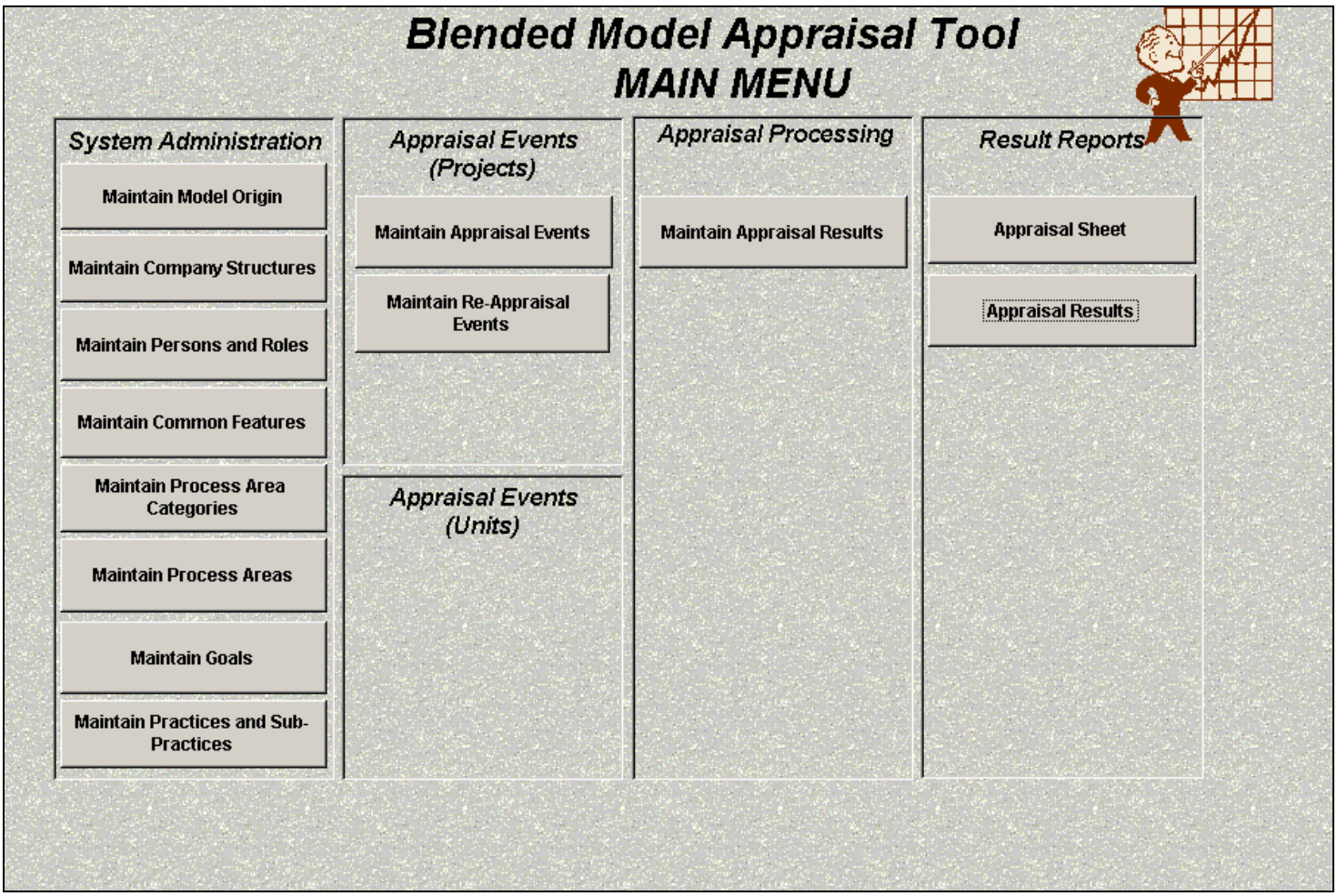


Figure 27: BMAT Main Menu

5.2 SCREENS

5.2.1 System Administration Screens

These screens are used to record details regarding companies, their projects and appraisal components that will be appraised in appraisal events.

5.2.2 Appraisal Events (Projects)

Two tab-structures are used to register appraisal / re-appraisal parameters, such as event details, process areas that are appraised and event members. Some of the parameters are then used to generate appraisal templates that will be populated during the appraisals process. Figure 28 portrays the 'Appraisal Event' tab-structure.

