# Executing innovation projects using the collaborative nature of integrated knowledge networks

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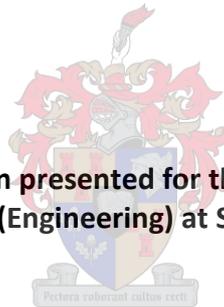
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Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

February 2010

Abstract

Innovation is important for competitiveness. It thrives on the availability of novel public and private domain knowledge. Thus the ability to access, analyze, synthesize, share, and re-use knowledge is paramount to enabling innovation within the different partners of the supply chain. These activities grow the available pool of knowledge. It also facilitates learning from mistakes, as well as capturing and enhancing opportunities for future innovation.

Proactively networking resources within a formal and informal structure improve the ability of any participating enterprise to use/re-use knowledge, in a concurrently growing knowledge base. Such a "Knowledge Network" (KN) enhances knowledge sharing between and among individuals, groups and organizations in informal and formal ways. This network is also scalable in the sense that more individuals and enterprise may join the network as success cases are reported on.

It is clear that knowing how to design, deploy and operate a Knowledge Network could be highly beneficial. How to successfully design and deploy a KN is a challenge and has been widely researched to a limited extent within in the past decade. The design, deploy and operate functions require understanding of social processes and how people learn and share knowledge. KN management requires a proactive, systematic approach to the planning and deployment of a formalized network for knowledge creation and transfer. It addresses promoting and improving conditions to cultivate informal and formal networking within a larger collaborative network of enterprises.

This dissertation presents a refined methodology for initiating, deploying, managing and operating an Innovation Project based on the available research reported in this domain. It incorporates concepts of generic, partial and specific roadmaps, best practices, templates and examples and allows individual teams to capture knowledge about specific projects and expertise in context for later re-use.

Opsomming

Om mededingend te kan wees, is innovasie belangrik. Laasgenoemde floreer op die beskikbaarheid van nuwe publieke, sowel as private domein kennis. Dus is die kundigheid om kennis te assesseer, te analiseer, saam te vat, uit te ruil met ander en dan weer te gebruik van die uiterste belang om innovasie moontlik te maak vir die onderskeie vennote in die voorsieningsketting. Hierdie genoemde aktiwiteite vergroot die beskikbare poel van kennis. Daarbenewens fasiliteer dit ook leer uit foute, sowel as die vasvang en versterking van geleenthede vir toekomstige innovasie.

Deur pro-aktief en vindingryk van netwerk bronne gebruik te maak, binne 'n formele sowel as informele struktuur, word die moontlikheid van enige deelnemende onderneming om kennis te gebruik of te hergebruik, vergroot in 'n gelyktydig groeiende kennisbasis. So 'n "Kennis Netwerk" (KN) versterk die uitruil van kennis tussen individue, groepe en organisasies op informele sowel as formele maniere. Hierdie netwerk is ook meetbaar in die sin dat hoe meer suksesse aangekondig word, deur individue en organisasies wat aansluit, hoe meer ondernemings wil aansluit.

Dit is duidelik dat kennis ten opsigte van die ontwerp, ontplooiing en bestuur van 'n Kennis Netwerk uiters voordelig kan wees. Dit is 'n uitdaging om 'n Kennis Netwerk suksesvol te ontwerp en te ontplooi en daar is die afgelope dekade op 'n wye front beperkte navorsing op hierdie terrein gedoen. Die ontwerp, ontplooiing en bestuursfunksies vereis 'n goeie begrip van sosiale prosesse met beklemtoning van hoe mense leer en kennis uitruil. Die bestuur van 'n Kennis Netwerk moet pro-aktief en sistematies benader word, ten opsigte van die beplanning en ontplooiing van 'n geformaliseerde netwerk vir die skep en oordrag van kennis. Die bevordering en verbetering van omstandighede kan formele sowel as informele netwerkbeoefening binne 'n groter samewerkende netwerk van ondernemings vestig.

Hierdie proefskrif bied 'n verfynde metodologie vir die inisiëring, ontplooiing en bestuur van 'n Innovasie Projek wat gebaseer is op die beskikbare navorsing wat in hierdie domein gerapporteer is. Dit behels konsepte van generiese, gedeeltelike en spesifieke padkaarte, asook die beste praktyke, patrone en voorbeelde en gee geleentheid vir individuele spanne om kennis ten opsigte van spesifieke projekte en kundigheid in konteks te bekom vir latere hergebruik.

Acknowledgements

"Make no little plans.
They have no magic to stir men's blood
and probably themselves will not be realized.
Make big plans…deep into the future.
Aim high in hope and work.
Have faith, remembering that a noble plan,
once recorded, will never die,
but long after we are gone will still be a living thing."
(Part of the De Villiers and Schonfeldt Credo)

Since I came across the above inspirational words many years ago, I have always kept them somewhere at the back of my mind.

When I started doing my research for this project, I could only hope that I would be able to make some contribution that would at least provide worthwhile material for future research to be done. In such a way it would then remain "a living thing."

But, I could never have done this without the valuable and most sincerely appreciated help of the following people:

- Niek – my promoter, who provided the necessary vision, guidance and support throughout the research project, and who never failed to surprise me with his insight.

- Eric Lutters, from the University of Twente, who visited, reviewed and commented on an early version of this document.

- Our Enterprise Engineering research group students, who worked on related domains, and provided inspiration through our own internal knowledge network.

- My colleagues at the Department of Industrial Engineering, who made, through different work allocations, time available for me to complete this.

- The Questionnaire Respondents, who were willing to spend valuable time with me to review and respond to the survey questionnaire.

- Jakkie, my mother, for refreshing her English schoolteacher skills to read and review the language.

- Jakkie, Rene, Anthony, Johan, Welma and the other members of my family, who supported me all along, from bringing me a welcome cup of coffee, to providing the continual motivation to complete this.

And what have I come to realize? That it is, above all other things, the ability to put in never-ending effort that will lead you to the realization of your goal. Intelligence plays a minor role, in fact, so do all other factors.

With appreciation and thanks.

Corne Schutte
(December 2009)

Table of Contents

List of Figures

List of Tables

Glossary

ASGISA	Accelerated Shared Growth Initiative – South Africa
BSC	Balanced Scorecard
CBPR	Community Based Participatory Research
CIDB	Construction Industry Development Board
CIRP	Collège International pour la Recherche en Productique (The International Academy for Production Engineering)
CoP	Community of Practice
DBSA	Development Bank of Southern Africa
EE	Enterprise Engineering
EMIRAcle	European Manufacturing and Innovation Research Association
GA	General Assembly
GCC	Global Competitiveness Centre
HRM	Human Resource Management
ICMM	Innovation Capability Maturity Model
ICT	Information and communication technologies
IDIP	Infrastructure Delivery Improvement Programme
IKN	Integrated Knowledge Network
IKNM	Integrated Knowledge Network Methodology
IPR	Intellectual Property Rights
JV	Joint Venture
KN	Knowledge Network
KPI	Key Performance Indicator
MIT	Massachusetts Institute of Technology
NoE	Network of Excellence
PGDS	Provincial Growth and Development Strategies
PIM	Personal Information Management
PSTN	Public Switched Telephone Network
R&D	Research and Development
STC	Scientific Technical Committee
VOIP	Voice over IP
VRL-KCiP	Virtual Research Lab for a Knowledge Community in Production
WG	Working Group

Chapter 1: Introduction

A significant portion of primary sources of the competitive advantage of an enterprise increasingly comes from outside the enterprise itself. Studies confirm that, in the case of innovation-driven industries, the acquisition and maintenance of enterprise-specific technological capabilities rely on extensive contacts with external expertise in both local and foreign economies. Technological innovation is especially characterized by the acquisition of tacit knowledge through local industry dynamics i.e. networks and clusters [5].

Although knowledge is increasingly recognized by modern enterprises as the most important source of lasting competitive advantage, the key to obtaining long-term competitive advantage is not obtained by only administering existing knowledge. It is based on the ability to constantly generate new knowledge, and to rapidly move on to new products and services (Von Krogh and Venzin [100]).

This document introduces the concept of Integrated Knowledge Networks (IKN). It shows how the successful deployment of an Integrated Knowledge Network can enhance the knowledge creation process so as to improve the innovation process.

Chapter 1 discusses related research, the research method, and a section on the structure of this report, and how to navigate the document (see Figure 1-1).
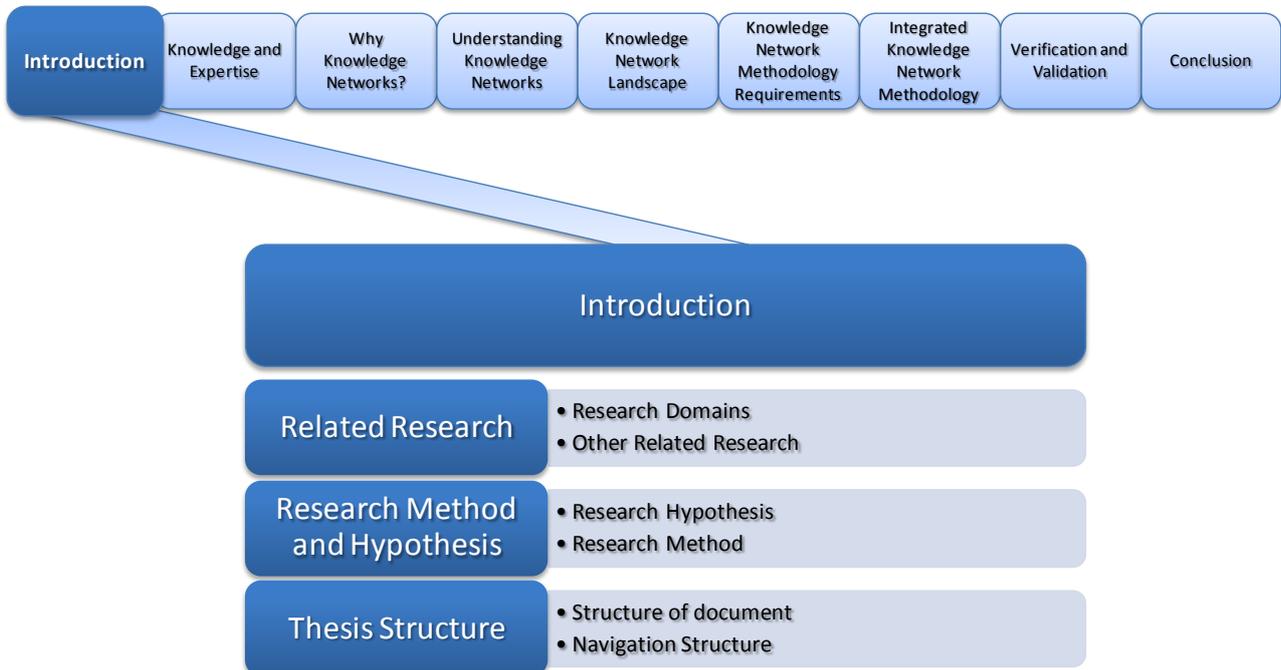
Figure 1-1: Chapter Structure

1.1 Research Domains and Related Research

This research was performed in collaboration with the Enterprise Engineering research group, Department of Industrial Engineering, at the University of Stellenbosch. Research in the group focuses on two domains:

- Innovation Management and Innovation Methodologies.

- Knowledge Creation and Knowledge Networking with the aim of supporting the innovation process.

In this research, the following domains contribute to a better understanding of the Innovation and Knowledge Network environments:

- Collaboration, virtual teams, and the promoters as well as inhibitors for collaboration

- The knowledge creation process

- How knowledge networking improves collaboration

- Innovation, and its (inter)dependence on knowledge

- Innovation project methodologies
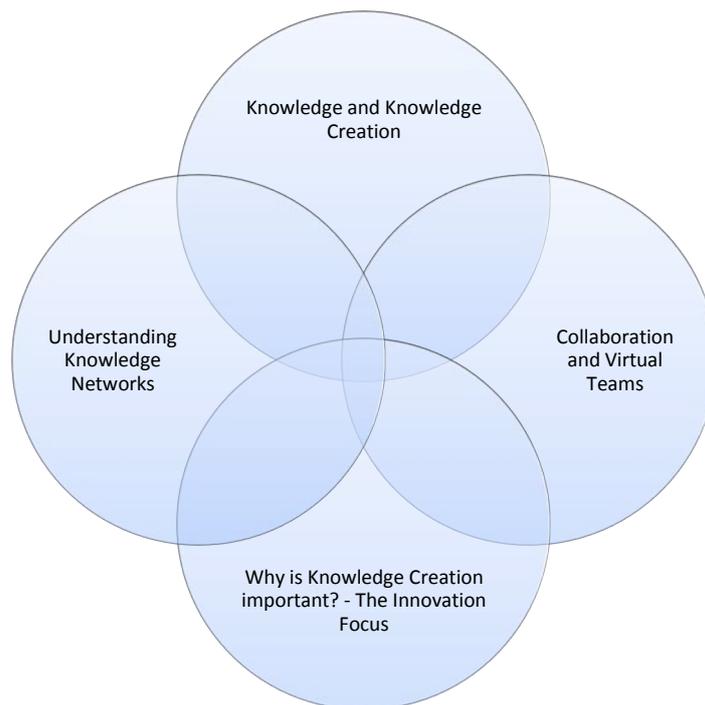
Figure 1-2: The Research Domains to understand Knowledge Networks

Existing research covers each of these domains with significant overlap. However, as will be illustrated in this document, each domain individually and collectively impacts on the success of innovation projects, and it is believed that a common framework that integrates these concepts into a single methodology will significantly improve the success of innovation projects.