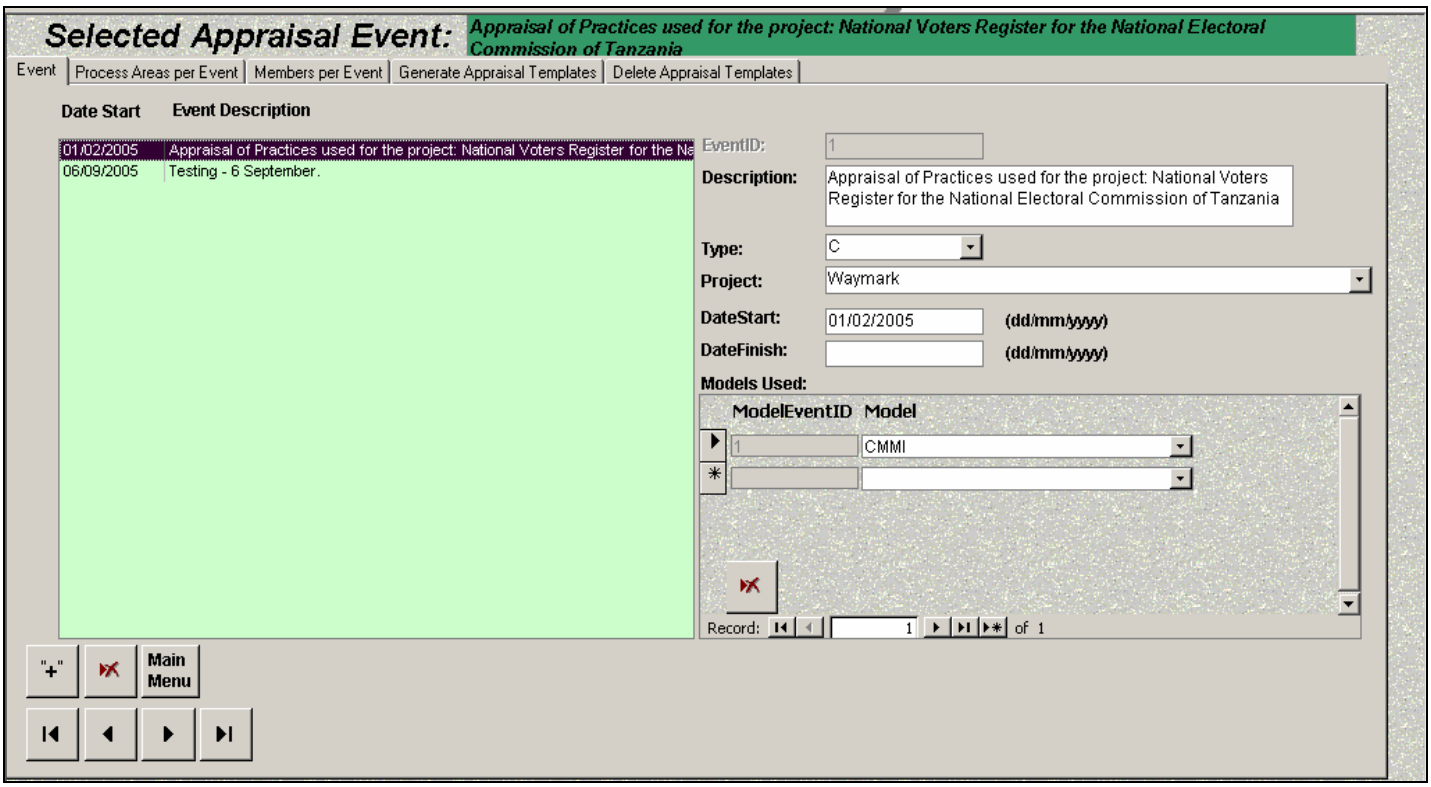


Figure 28: Appraisal Event Tab-Structure

5.2.3 Appraisal Events (Units)

Development of this module is not within the scope of this thesis. The database has though be configured to incorporate this module at a later stage.

5.2.4 Appraisal Processing

During the appraisals process, objective evidence are gathered to substantiate the appraisal results that are obtained. Both the objective evidence and appraisal results are registered on the same tab structure, which is portrayed in Figure 29.