1.2 Research Method and Hypothesis

If we knew what it was we were doing,
it would not be called research, would it?
-Albert Einstein

The Research Hypothesis for the study is defined as follows:

Integrated Knowledge Networks (IKN) have a positive (significant) impact on the rate at which innovation is deployed.

Utilizing an IKN requires an understanding of designing, deploying, operating and refining, and eventually phasing-out of an IKN.

The research method for this study is illustrated in Figure 1-3 and consists of the following phases:

- **Establishing the Current State of the Art**: It is important to identify the current state of the art thinking in the research community. The literature study documented in this report covers just a small portion of the extensive research being performed in this arena. The state of the art includes the following:

  1. Understanding the Research Domains.

  2. Identifying and researching existing methodologies relating to the research domains.

  3. Reviewing existing case studies.

  4. Highlighting research progress by researchers to position the coordinates of the leading edge.

  5. Highlighting gaps that were identified by other researchers.

Determine State of the Art – General Purpose

Identify Opportunities

Develop Framework and Methodology

Verify and Evaluate (Case Studies)

Research Conclusions
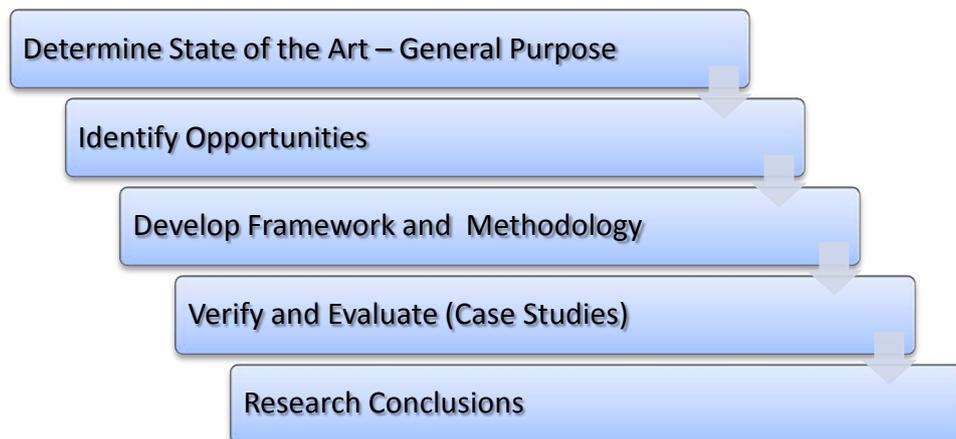
Figure 1-3: The Research Method

- **Identifying opportunities**: Once the current state of the art is fully understood, one can then identify the gaps and thereby identify opportunities to improve the management processes for improving the innovation process.

  1. Identifying existing methodologies being proposed in research and/or used in practice.

  2. Interpreting the gaps in these methodologies.

3. Identifying problems being experienced in practice.

4. Deriving and Documenting Requirements

- **Developing a Framework and Methodology**: Once existing methodologies are understood and the problems within these methodologies are identified, a new adapted framework can then be developed and constructed.

   1. Proposing good practices for managing innovation projects with virtual teams in integrated knowledge networks

   2. Structuring these practices in a generic framework that can be re-used on similar projects. Using a CASE tool to document the framework and methodology.

- **Evaluating and Validating**: In order to evaluate the validity and applicability of the proposed framework and methodology, it is necessary to verify it against the requirements identified, and to test it in practice with selected case studies.

- **Research Conclusions:** Based on the outcome of the verification and case studies, it is then possible to conclude the research by discussing how the hypothesis has been addressed, what contributions have been realised, and the potential for future work.

1.3   The Document Structure

This report firstly describes the main components of a knowledge network and defines the knowledge network landscape. Requirements for a methodology for deploying and operating a knowledge network are then discussed and specified, followed by its application in several networks analyzed in a case study. The structure of the document is depicted in Figure 1-6 on page 5, and is a derivative of the Research Method described in par 1.2.

To facilitate navigation of the main body of the document, the structure in Figure 1-6 has been simplified (see Figure 1-4 below) and, to aid in the navigation of this document, it is also depicted in the main document's header area, with the relevant (current) chapter indicated in dark blue and inverse text. (See the header at the top of this page for an example.)

Figure 1-4: The Navigation Structure of the Document

In addition, at the beginning of each chapter, the contents and purpose of the chapter is put into context, using the Navigation Structure and breaking it down into lower levels for the specific chapter. The chapters are also augmented by the following appendices:
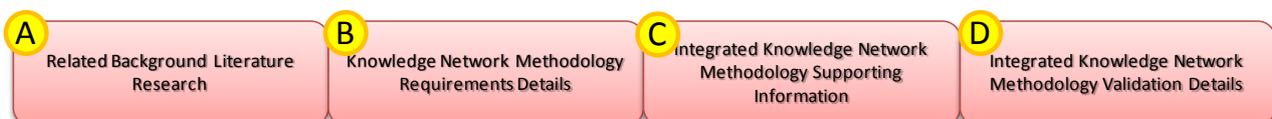
Figure 1-5: The Navigation Structure of the Appendices

Introduction

- Research Domains and Related Research
- Research Method and Hypothesis
- Document Structure

Knowledge and Expertise – A Valuable Asset

- Defining Knowledge
- How to Manage Knowledge
- The Knowledge Generation Process and Knowledge Work Processes
- Organizational Learning and Knowledge Based Network Organization

Why Knowledge Networks? The Innovation Focus

- Knowledge Network Purpose
- Focus on Innovation
- Innovation as a Process
- Innovation Project Landscape
- The Case for Integrated Knowledge Networks

Understanding Knowledge Networks

- Defining Networks and Knowledge Networks
- The Inter-organizational Knowledge Network Requirement
- Seufert Framework for KN, KN Reference Types and KN Life Cycles
- Challenges, Facilitating Conditions, and KN Measurement
- KN Functional Requirements

The Knowledge Network Landscape

- Knowledge Network Variants derived from Purpose
- Innovation focused Knowledge Networks
- Characteristics of each Knowledge Network Variation
- Knowledge Netork Variant support of the Innovation Life Cycle
- Integrated Knowledge Networks a Generic KN?

Knowledge Network Methodology Requirements

- Purpose of Knowledge Networks
- Functional Requirements
- Control Requirements
- Requirement Framework Summary
- Methodology Origins

Integrated Knowledge Network Methodology

- The Integrated Knowledge Network Methodology
- A Generic Knowledge Network Framework

Verification and Validation

- Verifying the Integrated Knowledge Network Methodology
- Validation
  - Questionnaire Structure
  - Networks Analyzed
  - Analysis

Conclusions

- Research Method and Conclusions
- Future Work
- Concluding Remarks

Figure 1-6: The Framework of the Document

Chapter 2: Knowledge and Expertise – A Valuable Asset

It is a widely accepted fact that the knowledge and expertise of employees is the main asset of knowledge-based organizations.

Most large enterprises only capture and act on (exploit) a fraction of the knowledge accessible to their organization. This knowledge is very often hidden within dozens of databases, reports and information systems. Knowledge also resides in knowledge workers' heads, and is lost to the organization when they leave the organization. Knowledge management and work covers a range of strategies, tools and processes that endeavour to capture this valuable knowledge, to deliver it to other people who can benefit from it, and to ensure that information can be acted on swiftly to the advantage of the organization [4].

Expertise specifies an organization's distinctive capabilities and core competencies aggregately associated with individuals in the organization (Holloway [43]; Olson and Shaffer [69]). A good way to exploit this asset is by enhancing communication between and among employees in order for them to share knowledge and expertise.

This chapter focuses on understanding knowledge, the knowledge generation process, and how knowledge is used in the organizational context (knowledge work).

Figure 2-1: The Structure of Chapter 2 within the Context of the Overall Navigation Structure

2.1 Defining Knowledge

"To know that we know what we know,
and to know that we do not know what we do not know,
that is true knowledge."
- Nicolaus Copernicus

The definition of knowledge is a matter of on-going debate among philosophers in the field of epistemology[1]. Plato's classical definition of knowledge has it that in order for a statement to be considered as knowledge, at least three criteria must be fulfilled: a statement must be **justified**, **true**, and **believed**. [6]

Much of the debate in this field has focused on analyzing the nature of knowledge and how it relates to similar notions such as truth, belief, and justification. It also deals with the means of production of knowledge, as well as scepticism about different knowledge claims. In other words, epistemology primarily addresses the following questions: "What is knowledge?," "How is knowledge acquired?," "What do people know?," "How do we know what we know?"

According to Plato in the Theaetetus dialogue, knowledge is a subset of that which is both true and believed. (See Figure 2-2)
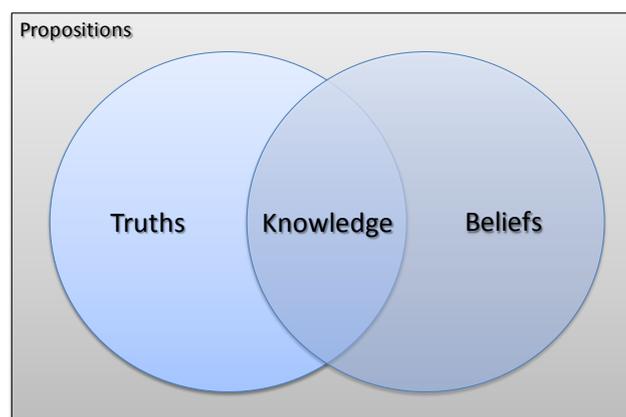
Figure 2-2: Knowledge is a Substitute of Truths and Beliefs

The Oxford English Dictionary defines Knowledge as:

- *expertise, and skills acquired by a person through experience or education;*
- *the theoretical or practical understanding of a subject;*
- *what is known in a particular field or in total;*
- *facts and information; or*
- *awareness or familiarity gained by experience of a fact or situation.*

---

[1] Epistemology (from Greek ἐπιστήμη - episteme, "knowledge" + λόγος, "logos") or theory of knowledge is a branch of philosophy concerned with the nature and scope of knowledge. The term was introduced into English by the Scottish philosopher James Frederick Ferrier (1808-1864).

However, Nonaka, et al. [65] argued that the definition of knowledge as "justified true belief" as per the traditional Western epistemology, is an absolute, static, and nonhuman view of knowledge and fails to address the relative, dynamic, and humanistic dimensions of knowledge.

Nonaka therefore defines knowledge as:

> *Knowledge is a dynamic human process of justifying personal belief toward the "truth".*

Knowledge is therefore:

- context-specific and relational.

- dynamic, as it is dynamically created in social interactions.

- also humanistic, and it has both an active and a subjective nature.

Nonaka's definition forms the base of the knowledge generation theories discussed in this document.

2.2   Managing the Knowledge Asset

"Knowledge is power."
- Francis Bacon

As described by Bornemann, et al. [16], Knowledge Management is the coordination of knowledge and the management of the organizational environment to support individual knowledge transfer and the subsequent creation and preservation of collective knowledge. Knowledge management is therefore not the management of "knowledge" itself, but rather the management of the organization with a particular focus on "knowledge".

A simplification of this process is to differentiate between the following two fundamental levels:

- the **data level** and

- the **knowledge level**.

This is based on the traditional differentiation between knowledge on the one hand and data and stimuli on the other.

There are three main aspects to knowledge:

- **Individual Knowledge**: the sum of an individual's capabilities and experience determines the possible actions open to an individual and, consequently, the contributions they are able to make to a particular project or task.

- **Action**: includes both physical and mental actions (e.g. problem solving), and

- **Data**: resulting from the actions. This includes both internal data (e.g. from other projects) and external data sources such as libraries or online databases.

These aspects form the operational layers in the knowledge management model depicted in Figure 2-3:

- **Knowledge level**: The knowledge level is made up of the knowledge of the individual members of the organization and their interaction with each other.

- **Data level**: The data level consists of all available documented knowledge (e.g. in databases or as printed documents).

- **Action level**: The knowledge and data levels provide input for the action level. This is where business processes are enacted and represents the organization's value creating processes.
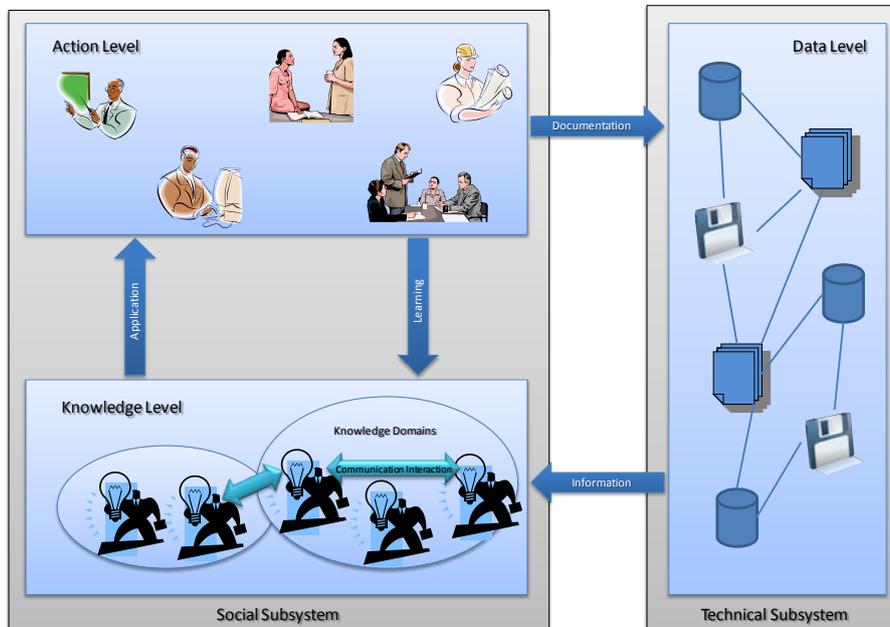
Figure 2-3: Basic Model of Knowledge Management

- Adapted from Bornemann, et al. [16]

These three levels are linked with the five core knowledge processes (information, documentation, communication, application and learning) to form a basic model of knowledge management.

2.3   Types of Knowledge

"The only true wisdom is in knowing you know nothing."
- Socrates

Michael Polanyi made a significant contribution to understanding knowledge. Central to Michael Polanyi's thinking was the belief that creative acts (especially acts of discovery) are charged with strong personal feelings and commitments (hence the title of his most famous work *Personal Knowledge*) (Polanyi [75]). He argued that the informed guesses, hunches and imaginings that are part of exploratory acts are motivated by what he describes as 'passions'. They might well be aimed at discovering 'truth', but they are not necessarily in a form that can be stated in propositional or formal terms. As Michael Polanyi [74] wrote in The Tacit Dimension, we should start from the fact that 'we can know more than we can tell'. He termed this pre-logical phase of knowing as 'tacit knowledge'.

A key distinction in categorizing knowledge, is Nonaka's reformulation of Polanyi's distinction between tacit and explicit knowledge (Nonaka and Takeuchi [66], Nonaka, et al. [65]). (See Figure 2-4)
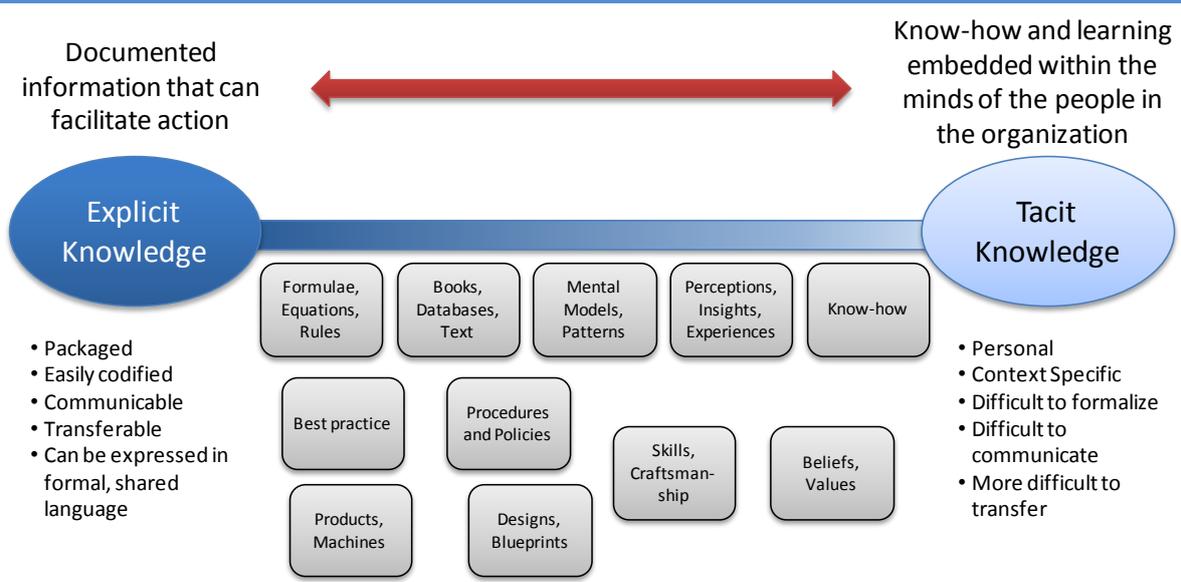
Figure 2-4: Explicit and Tacit Knowledge Landscape

- Adapted from Sobhi [91]

Explicit knowledge is knowledge that the individual holds explicitly and consciously in mental focus, and may communicate to others. Explicit knowledge can be expressed in words and numbers and shared in the form of data, scientific formulae, specifications, manuals, and the like. This kind of knowledge can be readily transmitted across individuals formally and systematically.

Tacit knowledge, on the other hand, is highly personal and hard to formalize, making it difficult to communicate or share with others. It is often subconscious, internalized, and the individual may or may not be aware of what he or she knows and how he or she accomplishes particular results. Subjective insights, intuitions, and hunches fall into this category of knowledge. Difficult to verbalize, such tacit knowledge is deeply rooted in an individual's action and experience, as well as in the ideals, values, or emotions he or she embraces.

In the popular form of the distinction, tacit knowledge is what is in our heads, and explicit knowledge is what we have codified.

Newman and Conrad [61] made a further distinction by defining **three** different types of knowledge:

- **Explicit Knowledge**: This consists of knowledge artefacts that have been articulated in such a way that they can be directly and completely transferred from one person to another. This normally means that they have been codified so it is possible to touch, see, hear, feel and manipulate them (e.g. books, reports, data files, newsreels, audio cassettes and other physical forms).

- **Implicit Knowledge**: This consists of knowledge artefacts whose meaning is not explicitly captured, but can be inferred; in effect, the codification process is incomplete. Explicit artefacts can be interpreted totally on their content. Interpreters of implicit artefacts must rely on previously retained knowledge.

- **Tacit Knowledge**: This may be the most insidious and powerful of the three. As discussed before, Michael Polanyi referred to tacit knowledge as "knowing more than we can say".

Simply stated, tacit artefacts are those that defy expression and codification. Tacit knowledge can be conceptualized as possessing a technical and a cognitive dimension:

- The technical dimension contains informal, personal abilities and skills, often designated as "know-how"

- The cognitive dimension includes our mental model influenced by our beliefs, values and convictions

(For the purpose of this research, the "Implicit Knowledge" categorization is not specifically addressed.)

The above categorization is sometimes referred to as the **articulability** of the knowledge.

Knowledge can also be categorized in two additional dimensions: Bornemann, et al. [16]

- **Knowledge psychology** differentiates between **declarative** and **procedural** knowledge. Whilst declarative knowledge refers to facts (issues, processes, etc.) and objects (persons, things, etc.), procedural knowledge concerns the way cognitive processes and actions are performed. Declarative knowledge is also described as knowledge of something (knowing), or "know what". Procedural knowledge is also described as process knowledge, or "know-how".

- A categorization according to **knowledge holder** differentiates between **individual** and **collective** knowledge. Individual knowledge is knowledge held by one person. It is not dependent on a specific context and is controlled by the individual concerned. Collective knowledge is knowledge that is relevant in a specific environment. It can include individual knowledge that only reaches its full potential when combined with that of others. It can also include knowledge shared by everyone, i.e. knowledge common to all members of a collective.

The three different dimensions of knowledge categorization are depicted in the figure below. (Bornemann, et al. [16])
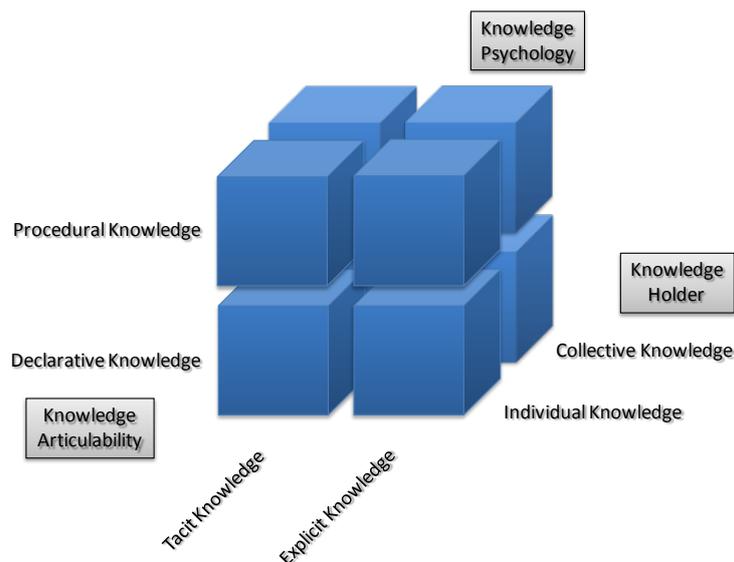
Figure 2-5: Knowledge Categorization Framework

2.4   The Knowledge Generation Process

"The only source of knowledge is experience."
-Albert Einstein

In his book: A New Leadership Ethos: The Ability to Predict, Marc Van Der Erve [98] wrote:

> *People construct an image of their world starting with the things they know. In other words, when exploring the world around us, we search for things that we are familiar with in our 'mental backyard.' By comparing what we find with what we know, a notion of differences and similarities in the world around us emerges. These differences and similarities effectively serve as our model of interpretation. When we have reached that point, our mind is ready for things that we don't know. A haphazard process of discovery unfolds in which the brain first identifies and then fills in the gaps.*

The key to obtaining long-term competitive advantage lies in our ability to continuously generate new knowledge and to move on to new products and services (Von Krogh and Venzin [100]).

Rather than viewing enterprises as devices for processing information, making decisions, and solving problems, one should realize that their success is increasingly based on knowledge-seeking and knowledge-creation. (Seufert, et al. [89])

Knowledge is often viewed as an objective commodity which is transferable independently of person and context. On this basis people often try to solve problems by improving the information flow using modern technologies. The potential of innovative technologies for the capturing and distribution of explicit knowledge is undisputed. Re-use of this explicit knowledge is an important aspect of knowledge management, but researchers argue that there is currently an over-emphasis on knowledge exploitation (Nonaka and Takeuchi [66]; Swan, et al. [93]).

However, tacit knowledge is difficult to exploit due to its close dependence on the knower and the context where it was created (Kogut and Zander [49]; Orlikowski [70]). Since tacit knowledge is deeply rooted in personal experiences, subjective insights, values and feelings, it can hardly be completely communicated and shared. Tacit knowledge possesses a technical as well as a cognitive dimension. Whereas the technical dimension contains informal, personal abilities and skills, often designated as "know-how", the cognitive dimension includes our mental model influenced by our beliefs, values and convictions (Nonaka and Takeuchi [66]). When knowledge is transferred it is suggested that knowledge has to be internalized by the receiving individual firstly before it can be used. However, what is required is an integrated approach which includes both explicit and tacit knowledge.

This process is described by the SECI model (see Figure 2-6), which describes the processes of socialization, externalization, combination, and internalization as four conversion modes from implicit to explicit knowledge (Nonaka and Takeuchi [66]):

- **Socialization** comprises the exchange of tacit knowledge between individuals in order to convey personal knowledge and experience. The term "socialization" is used to emphasize the importance of joint activities in the process of converting new tacit knowledge through shared experiences. Since tacit knowledge is context specific and difficult to formalize, transferring tacit knowledge requires sharing the same experience through joint activities. In practice, socialization involves capturing knowledge through physical proximity. Knowledge is acquired

from outside the organization through direct interactions with suppliers and customers. Capturing tacit knowledge embedded within the organization by walking around inside the organization is another process of acquiring knowledge.