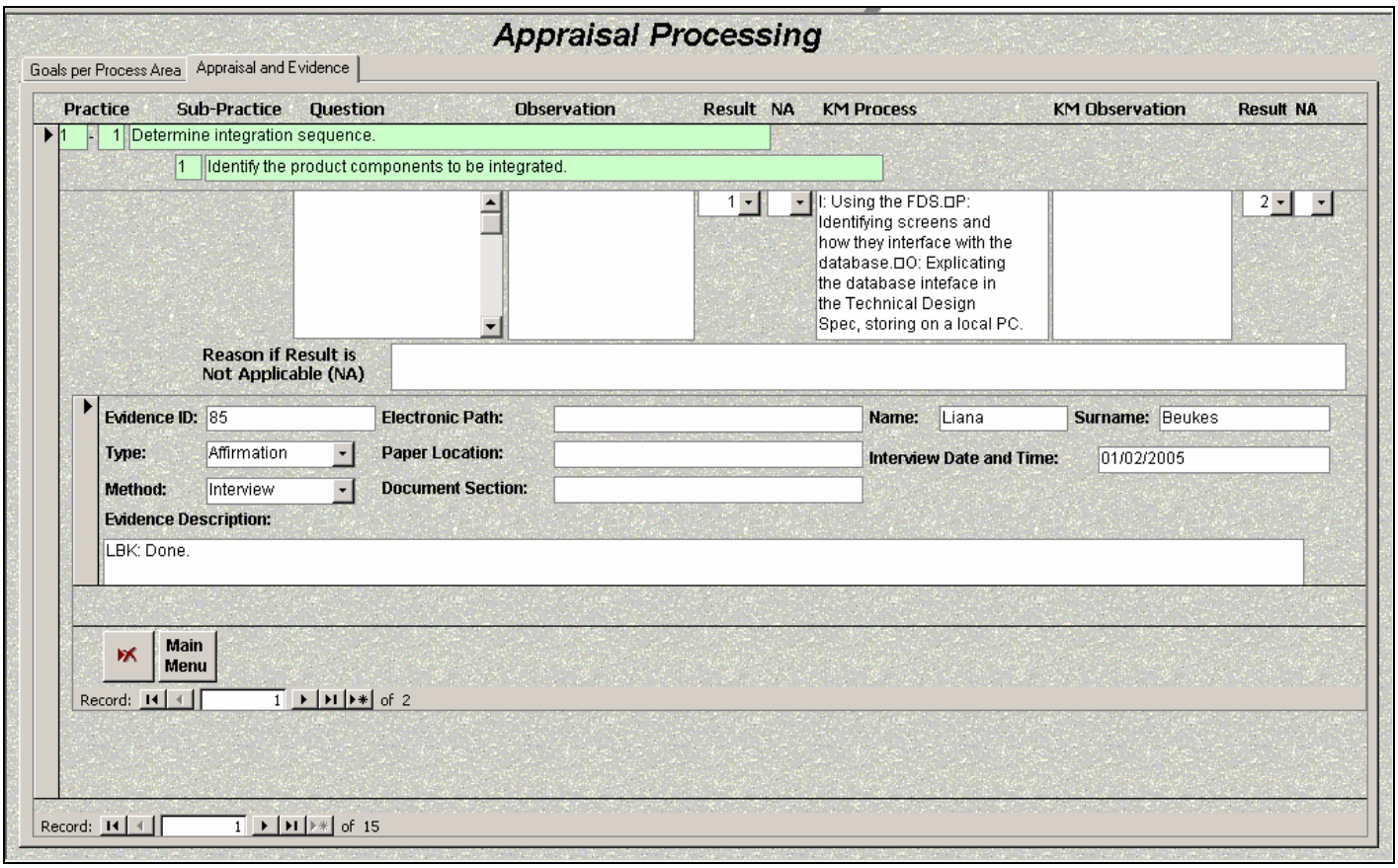
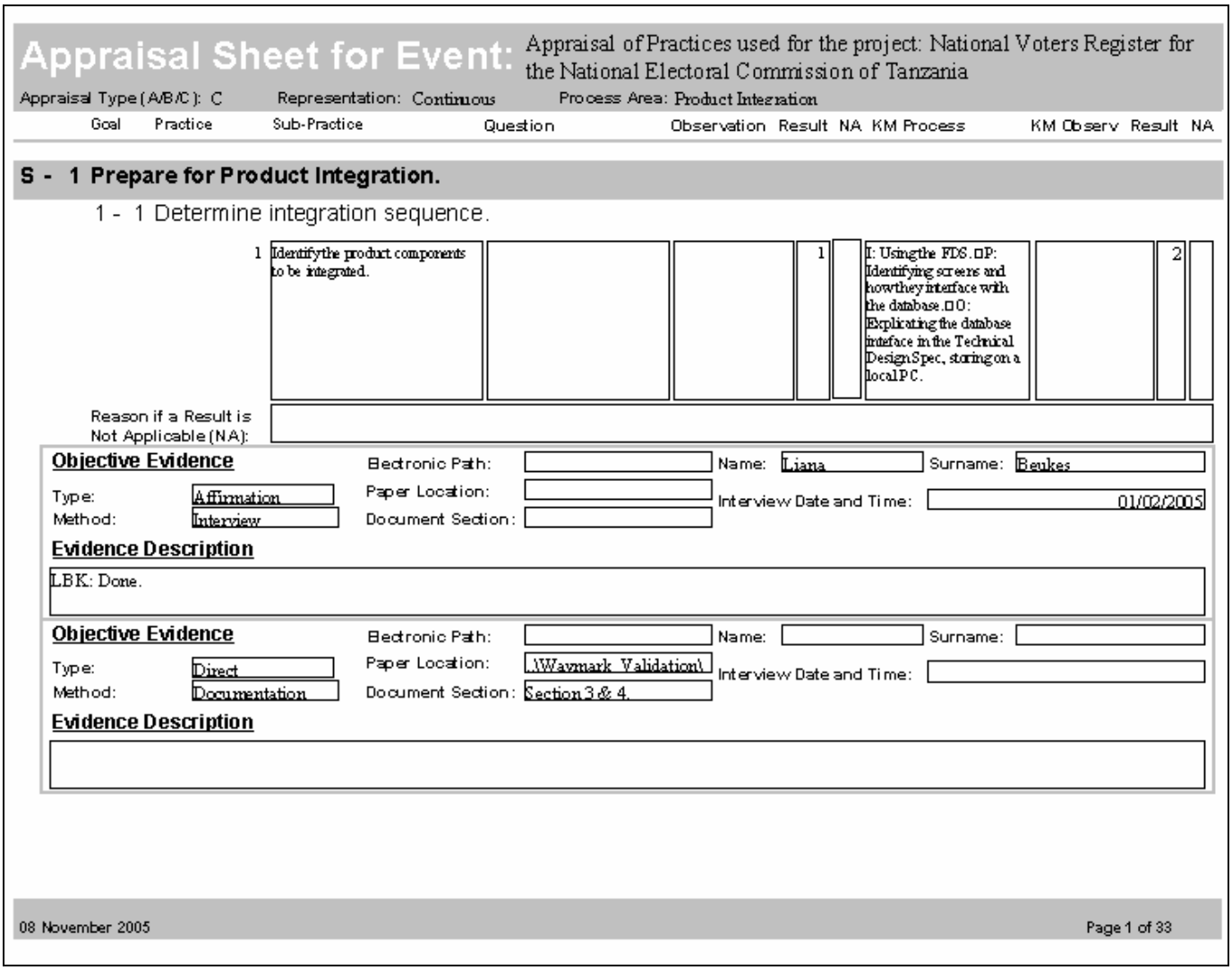


Figure 29: Appraisal Processing Tab-Structure

5.3 REPORTS

Three reports are available.

The Appraisal Sheet is based on the generated templates for Appraisal Events. These sheets may be used to capture appraisal information manually during appraisal work sessions. An example is displayed in Figure 30.



Appraisal Sheet for Event: Appraisal of Practices used for the project: National Voters Register for the National Electoral Commission of Tanzania

Appraisal Type (A/B/C): C Representation: Continuous Process Area: Product Integration

Goal	Practice	Sub-Practice	Question	Observation	Result	NA	KM Process	KM Observ	Result	NA
S - 1 Prepare for Product Integration.										
	1 - 1 Determine integration sequence.									
		1	Identify the product components to be integrated.			1		I: Using the FDS. □P: Identifying screens and how they interface with the database. □O: Explicating the database inteface in the Technical Design Spec, storing on a local PC.		2	

Reason if a Result is Not Applicable (NA):

Objective Evidence

Type: Affirmation
Method: Interview
Electronic Path:
Paper Location:
Document Section:
Name: Liana
Surname: Beukes
Interview Date and Time: 01/02/2005

Evidence Description

LBK: Done.

Objective Evidence

Type: Direct
Method: Documentation
Electronic Path:
Paper Location: .\Wavmark Validation\
Document Section: Section 3 & 4.
Name:
Surname:
Interview Date and Time:

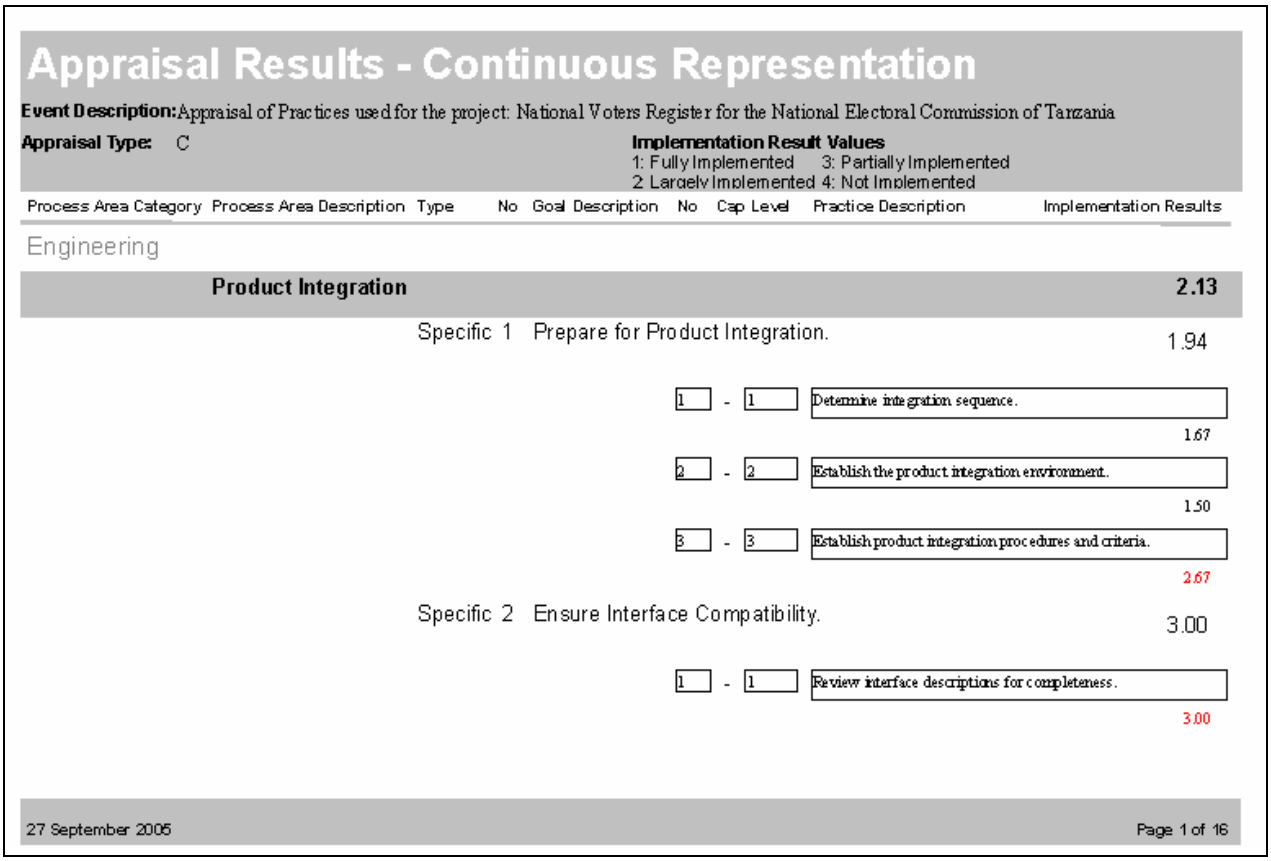
Evidence Description

08 November 2005 Page 1 of 33

Figure 30: Appraisal Sheet

Two Appraisal Results reports are available:

- A Sub-Practice Appraisal Results report, which is based on the sub-practice appraisal results summarised per practice, goal and process area. See Figure 31.
- A KM Appraisal Results report, which is based on the sub-practice KM results summarised per practice, goal and process area. See Figure 32.



Appraisal Results - Continuous Representation

Event Description: Appraisal of Practices used for the project: National Voters Register for the National Electoral Commission of Tanzania