- **Externalization** describes transformation processes. This means the conversion of tacit into explicit knowledge, and the exchange of knowledge between individuals and a group. Through externalization, the process of articulating tacit knowledge into explicit knowledge, knowledge becomes crystallized, thus able to be shared by others, and becomes the basis of new knowledge. Through externalization, tacit knowledge is expressed and translated into such forms as metaphors, concepts, hypotheses, diagrams, models, or **prototypes** so that it can be understood by others. Yet, expressions are often inadequate, inconsistent, and insufficient. Such discrepancies and gaps between images and expressions can help promote "reflection" and interaction between individuals.
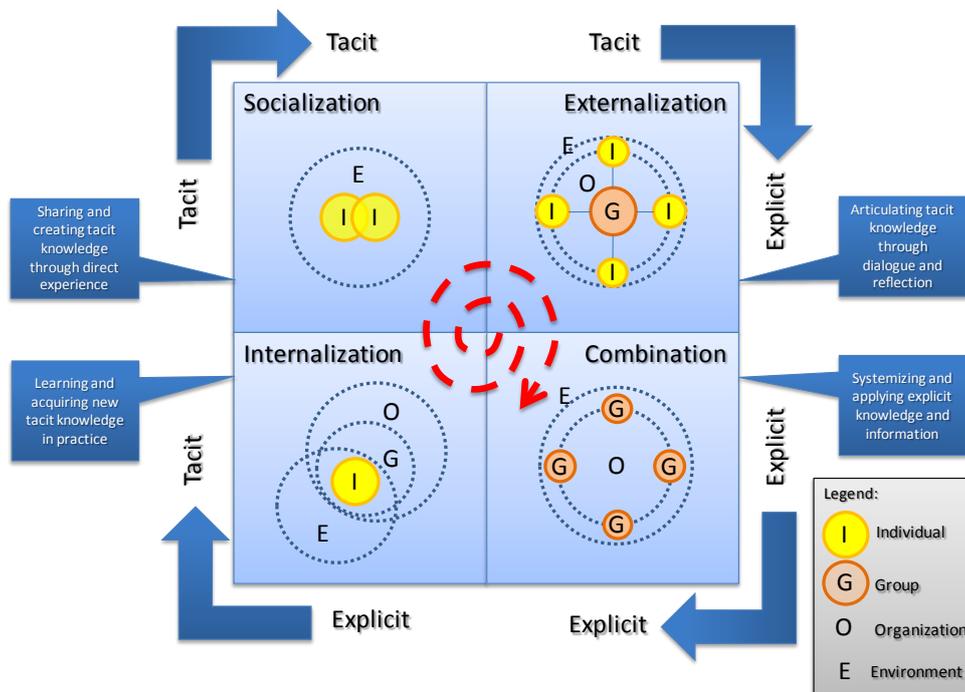
Figure 2-6: Organizational Knowledge Creation SECI Model

- Adapted from Nonaka, et al. [65]

- **Combination**: The transformation of explicit knowledge into more complex and more systematized explicit knowledge represents the stage combination. In combination, the process of converging explicit knowledge into more complex and systematic explicit knowledge, knowledge is exchanged and combined through such media as documents, meetings, telephone conversations, or computerized communication networks. Reconfiguration of existing knowledge through sorting, adding, combining, and categorizing can create new knowledge. In this mode, communication, diffusion, and systemization of **knowledge** are the keys. Combination can also include the "breakdown" of concepts. Breaking down a concept, such as a corporate vision, into operationalized business or product concepts also creates systemic, explicit knowledge. In the combination process justification of knowledge takes place so as to form the basis for agreement and allows an organization to take practical concrete steps. (Nonaka later renamed this stage systematization.)

- **Internalization** is the conversion of organization-wide, explicit knowledge into the tacit knowledge of the individual. This requires that the individual should be able to recognize personally relevant **knowledge** within the organization. Internalization, the process of embodying explicit knowledge into tacit knowledge, is closely related to "learning by doing." Through internalization, knowledge that has been created is shared throughout an organization. Internalized knowledge is used to broaden, extend, and reframe organizational members' tacit knowledge. When knowledge is internalized into individuals' tacit knowledge bases in the form of shared mental models or technical knowhow, it becomes valuable assets. This tacit knowledge accumulated at the individual level is in turn shared with others through socialization, setting off a new spiral of knowledge creation.
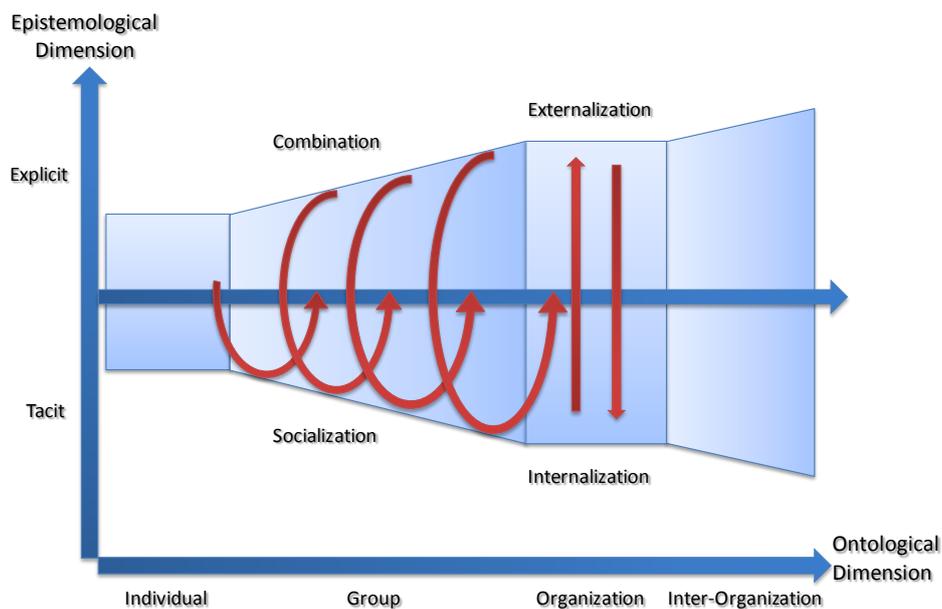
Figure 2-7: The Knowledge Network Spiral

- Nonaka and Takeuchi [66]

The Knowledge Network Spiral in Figure 2-7, illustrates how new knowledge is created in all of the 4 SECI exchange processes. (Back, et al. [14], Nonaka and Takeuchi [66])

2.5   Transferring and Sharing Knowledge

Knowledge transfer is the process of linking knowledge requirements and available knowledge. (Bornemann, et al. [16]). Knowledge transfer seeks to organize, create, capture or distribute knowledge and ensure its availability for future users. It is considered to be more than just a communication problem. If it were merely that, then a memorandum, an e-mail or a meeting would accomplish the knowledge transfer. Knowledge transfer is more complex because:

- knowledge resides in organizational members, tools, tasks, and

- much knowledge in organizations is tacit or hard to articulate (Nonaka and Takeuchi [66]).

Knowledge transfer can occur either via human networks or via information and communication tools (Figure 2-8) as illustrated in the Basic Model of Knowledge Management (see Figure 2-3).
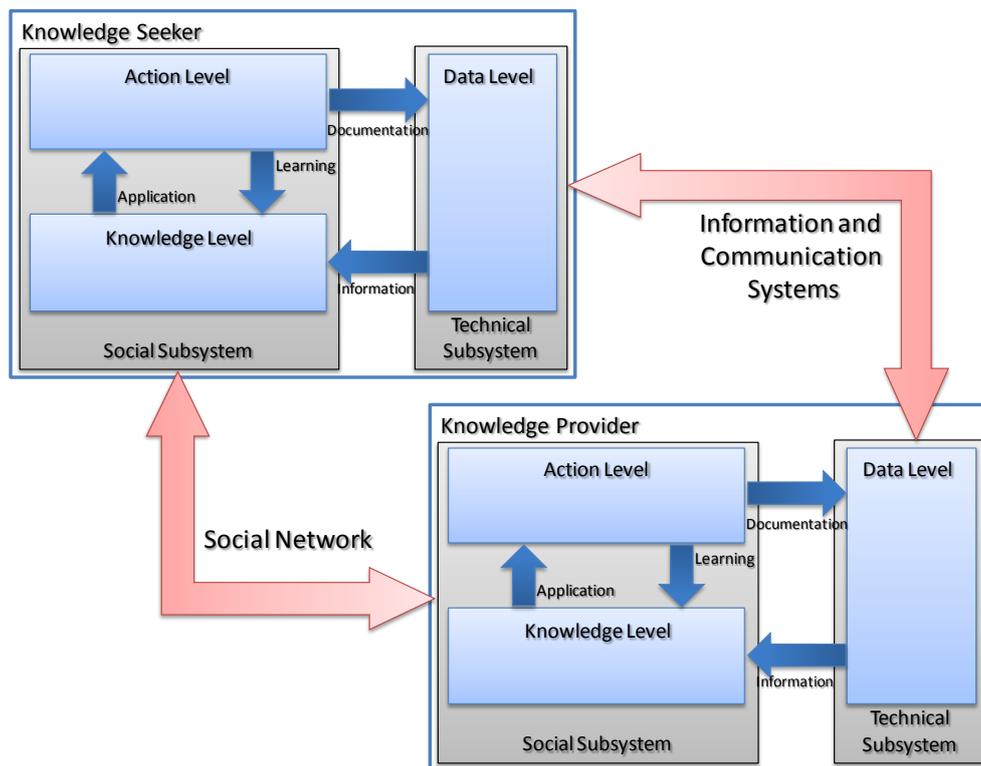
Figure 2-8: Knowledge Transfer between Knowledge Seekers and Providers

- Bornemann, et al. [16]

To enable effective knowledge transfer via human networks, knowledge seekers and providers must have access to suitable communication methods (e.g. meetings, coaching sessions). Face-to-face communication is the most valuable and, at the same time, most time consuming form of knowledge transfer and is most suitable for complex issues (e.g. clarification of R&D problems).

Knowledge is transferred via information and communication networks when a knowledge seeker accesses relevant stored data and turns this into knowledge. This requires prior knowledge of a particular knowledge domain (context). Special mention should also be given to knowledge transfer via telecommunication tools which enable communication across geographical boundaries. The possibilities now offered by video conferencing tools are very similar to those offered by face-to-face communication.

The context and background available to the knowledge seeker plays a key role in the selection of the appropriate form of knowledge transfer. Face-to-face communication provides knowledge seekers with the added benefit of being able to increase their contextual knowledge, whereas for information- and documentation-based knowledge transfer, they must already have the relevant contextual knowledge.

It is, however, not possible to transfer experience through communication and/or documentation and information processes – nothing more can be transferred than a description of what was experienced and any insights gained. Experiential knowledge can only be created through the process of experiential learning and not through transfer processes.

> *"We studied a particularly successful program of the World Bank Group's International Finance Corporation called SmartLessons. Started in 2005 in response to a push from managers in the field, the voluntary program teaches employees how to deliver information through human stories that people can connect with. It offers a simple guide for writing narratives to post online, as well as the services of an editor, who ensures that the articles and multimedia presentations posted on the SmartLessons site really are in story form. We found that storytelling dramatically increased IFC employees' ability to absorb information." (Morris and Oldroyd [59])*

The transfer of experience is a special form of knowledge transfer and, as part of a corporate knowledge management strategy, has two basic aims:

- Firstly, the transfer of experience should provide individual employees with a broader spectrum of decision-making options and possible courses of action in business situations. This avoids unnecessary effort and repeated learning through "trial and error".

- Secondly, the transfer of experience supports individual and organizational learning processes and helps to build up individual expertise and develop the company's capacity to learn.