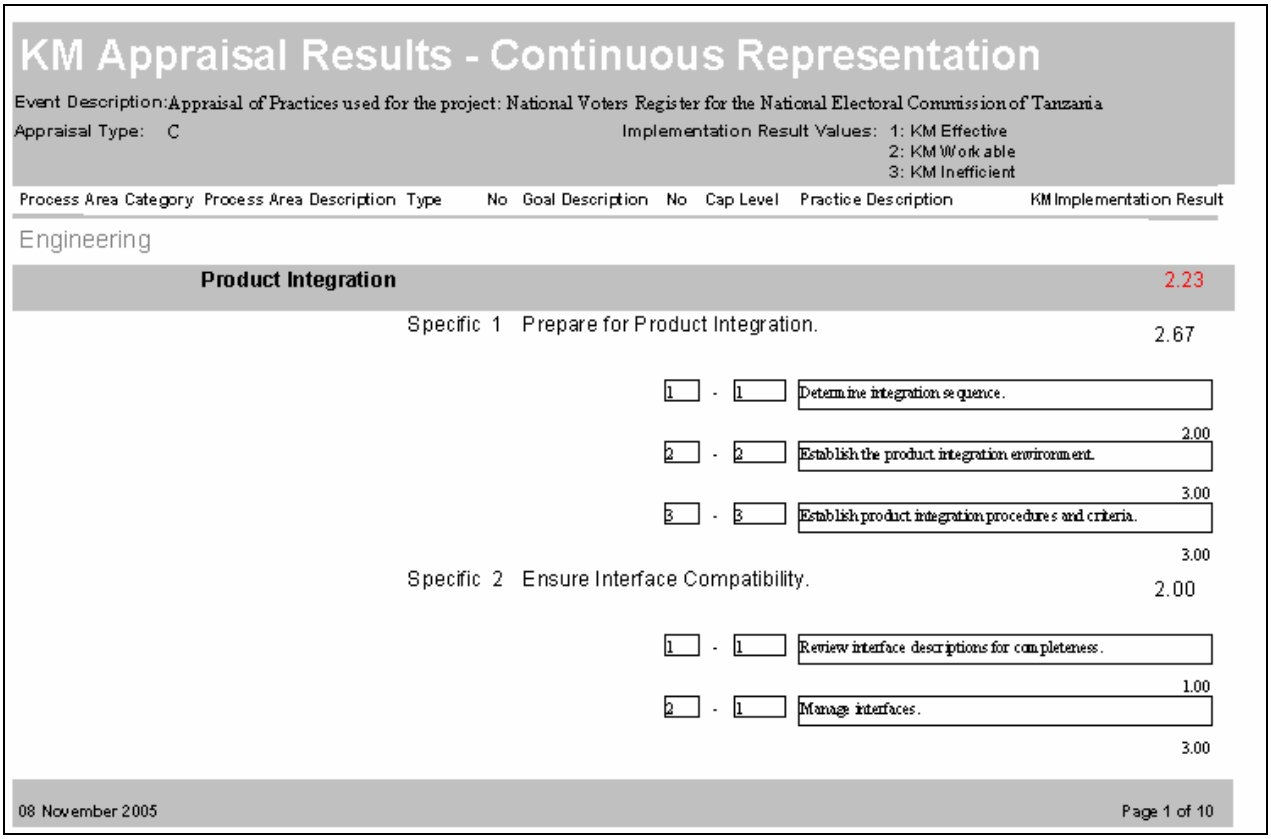
Appraisal Type: C

Implementation Result Values
1: Fully Implemented 3: Partially Implemented
2: Largely Implemented 4: Not Implemented

Process Area Category	Process Area Description	Type	No	Goal Description	No	Cap Level	Practice Description	Implementation Results
Engineering								
	Product Integration							**2.13**
				Specific 1 Prepare for Product Integration.				1.94
					1	1	Determine integration sequence.	1.67
					2	2	Establish the product integration environment.	1.50
					3	3	Establish product integration procedures and criteria.	2.67
				Specific 2 Ensure Interface Compatibility.				3.00
					1	1	Review interface descriptions for completeness.	3.00

27 September 2005 Page 1 of 16

Figure 31: Sub-Practice Appraisal Results Report



KM Appraisal Results - Continuous Representation

Event Description: Appraisal of Practices used for the project: National Voters Register for the National Electoral Commission of Tanzania

Appraisal Type: C

Implementation Result Values: 1: KM Effective
2: KM Workable
3: KM Inefficient

Process Area Category	Process Area Description	Type	No	Goal Description	No	Cap Level	Practice Description	KM Implementation Result
Engineering								
	Product Integration							2.23
				Specific 1 Prepare for Product Integration.				2.67
					1	1	Determine integration sequence.	2.00
					2	2	Establish the product integration environment.	3.00
					3	3	Establish product integration procedures and criteria.	3.00
				Specific 2 Ensure Interface Compatibility.				2.00
					1	1	Review interface descriptions for completeness.	1.00
					2	1	Manage interfaces.	3.00

08 November 2005 Page 1 of 10

Figure 32: KM Appraisal Results Report

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APPENDIX B

Capability Levels and Maturity Levels

The CMMI Product Team ([6], p. 18) distinguishes between capability levels and maturity levels:

> "The continuous representation [of CMMI] uses capability levels to measure process improvement, while the staged representation uses maturity levels. The main difference between maturity levels and capability levels is the representation they belong to and how they are applied:
>
> - Capability levels, which belong to the continuous representation, apply to an organisation's process-improvement achievement for each process area…Each capability level corresponds to a generic goal and a set of generic and specific practices.
>
> - Maturity levels, which belong to the staged representation, apply to an organisation's overall maturity…Each maturity level comprises a predefined set of process areas".