Two basic strategies play a role in the transfer of experience:

- A codification strategy attempts to document the parts of experiential knowledge that can be made explicit (i.e. can be written down), thus detaching it from the individual employee and making it available to others in a codified form (Figure 2-9). Other employees who encounter similar situations can refer to and apply these documented learning experiences (e.g. Lessons Learnt Reports) whenever appropriate without direct contact with the expert.
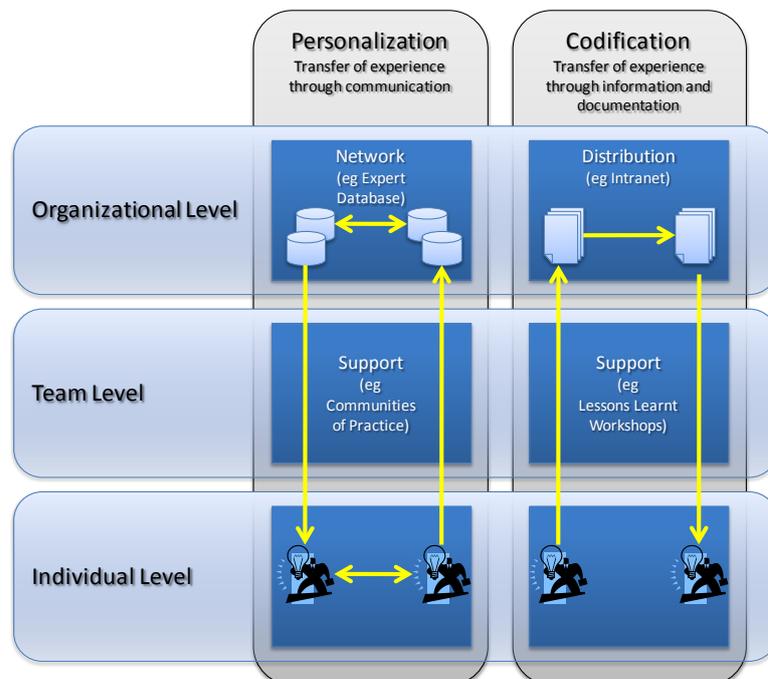
Figure 2-9: Transfer of Experience

- Adapted from Bornemann, et al. [16]

- A personalization strategy, on the other hand, focuses on transferring experience through direct contact (Figure 2-9). The intention here is to encourage additional tacit knowledge transfer through processes of communication and mutual observation. To ensure that these contacts occur systematically, and are not just left to chance, a company must know what expertise its employees have. E-mails, project documents, minutes, reports, interviews, etc. contain good indications of what could be included in expert profiles.

The three levels indicated in Figure 2-9 serve as the basis for the analysis, design and development of the transfer of experience in a company. Transfer of experience will always begin and end at the individual level. In codification strategies, the organizational level represents the repository and distribution source for documented learning experiences, whereas in personalization strategies it provides the necessary tools (e.g. expert profiles) for identifying colleagues and/or experts with the experience sought. The team level not only delivers the required context for the transfer of experience (e.g. projects), it also acts as an important link between the individual and organizational levels (e.g. Communities of Practice or Lessons Learnt Workshops).

2.6   Knowledge Work Processes

"This life is a process of learning."
- Lauryn Hill

Knowledge flows involve the events, activities and processes that transform knowledge from one state to another. The "*General Knowledge Model*" of Newman and Conrad [61] organizes knowledge into five main activity areas namely: knowledge creation, retention, transfer, utilization and exploitation.

- **Knowledge Creation**. This comprises activities associated with the entry of new knowledge into the system, and includes knowledge development, discovery and capture.

- **Knowledge Retention**. This includes all activities that preserve knowledge and allow it to remain in the system once introduced. It also includes those activities that maintain the viability of knowledge within the system.

- **Knowledge Transfer**. This refers to activities associated with the flow of knowledge from one party to another. This includes communication, translation, conversion, filtering and rendering.

- **Knowledge Utilization**. This includes the activities and events connected with the application of knowledge to business processes.

The model illustrates the activity areas in predictable sequences, but in reality comprises of complex sets of processes. The model provides associations between general activity areas and very dynamic behaviours and processes. Individual knowledge flows can be traced from the model, because the model helps to understand how specific actions and decisions are enabled by knowledge.
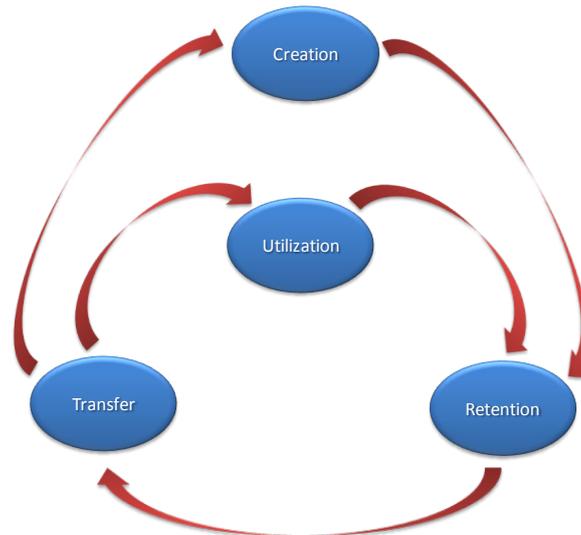
Figure 2-10: The General Knowledge Model

- Adapted from Newman and Conrad [61]

Each activity part consists of other smaller knowledge flows and sequences. All these smaller flows are layers which include a wide range of macro- and micro behaviours, including all the principal layers: tasks, workflows, activities, interfaces, systems and transformations.

In Back, Von Krogh, Seufert, and Enkel's framework they categorized knowledge work processes as follows:

- **locating** and **capturing** knowledge,

- **transferring** and **sharing** knowledge, and

- knowledge **creation**.

The main focus for all categories is the **application** of existing or newly gained knowledge to create value. As knowledge should not be managed per se, but needs also to be tightly connected to business drivers, the application of knowledge is at the centre of all knowledge management activities.
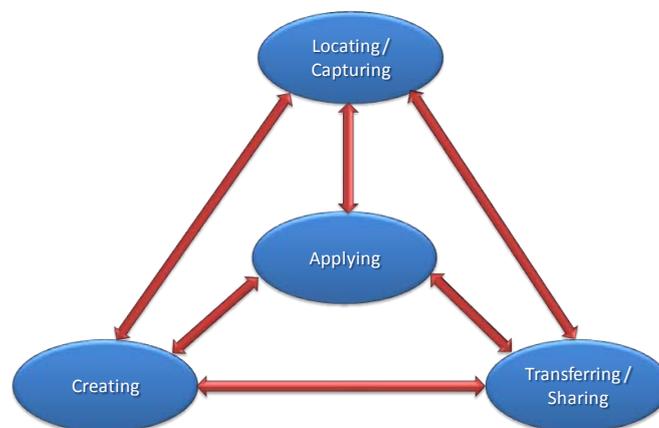
Figure 2-11: Knowledge Work Processes

- Back, et al. [14]

For example, most companies start with focusing on the knowledge they have and on the content of this knowledge. In this phase, knowledge management is mostly about locating and capturing knowledge.
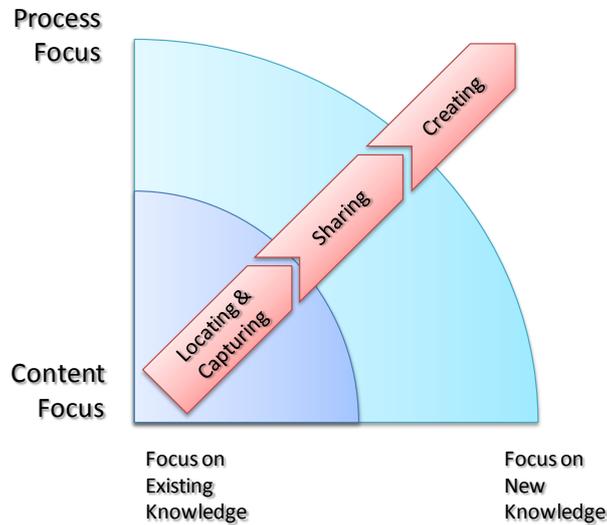
Figure 2-12: Evolution of Knowledge Work Processes

- Back, et al. [14]

Over time, companies start to focus more on new processes that enable them to share knowledge across units and to create completely new knowledge assets. (See Figure 2-12: Evolution of Knowledge Work Processes.) This phase is the knowledge transfer phase. Finally, the most ambitious and challenging phase, knowledge creation takes place. Some scholars predict that within ten years knowledge creation will be the key factor distinguishing successful companies from less successful ones.

2.7   From Individual to Organizational Learning

Peter Senge [88] defined a process of "Team Learning" as follows:

> *Team Learning is the process of aligning and developing the capacity of a team to create the results its members truly desire. It builds on the discipline of developing shared vision. It also builds on personal mastery, for talented teams to be made up of talented individuals. But shared vision and talent are not enough.*

Senge continues to explain that team learning has three critical dimensions:

- The need to think with insight about complex issues – to tap the potential of many minds to be more intelligent than one mind.

- The need for innovative and coordinated action – good teams normally develop a relationship of "operational trust" where each team member remains conscious of other team members and can be counted on to act in ways that complement each other.

- The influence of team members on other teams – a learning team continually fosters other learning teams through inculcating the practices and skills of team learning more broadly.

The Center for Collective Intelligence at MIT [10] lists a number of factors that affect Collective Intelligence: Diversity, Formal and Informal Structure, Modularization of Tasks, Density of the Communication Structure, Incentive for Contribution, Shared Vocabulary, Awareness, and the Powers of "Edge" and "Eco Systems".

A learning model for humans (Figure 2-13) shows the learning process as a four-phase cycle, with different types of knowledge created in each phase. This new knowledge then forms the starting point and object of the next learning activity.

Procedural learning in humans involves the perception of stimuli and the initiation of appropriate behaviour (action). The analysis of prior experiences (contextual placement) and the development of behavioural guidelines (cognitive association) are known as declarative learning. Both levels of learning (and types of knowledge) are activated in and interact with the learning process, even if one of them assumes a more prominent role.

A comparison of analogies between humans and organizations shows organizational structure as a procedural element and organizational culture as a declarative element in organizations. These analogies are based on the following assumptions:

- People use procedural knowledge (know how) to interact with their environment through action. In comparison, organizations use appropriate structures (procedures, processes) to generate activities and interact with their environment.

- In humans, declarative knowledge (know what) is the starting point for procedural knowledge and any subsequent actions. Correspondingly, culture can be described as the declarative knowledge of an organization, since it provides the meaning and guidelines for behaviour and thus forms the basis of all actions.
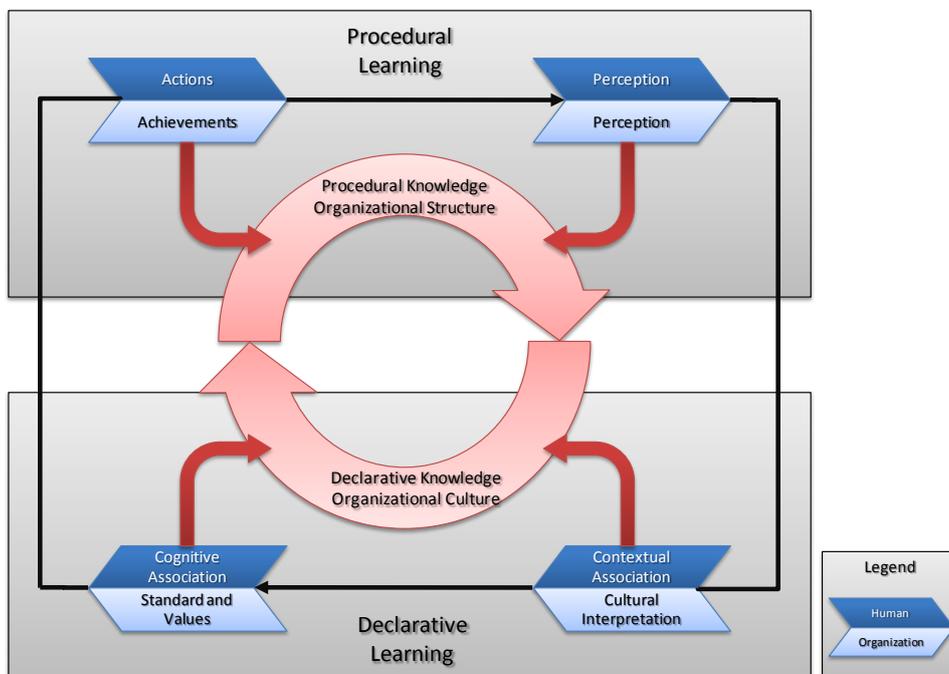
Figure 2-13: Human/Organizational Learning Model

- Adapted from Bornemann, et al. [16]

Consequently, the organizational learning process follows comparable phases to its human counterpart, whereby any changes in structure can be seen as procedural learning and changes in culture as declarative learning in an organization. Although it is again possible that one particular learning process will assume a more prominent role, in practice they will always interact.

Individual learning processes form the starting point for organizational learning. It is individual learning that provides the impetus for organizational change. The implementation of any such change also requires individual learning processes, which can involve all members of the organization or smaller groups, depending on the scope of the actual change.

2.8   The Knowledge-based Network Organization

The Fifth Discipline (1990) author Peter Senge [88], a pioneer in organizational learning, warned that the hierarchical business model no longer worked in the complex, dynamic and global organizations of the day. Rather, he believed that open communication and collaboration and continuous generative and adaptive learning would be critical to organizational survival.

One of the main requirements for effective knowledge management is an organizational framework that supports the optimal acquisition and networking of knowledge. The knowledge-based network organization is one such possibility (Bornemann, et al. [16]).

Since knowledge is intrinsically linked to people, location plays an equally important role for knowledge as it does for other factors of production. In "topographical" terms, an organization can be described as the sum of its locations and departments (see Figure 2-14).
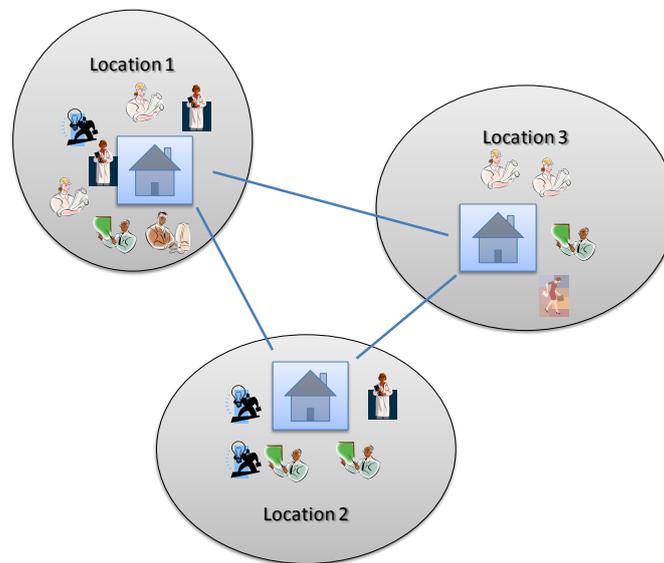
Figure 2-14: The Organization from a "Topographical" Perspective

- Adapted from Bornemann, et al. [16]

However, if the focus is placed on "knowledge", the change in perspective yields a totally different picture. The organization now appears as a network of individual knowledge domains. This can be seen clearly in Figure 2-14 and Figure 2-15, which illustrate the same organizational structure, but

in two different forms. A knowledge domain is not a subject area in the lexical sense: it is a social system that concerns itself with a common area of interest. Knowledge domains can also be thought of as virtual departments "set up" to enable collective knowledge creation. Since the individual members of a given knowledge domain can be spread across different departments or locations, they will require support to ensure effective communication. This can be achieved with an appropriate organizational framework, e.g. virtual departments with the same status as "traditional" departments.
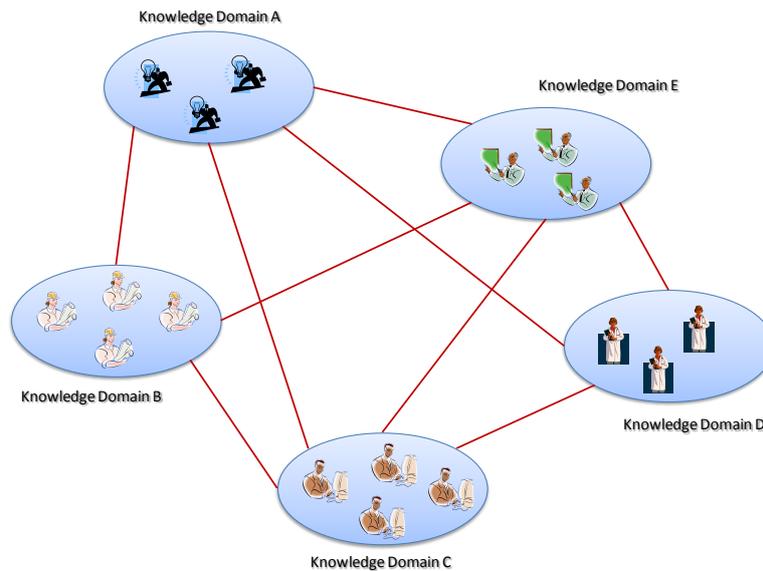
Figure 2-15: The Organization from a "Knowledge" Perspective

- Adapted from Bornemann, et al. [16]

Knowledge domains can also encompass members of other organizations. These might include research staff at universities and research institutions, or the employees of customers and suppliers integrated in value creation processes. A good example of this is the innovation process. New, innovative products are often the result of close cooperation with customers and suppliers. Some innovation activities may even be outsourced to external partners. More information is provided in Chapters 3 and 4.

2.9   Chapter Conclusion: Collaborate and Network to Create and Exploit Knowledge

In this chapter, the components of Knowledge Work were reviewed, and this showed that significant utilization of exploiting knowledge is only possible when collaboration happens and this is integrated in a network. There is thus a need for a framework to create and operate networks between and among organizations to create and exploit knowledge.

The following chapters will deal with the development of a framework to facilitate the design and deployment of knowledge networks.

Chapter 3: Why Knowledge Networks? – The Innovation Focus

"The daily New York Times now contains more information than the 17th century man or woman would have encountered in a lifetime."
- Wurman (Information Overload Statistics 2003)

The exponential proliferation of knowledge has become a significant challenge and stumbling block in fostering and advancing innovation.

Peter Senge [88] in "*The Fifth Discipline*" noted:

> *Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace.*

In their book "*Wikinomics*", Tapscott and Williams [95] highlight the wave of innovation which follows the paradigm change to 'mass collaboration' via the internet which builds on social networks and communities.
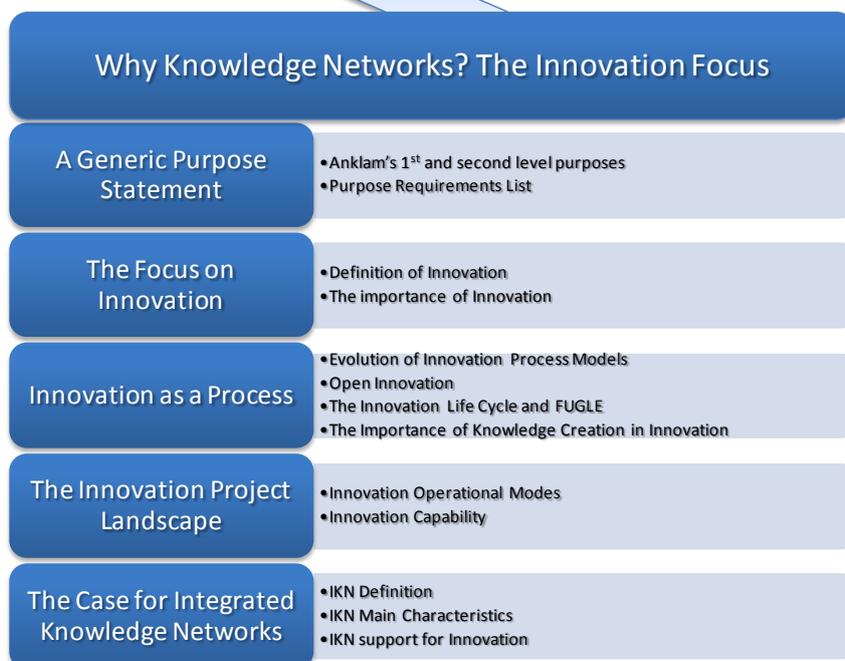
Figure 3-1: The Structure of Chapter 3 within the Context of the Overall Navigation Structure

We are thus living in a world where knowledge is created at a faster rate than ever before, and we need new mechanisms through collaboration to be able to benefit from this.

Knowledge Networks contribute significantly to the innovation process in both quality and the speed at which innovation can be implemented. This chapter addresses the rationale for Knowledge Networks, with a specific focus on Innovation. Different innovation models are covered below.

3.1   The Purposes of a Knowledge Network

This section explores the generic reasons for the existence of knowledge networks. The requirements for a knowledge network are derived from the purpose, that is, why do we need (or have) a knowledge network? If it is clear why the knowledge network is required, or what the purpose of an existing knowledge network is, one is then in a better position to derive the detailed requirements for a knowledge network.

In the section below, two different viewpoints on network purposes are covered.

Von Krogh, et al. [99] identified the following key business objectives for Knowledge Networks:

- **Risk optimization:** *"We have to discover what we have and record and save it before it is too late!"* This implies reducing supply chain costs, sharing best marketing practices, sharing of human resource practices, and leveraging product development costs across subsidiaries, etc.

- **Efficiency improvement:** *"We must make what we have easily accessible to the organization - and find new uses for existing knowledge!"* This includes dealing with uncertainty in government policy making, competitors' reactions to your strategies, the risk of over-taxing your resources, and dealing with the risk of knowledge becoming outdated. The knowledge activity should also help to achieve innovation goals.

- **Innovation increase:** *"What we have is not sufficient for creating a knowledge-based business: We need to enable the creation of new knowledge,"* e.g. creating new products and service innovation to meet consumer needs and building unique and lasting customer relations.

Patti Anklam [13] in chapter 3 of her book, "***Net Work***", describes the purpose of a knowledge network in a much more generic structure and, as a result, Anklam's definition subsumes the purposes defined by Von Krogh, et al. [99].

Anklam defines the purpose of a network as:

> *The purpose of a network is that which animates it and causes its members to care about it.*

Type	Design Motivation
Mission	Social good or environmental improvement at the local, national, regional or global level.
Business	Creation of tangible value – business development, production of goods and services, financial wealth, or any project or operationally output-focused endeavour.
Idea	Generative thinking for innovation, problem-solving or advocacy.
Learning	Continuous improvement and enhancement of personal or collective knowledge.
Personal	Individual support, growth, and knowledge.

Figure 3-2: Taxonomy of Network Purposes

- Anklam [13]

Anklam proposes a taxonomy for categorizing network purpose, as illustrated in Figure 3-2, and expands it further as:

- The need to define "**community**". A community is an aspect of a network that is aware of its common purpose. It exists as a community because it says it is a community, but it is always a network, just as are partnerships, alliances, consortia, and other names that people attach to specific sets of relationships.

- Subdivisions within the purpose type of "**business**" to allow for various forms of networks within for-profit, non-profit, educational, and governmental enterprises.

Anklam also states that networks will often have more than one purpose.

Based on Anklam's taxonomy, the generic high level purposes are illustrated in Figure 3-3, and are defined as follows:

Personal Growth and Support Networks:
Personal networks have many dimensions—families, school friends, co-workers, neighbours, people we know through religious, civic, or wellness activities—all of which tend to be informal. We leverage these networks when we need assistance looking for a job, a new car, or a good book to read. These networks grow organically and randomly as we meet people in our daily modus operandi. The sum of the people we know through our networks constitute our personal network, those we are most likely to turn to when we have an idea, need advice, or desire fellowship.

Idea Networks:
Idea networks are based on a creative exchange that lets ideas build on each other. The results or outcomes of idea networks are emergent: when you enter an idea network's virtual space or enter a room where it is meeting, you do so, knowing that you will not know where the conversation will lead. (Anklam [9])
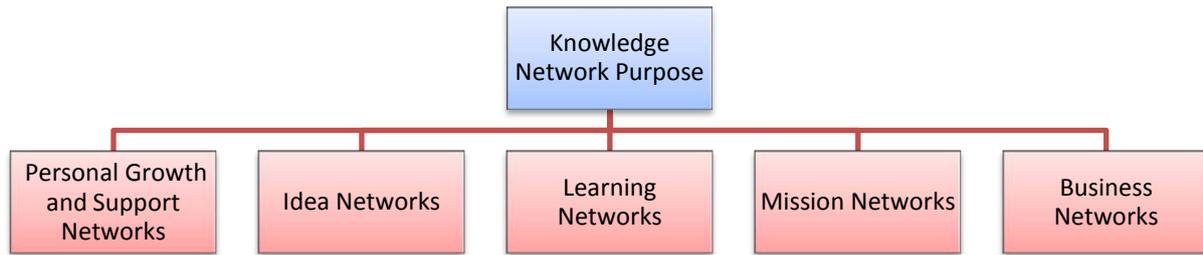
Figure 3-3: A Breakdown of Knowledge Network Purposes

- Adapted from Anklam [13]

Learning Networks: Learning networks focus on augmenting the personal capacity of an individual or a group in a particular area of skill, expertise, vocation, avocation, or knowledge.

Mission Networks: Mission networks are directed to the social good. Arts and culture, education, environment, health, human services, religion, and social justice are the primary categories of service to which non-profit organizations (NPOs) devote themselves.

The networking strategy for these organizations is often dualistic:

- Creating a network of organizations to develop and maintain the program;
- Creating networks in the target population.