Communities of Practice (CoP)

Wenger and Snyder (cited in Smith and McKeen [46], p. 394) provide the following definition:

> "A very broad definition of a CoP is that it is a group of people with a common interest who work together informally in a responsible, independent fashion to promote learning, solve problems, or develop new ideas".

Wenger [45] maintains that a community of practice is different from a mere geographical community of interest. A community of practice implies a shared practice and contains three basic elements:

- "What it is about – the sense of *joint enterprise* that brings members together".

- "How it functions as a community – the relationships of mutual engagement that bind members together into a social entity".

- "What capability its practice has produced – the shared repertoire of communal resources that members have developed over time through their mutual engagement" (Wenger [45], p.208).

Competency

Abell and Oxbrow ([27], p. 106) provide the following definition:

> "At its simplest a competency is the mix of skills, experience and behaviour that allows an individual to execute their work successfully".

Corporate Performance Management

Buytendijk, Wood and Geishecker ([30], p. 5) define 'Corporate Performance Management' (CPM) as follows:

> "CPM is an umbrella term. It comprises all processes, **methodologies**, metrics and technologies that enterprises use to measure, monitor and manage business performance. It is an enterprise-wide strategy that seeks to align departmental initiatives to prevent managers from optimising local business at the expense of overall corporate performance. It is not a 'one-off' project but an ongoing process – part of the daily work of managers".
>
> The **methodologies** mentioned in the definition include Balanced Scorecard, Quality Management (such as Six Sigma and the European Foundation for Quality Management), Activity-based Management and others (Buytendijk *et al* [30]).

Data

Whitten, Bentley and Dittman [12] (p. 27) define 'data' as follows:

> "Raw facts about people, places, events, and things that are of importance in an organisation. Each fact is, by itself, relatively meaningless".

Explicit versus Implicit / Tacit Knowledge

The philosopher Michael Polanyi said: "We can know more than we can tell" (cited in Ahmed, Kok & Loh [25], p. 10). This leads to the distinction between explicit and implicit (also called 'tacit') knowledge.

Polanyi (cited in Ahmed *et al* ([25, p. 10)] defines 'explicit knowledge' as follows:

> "Explicit knowledge is that which is easily written down or codified. It is relatively easy to articulate and communicate, and is easier to transfer between individuals and organisations. Explicit knowledge resides in formulae, textbooks or technical documents".

Polanyi (cited in Ahmed *et al* ([25, p. 10)] defines 'implicit knowledge' as follows:

> "Implicit knowledge is that which is very difficult to describe or express. It is the knowledge which is usually transferred by demonstration, rather than description, and encompasses such things as skills".

Information

Whitten *et al* [12] (p. 27) define 'information' as follows:

> "Data that has been processed or reorganised into a more meaningful form for someone. Information is formed from combinations of data that hopefully have meaning to the recipient".

Intellectual Capital

Roos *et al* (cited in Bahra [26], p. 73) define 'intellectual capital' as:

> "…a language for thinking, talking and doing something about the drivers of companies' future earnings. Intellectual capital comprises relationships with customers and partners, innovation efforts, company infrastructure and the knowledge and skills of organisational members. As a concept, intellectual capital comes with a set of techniques that enable managers to manage better".

Knowledge

Davenport & Prusak [2] define 'knowledge' as follows:

> "Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organisations, it often becomes embedded not only in documents or repositories but also in organisational routines, processes, practices, and norms."

Whitten *et al* [12] (p. 27) define 'knowledge' as follows:

> "Data and information that is further refined based on the facts, truths, beliefs, judgments, experiences, and expertise of the recipient. Ideally information leads to wisdom".

Drucker (cited in Ahmed, Kok & Loh [25], p. 9) presents the following definition:

> "Knowledge is information that changes something or somebody, either by becoming grounds for actions, or by making an individual (or an institution) capable of different or more effective action".

Ahmed *et al* ([25], p. 9) add the following interpretation to the previous definition:

> "Knowledge starts off with an information base, but it is the intelligence added to that information that converts it into knowledge".

Knowledge Management

Ahmed *et al* ([25], p. 12) define 'knowledge management' as:

> "…the coming together of organisational processes, information processing technologies, organisational strategies and culture for the enhanced management and leverage of human knowledge and learning to the benefit of the company".

Barron (cited in Bahra [26], p. 72) provides the following definition:

> "Knowledge Management is an integrated, systematic approach to identifying, managing, and sharing all of an enterprise".