Business Networks: The goal of a for-profit business network is production and growth—growth of revenue, profit, and returns to shareholders through growth of market reach, product breadth, expertise and knowledge.

In this category of business networks are non-profit organizations (including public and educational institutions) whose stakeholders demand accountability for financial and operational functions. All these types of business-based institutions are seeing the benefits of the network approach to growth—to partner rather than acquire, to work through alliances, to bring customers into the planning and assessment processes, and to reach out and reach within to leverage networks for strategic change.

The main purposes of different networks have been covered. In the next section the innovation purpose is discussed.

3.2   The Focus on Innovation

"Innovation is the specific instrument of entrepreneurship.
The act that endows resources with a new capacity to create wealth."
- Peter F. Drucker

Innovation is essential for any enterprise to remain competitive, survive and grow (Drucker [26]; IBM's Global Innovation Outlook 2.0 [2]).

Many definitions exist for innovation. (Drucker [26]; Tidd, et al. [96]). A thorough definition of innovation is provided by Salvendy [84] (p.1170):

> *Innovation is not just one simple act. It is not just a new understanding or the discovery of a new phenomenon, not just a flash of creative invention, not just the development of a new product or manufacturing process; nor is it simply the creation of new capital and markets.*
>
> *Rather innovation involves related creative activity in all these areas. It is a connected process in which many and sufficient creative acts, from research through service, are coupled together in an integrated way for a common goal.*

This definition acknowledges that innovation is a complex and multidimensional activity that cannot be characterized by a single input measure.

Innovation is traditionally viewed as a linear progression from research to invention, from engineering design to product, and from manufacturing to marketing. This model suggests that innovation can be increased by increasing Research and Development (R&D) inputs (technology push). Innovation is however much more complex than a sum of knowledge inputs. It is measured by the successful market outcomes and the process by which those outcomes are generated. Innovation is not simply an invention or novel idea, but covers the complete process from developing the idea through to successfully exploiting it in the market.

Surveys such as the annual innovation survey in 2005 from The Boston Consulting Group [3], however, suggest that although the importance of innovation is fully realized by most companies and they continue to spend more and more on innovation, many do not seem to generate satisfactory profit or competitive advantage. The problem does not seem to lie in the invention part or the generation of innovative ideas, but more in the successful management of the innovation process from an idea to a successful product in the market.

Organizations are evolving from well-structured and manageable systems into interwoven networked systems with blurred boundaries. To remain innovative and competitive in this environment, a new paradigm is required.

3.3   Innovation as a Process

"Innovation is organized, systematic, rational work."
- Peter F. Drucker

Innovation is a process that must be managed. According to Tidd, et al. [96], organizations essentially have to manage four different phases in the innovation process of turning ideas into successful reality:

1. **Scanning**: Scan and search their environments (internal and external) to pick up and process signals about potential innovation.

2. **Selecting**: Strategically select from this set of potential triggers for innovating those things which the organization will commit resources to doing.

3. **Planning**: Having chosen an option, organizations need to resource it - providing (either by creating through R&D or acquiring through technology transfer) the resources to exploit it.

4. **Implementing**: Finally organizations have to implement the innovation, growing it from an idea through various stages of development to the final launch - as a new product or service in the external market place or a new process or method within the organization.

Innovation management is therefore about learning to find the most appropriate solution to the problem by consistently managing this process.

3.3.1   The Evolution of Innovation Process Models

Several theories have been developed in order to analyze and understand the nature of innovation and how it occurs. Each of these focuses on different areas that were dominant during the period that the theories were developed. Rothwell [83] has grouped these theories into five historical generations of theories about how the innovation process occurs.

An expansion of Rothwell's 5 generations into 6 generations, proposed by Du Preez and Louw [28], argues that Innovation Process Models have since evolved into a sixth generation from simple linear models to advanced interactive models (see Table 3-1 on page 29).

The **first** and **second** generation models are linear models explaining innovation as either being pulled by market needs, or pushed by technology and science.

The **third** generation model is a coupling model that recognizes the influence of technological capabilities and market needs within the framework of the innovating organization. Although the coupling approach contains feedback loops it is essentially a sequential model with limited functional integration.

To improve the lack of functional integration in the linear models, the **fourth** generation innovation process model, the interactive approach, was developed. This approach views the innovation process as parallel activities across organizational functions. These interactive models, however, do not explain the whole innovation process.

The **fifth** generation or network models originated in the 1990's and attempt to explain the complexity of the innovation process. Major characteristics of the network model are the influence of external environment and the effective communication with external environment.

Innovation happens within a network of internal and external stakeholders. It is therefore important to establish links between and among all the role-players.

Table 3-1: Development of Innovation Process Models

Gene-ration	Model	Characteristic
1st	Technology push	Simple linear sequential process, emphasis on R&D and science
2nd	Market Pull	Simple linear sequential process, emphasis on marketing, the market is the source of new ideas for R&D
3rd	Coupling model	Recognizing interaction between different elements and feedback loops between them, emphasis on integrating R&D and marketing.
4th	Interactive model	Combinations of push and pull models, integration within enterprise, emphasis on external linkages.
5th	Network model	Emphasis on knowledge accumulation and external linkages, systems integration and extensive networking.
6th	Open Innovation	Internal and external ideas as well as internal and external paths to market can be combined to advance the development of new technologies.

- Du Preez and Louw [28], adapted from Rothwell [83]

A very comprehensive model of such an integrated and networked fifth generation innovation process model is proposed by Galanakis [37]. He describes an innovation process, the Creative Factory Concept, using a systems thinking approach (Refer Figure 3-4).

This model has at its centre the enterprise, which is the generator and promoter of innovations in the market, the industrial sector and the nation. The model's overall innovation process is constructed of three main innovation processes:

1. the knowledge creation process from public or industrial research;

2. the new product development process, which transforms knowledge into a new product; and

3. the product success in the market, which depends on the product's functional competencies and the organizational competencies of the enterprise to produce it at a reasonable price and quality and place it adequately in the market.

This process is affected by other internal factors of the enterprise as well as by external factors, in the National Innovation Environment.

- The internal factors refer to the Corporate Strategy; the Risk-Taking Policy; the Technological Capabilities of the enterprise; the Organizational Structure; the Organizational Climate and the Creativity of the enterprise's employees.

- The National Innovation Environment is constructed from the Financial System of a Nation; the Infrastructure; the Demand Conditions; the Critical Mass and Physical Resources available in the nation; the Knowledge and Human Resources available and the Regulations relevant to the activities of an enterprise.
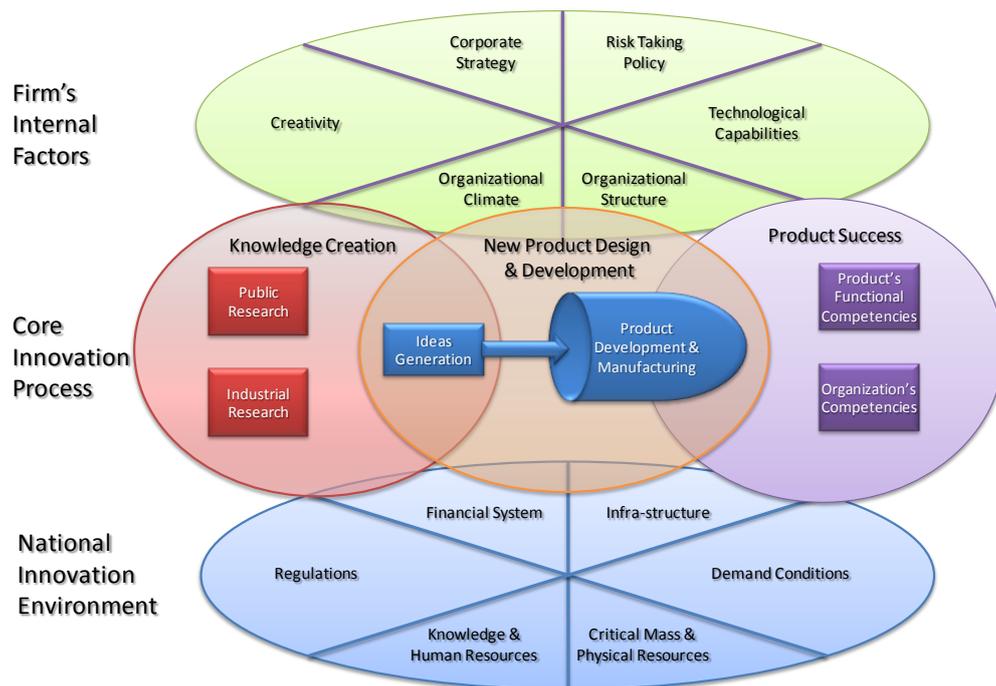
Figure 3-4: The Creative Factory Concept

- Galanakis [37]

These fifth generation models are mainly closed networks of innovation. Traditionally, new business development processes and the marketing of new products take place within the enterprise boundaries. In closed innovation systems, employees within the organization develop the ideas internally and in secrecy.

A new **sixth** generation of innovation models can be called **open innovation** models. These are also network models of the innovation process, but instead of being only focused on internal idea generation and development, internal and external ideas as well as internal and external paths to market can be combined to advance the development of new technologies. Open Innovation is discussed in the following paragraphs.

3.3.2 Open Innovation

"The New Leaders in Innovation will be those who figure out the best way to leverage a network of outsiders"
- Pisano and Verganti [73]

In order to remain competitive, enterprises are investigating alternative options for remaining innovative. A new concept that helps enterprises to improve their innovation, reduce R&D costs and shorten the time to market, is the concept of Open Innovation.

The concept of Open Innovation was first termed by Chesbrough, et al. [22]:

"Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."

Open Innovation thus clearly stands in contrast to closed innovation, where an organization relies only on internal research & development (R&D), idea generation and problem solving. Open Innovation is the methodology and mindset where an organization has well defined structures, and makes use of individuals and/or organizations outside the organizational hierarchical structure to have an input as to the R&D, idea generation, and problem solving within that organization.

One of the most obvious benefits of open innovation is the much larger base of ideas and technologies from which to draw to drive internal growth. But beyond that, leading companies also recognize open innovation as a strategic tool to explore new growth opportunities at a lower risk. The innovation environment has changed through networking and collaboration. Open innovation calls for a new logic, which puts openness and collaboration at its centre. Networked or web communities are the open and agile tools to put into practice the open innovation concept.

Procter & Gamble's strategy of open innovation now produces more than 35% of the company's innovations and billions of dollars in revenue. (Huston and Sakkab [44]) Through Procter & Gamble's open innovation implementation, called connect and develop – along with improvements in other aspects of innovation related to product cost, design, and marketing – their R&D productivity has increased by nearly 60%, the innovation success rate has more than doubled, while the cost of innovation has fallen.

3.3.3 Innovation Life Cycle

An innovation life cycle (Du Preez, et al. [27]) is described in Figure 3-5. At the core of this innovation model lies market value, and the aim of the innovation project is to increase the market value of the enterprise.

The three planning terms - strategic, tactical and operational planning - covers the different kinds of projects within the enterprise. It is assumed that innovation should be driven using a top down approach by planning and developing innovation projects on a strategic and tactical level, and then implementing, monitoring and evaluating on an operational level. The methodology is described according to the following steps of the proposed Innovation Life Cycle:

- **Identification of Internal and External Innovation Drivers**: The innovation process can be initiated by various internal and/or external drivers. If innovation is to help a business grow and improve its competitiveness, it is important to plan the innovation carefully. Though some drivers come unexpectedly, an organization also needs to have a strategic vision of how it wants the business to develop. This will help to focus its innovative efforts on the most important areas. Innovation has to be a product of ongoing well-defined processes that capture and evaluate innovation regularly and not occasionally. There should be a plan for regular periodical meetings that will discuss innovation, market trends competitive landscape, new technology availability and changes in customer preferences as well as trends in order to create fruitful soil for innovative thinking.

- **Assessment**: This stage of the innovation process involves assessing the impact of the identified potential innovation drivers from the previous stage. The next step is to determine what the impact of such changes on the current enterprise will be, in order to identify potential innovation projects. Due to complex inter-dependencies inherent in the systems of interacting parts of the enterprise and its projects, models are required to gain a better

understanding of the As-Is state of the enterprise in order to determine what impact the improvements required to arrive at the To-Be of the enterprise, will have on the enterprise.