Masie (cited in Bahra [26], p. 66) defines ‘knowledge management’ as follows:

> “The systematic process of finding, selecting, organising, distilling and presenting information in a way that improves an employee’s comprehension in a specific area of interest. Knowledge management helps an organisation to gain insight and understanding from its won experience. Specific knowledge management activities help focus the organisation on acquiring, storing and utilising knowledge for such things as problem solving, dynamic learning, strategic planning and decision making. It also protects intellectual assets from decay, adds to firm intelligence and provides increased flexibility.”

Knowledge management focuses on:

> “…the ways in which firms facing highly turbulent environments can mobilise their knowledge base (or knowledge assets) in order to ensure continuous innovation in projects” (Scarbrough *et al,* cited in Bahra [26], p. 78).

Howard (cited in Abell and Exbrow [27], p. 36) provides the following perception on ‘knowledge management’:

> “The idea is not to create an encyclopaedia of everything that everyone knows, but to keep track of people who ‘know the recipe’, and nurture the technology and culture that will get them talking”.

Blair (p. 1023) distinguishes ‘knowledge management’ from ‘decision support systems’ and ‘expert systems’ as follows:

> “Decision Support Systems and Expert Systems attempt to improve human decision making (DSSs) or replace it entirely (ESs). But human decision making is a kind of expertise, it is the activity of knowledgeable individuals, and this expertise is not something that, in general, can be easily supplemented or replaced by computer technology, as DSSs and ESs tried to do. In contrast, Knowledge Management does not try to actively supplement or replace human expertise, it simply tries to encourage and facilitate it. For DSSs and ESs, the expert was external to the system, but for Knowledge Management, the expert is an essential part of the system.”

Tiwana ([28], p. 78) supports the previous definition by commenting:

> “A good KM system is not about capturing your smartest employee’s knowledge in a knowledge base or expert system. Even though that was the original intent of the artificial intelligence community, the possibility of that has now become a joke”.

Learning (vs Knowledge)

According to Kofman (cited in Ahmed *et al* ([25], p. 17)), 'knowledge' is not different from 'learning'. Kofman claims that learning is:

> "…the enhancement of or increase in knowledge, and knowledge is the capacity for effective action in a domain, where effectiveness is assessed by a community of fellow practitioners".

Learning - Adaptive and Generative

Argyris (cited in Malhotra [51], p. 2) distinguishes between two types of learning: 'adaptive learning' and 'generative learning'.

> Adaptive learning is used to solve problems in the present without evaluating the appropriateness of current learning and problem-solving behaviours. Adaptive organisations focus on their past record of successes and provide incremental improvements.
>
> Generative learning, in contrast, emphasizes continuous experimentation and feedback in evaluating the ways in which previous problems were solved.

Learning Organisation

Senge (cited in Abell and Oxbrow [27], p. 33) defines a 'learning organisation' as an organisation where:

> "…people continually expand their capacity to create results they truly desire, where new and expansive patterns of thinking are nurtured, where aspiration is set free, and where people are continually learning how to learn together".
>
> A learning organisation not only focuses on people and their development, but also on "culture and processes, and on communities and networks" (Abell and Oxbrow [27], p. 33).

Malhotra ([51], p. 2) defines a 'learning organization' as:

> "…an organisation with an ingrained philosophy for anticipating, reacting and responding to change, complexity and uncertainty".

Process

CMU/SEI ([38], p. 8) defines a 'process' as follows:

> "A process is a sequence of steps performed for a given purpose. More simply stated, a process is what you do. The process integrates people, tools, and procedures together. Process is what people do, using procedures, methods, tools, and equipment, to transform raw material (inputs) into a product (output) that is of value to customers".

Process Maturity [Software]

The first Capability Maturity Model (CMM), that was developed by the Software Engineering Institute, provided a framework for describing the key elements of an effective software process. Though the CMM concepts have been applied in various domains, the basic concepts underlying process maturity in the **software development** domain are also applicable to process maturity in other domains. One could thus apply the same concepts to KM processes. The original process maturity concepts are now quoted:

CMU/SEI ([38], p. 9) provides the following definition:

> "…describes the range of expected results that can be achieved by following a [software] process. The [software] process capability of an organisation provides one means of predicting the most likely outcomes to be expected from the next [software] project the organisation undertakes."
>
> Also:
>
> "…the extent to which a specific process is explicitly defined, managed, measured, controlled, and effective. Maturity implies a potential for growth in capability and indicates both the richness of an organisation's [software] process and the consistency with which it is applied in projects throughout the organisation."

Process Performance [Software]

CMU/SEI ([38], p. 9) provides the following definition:

> "…represents the actual results achieved by following a [software] process. Thus [software] process performance focuses on the results achieved, while [software] process capability focuses on results expected."