Figure 3-5: Innovation Life Cycle Model

- Adapted from Du Preez, et al. [27]

- **Planning the Project Portfolio**: This stage of the innovation process involves the identification and prioritization of projects that, once implemented, will result in an organization moving from a current (As-Is) state to a future (To-Be) state. A portfolio of innovation projects is therefore developed. The identification of projects results from the development of transition paths in the form of a Master Plan roadmap. When these transition paths are combined, have resources and budgets attached and have clearly defined objectives, these projects have been defined as a result. The basic function of the Master Plan roadmap is to define and build the infrastructure (the "what") and the architecture (the "how") for the project or projects that need to be initiated to drive the enterprise through the required change. The outcome of the Master Plan is a prioritized list of innovation projects (which defines the innovation project portfolio). By ordering the implementation of a variety of innovation projects it ensures that the required resources and knowledge are available during each project and that there is integration between different projects.

- **Developing / Designing**: The Master Plan roadmap in the previous stage defined different innovation projects to be implemented. These innovation projects were planned on a tactical level. When these innovation projects are finally launched for implementation, the first stage of the project involves a detailed design or development of the proposed innovation. Different design teams are normally involved in such an innovation project, and they all need to be guided throughout the design phase of the project (in terms of their specific design objectives as well as providing them with best practice experience from previous designs). Roadmaps, constructed according to the required activities of the different design teams, provide the structure or framework to guide the design activities of the different teams by providing them with the best practice knowledge and information in context with where it is required. The

design roadmap also provides the structure for capturing and storing all design information and explicit knowledge developed during the design process. This is important for ensuring a successful implementation of the innovation and the transfer of the innovation to operations.

- **Implementing**: The implementation phase entails the roll-out of the completed designed or developed innovation within the enterprise. It is therefore the handover from design to operations and involves the actual use or operation of the new innovation within the enterprise. Roadmaps are again useful to manage the handover of the newly developed knowledge to the operational side of the enterprise. At this stage the conceptual framework model of the enterprise should be updated to reflect the new enterprise architecture. This conceptual framework model of the new enterprise can then be used in the next innovation cycle.

- **Monitoring and Evaluating**: This is the optimization phase of the implemented innovation. Once in operation the performance of the innovation can be monitored and adjustments made to improve the innovation. Knowledge obtained from the operation of the innovation should be collected and stored in both a roadmap structure as well as the conceptual framework in order to guide future improvements or re-designs.

3.3.4 The FUGLE Innovation Process

"To turn really interesting ideas and fledgling technologies into a company that can continue to innovate for years, it requires a lot of disciplines."
- Steve Jobs

"Innovation is the process, success is the result."
- IBM Global Innovation Outlook

Most innovation process models evaluated focus mainly on the funnel part of the innovation process (i.e. identifying and filtering new ideas and concepts). Furthermore, they mostly address product innovation as opposed to service companies that have less tangible products (e.g. insurance companies).

These models also neglect or totally exclude the exploitation part of a new innovation, i.e. to successfully exploit the innovation in different markets and application areas (including exploitation of different business models for the enterprise). This is important since an innovation should in the end generate more value to the company than the cost that is associated with it.

Du Preez and Louw [28] presented a new innovation framework called the FUGLE model which was developed and applied within an insurance company. It was generalized to make it applicable to product as well as service companies. The model revolves around a generic innovation process that combines the convergent innovation "funnel" with a divergent exploitation and deployment of the innovation (termed a "bugle"), with the combination of the "funnel" and "bugle" then termed a "fugle". Figure 3-6 illustrates the FUGLE Innovation Process.

The innovation process (the funnel and bugle) operates internally in the enterprise, but all the stages of the process are linked to the external environment. This emphasizes the network aspect of innovation, as well as the open innovation trend to incorporate external inputs in the process. These inputs could influence any stage of the process, even up to the point of outsourcing.

The complete process is guided and supported by the strategies of the enterprise, people and culture, organizational structure and processes, as well as information and knowledge.

The FUGLE model consists of a number of stages with gates and filters. The model is flexible and allows for activities to overlap between stages. Iterative loops are possible between the concept definition and concept feasibility stages, as well as between the deployment and refinement stages. Iterative loops are also possible within the stages.

Gates and filters are used as decision points between certain activities and stages. During the idea generation stage and concept definition and evaluation stages these decision points are called filters. This illustrates the less rigid approach that should be applied during these initial development stages. Filters are used to separate the promising and less promising ideas and concepts. The less promising ideas and concepts should, however, still be documented along with their full context and stored for future revisit and evaluation, as circumstances may be more favourable for these ideas and concepts in the future.

The various activities that take place in the different stages are described below:

- **Idea Generation / Identification Stage:** This is the creative stage where new ideas are generated and/or new opportunities identified. As the model embraces the open innovation paradigm, these new ideas can come from internal or external sources.

  By efficiently and effectively identifying, capturing, classifying and presenting information, information can act as a constructive stimulus for idea generation. This information may be about problems, competitors, clients and markets, technologies or strategies that are available to the business. Although ideas are often the result of moments of inspiration, idea generation can be proactively encouraged and facilitated in workshops and brainstorming sessions. By properly managing a formalized Knowledge Supply Chain (Du Preez and Louw [30]), the right information can be made available to the right people in the right manner, thereby helping to trigger new and innovative ideas.

  Irrespective of the process that was followed to generate an idea, it is important to capture the idea in a fashion that allows for it to be communicated to others and to be developed further as a concept (Gaynor [39]). All ideas should be captured, as even ideas that do not seem promising at first may prove valuable if the business context changes over time. The idea capturing mechanism should include as much metadata as possible, including any available context in terms of development life cycle, team members that were involved and any external considerations or influences. Ideas should be evaluated against a company's strategic objectives, and those that are clearly not in line may be rejected. This leaves only promising ideas that are in line with objectives as candidates for further development, thereby ensuring that resources dedicated to the development of these ideas, have a good chance of generating returns. Rejected ideas should not be removed from the system, as a change in future circumstance may render them more promising and relevant.

- **Concept Definition Stage**: The focus of this stage is to transform the idea into a workable concept. Concepts are often developed by combining different ideas. Once the initial concept definition is done, some time should be provided to share the concept with different people in order for the concept to incubate. If necessary, this may lead to

refinement of some of the ideas followed by another filtering process to select the concepts that are most promising for further evaluation in order to determine their feasibility.

- **Concept Feasibility and Refinement Stage**: The concept feasibility stage is about further investigation of the concept and collecting of additional information to complement the potentially limited information that was available during the definition stage. Modelling and prototyping also provide valuable information on concept feasibility. Iterative loops of concept refinement and evaluation will typically occur, and should be used as a learning experience. It is better and more cost effective to fail at this stage than later during the deployment stage. The funding gate at the end of the stage is used to make decisions on which concepts should be resourced and developed further, thereby producing a list of prospective innovation projects as the stage output.

- **Portfolio Stage**: Innovation Portfolio Management entails the holistic management of the innovation initiatives of the enterprise and includes prioritization, scheduling and alignment of prospective innovation projects. Resource allocation is also considered during this stage, along with assignment of responsibility.

  Innovation initiatives should be continuously monitored to understand the aggregate effect of the innovation portfolio on the strategic objectives of the enterprise. Innovation projects progress towards deployment by determining a launch date for each individual project.

- **Deployment Stage**: The innovation solutions that were identified, conceptualized and approved during the previous stages are now designed, implemented and tested. This includes the detailed project planning and management of the design and implementation projects. An implementation gate is used after the detailed design is completed to serve as a final design review before implementation. Implementation of the design involves the development and deployment of the new innovation.

- **Refinement and Formalization Stage**: After initial deployment the innovation project is in operation, but will most likely not function optimally. The progress of the project should therefore be monitored, measured, evaluated and refined until it functions satisfactorily according to specifications. Once the solution is performing satisfactorily it can be formalized in terms of operational documentation.

- **Exploitation Stage**: Once the solution has been formalized, a final stage is reached where the solution is further exploited through new business models and markets, thereby generating more value from the innovation project. An exploitation gate is however used to determine which projects should advance to this stage.

Although this innovation process model appears to have a linear structure, several iterative loops and overlaps exist between the stages. Many of the tasks in the process also occur concurrently, e.g. idea generation and idea capturing. Activities such as portfolio management and the management of information occur throughout the process.
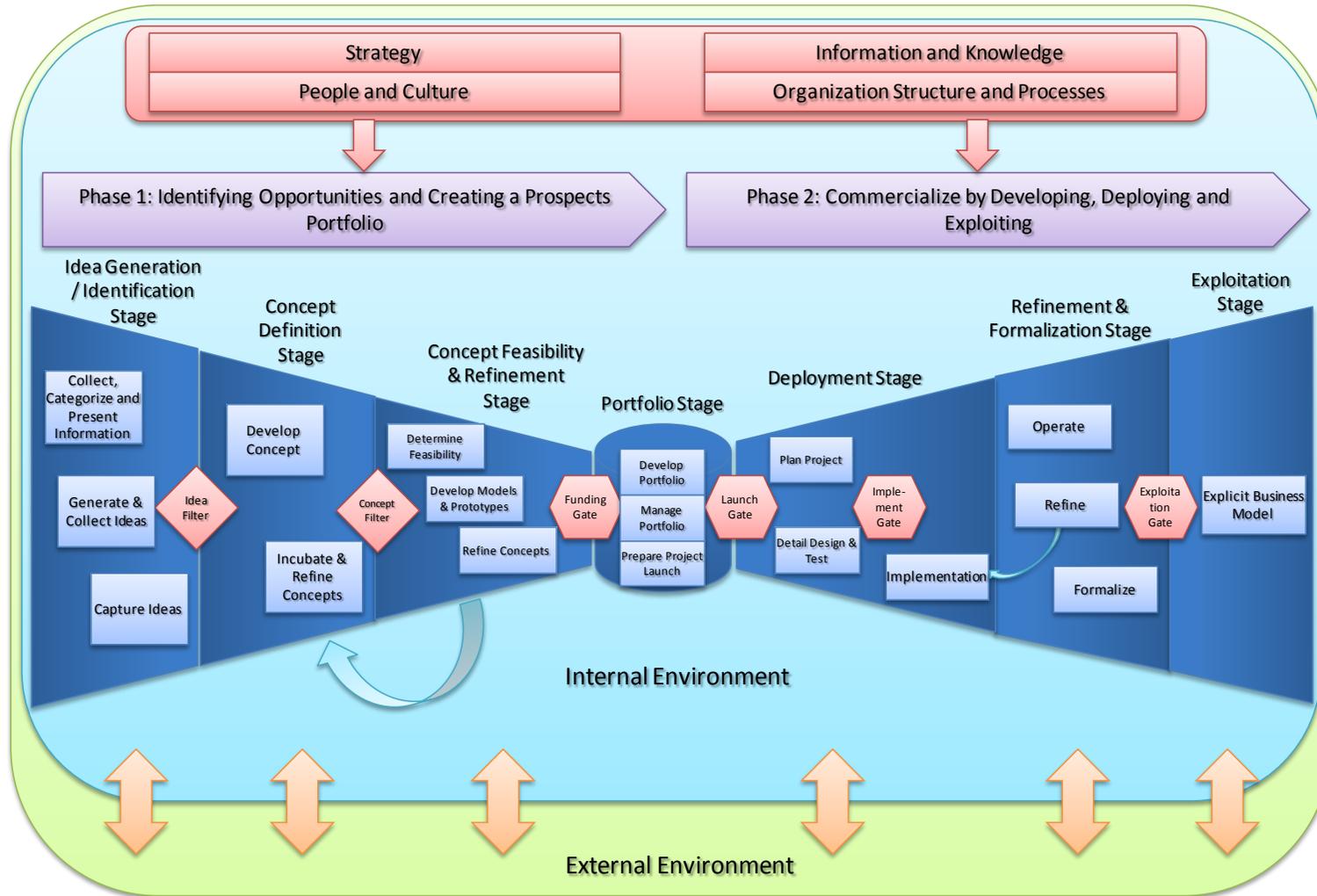
Figure 3-6: The FUGLE Innovation Process

- Du Preez and Louw [28]

3.3.5 The importance of Knowledge Management in the Innovation Process

Although working, learning and innovation complement each other, they are still strictly separated in many enterprises as a result of their disparate mental models (Brown and Duguid [17]).

- **Working** is traditionally seen as the production and delivery of products or services. Formal operating instructions and work flows are designed to execute this as efficiently as possible. As attention is focused upon the efficiency with which the task is carried out, this field is frequently resistant to modifications.

- **Learning** is regarded explicitly as the absorption of new knowledge, whereas this potential is in fact used most inadequately to increase the enterprise's ability to innovate. The underlying pattern of the learning processes is often responsible for this. These processes simply focus on individual employees' acquisition of knowledge instead of inducing them to learn how to learn, and how to inter-link areas of knowledge. They often obstruct the transfer of new knowledge into working-skills by using training-methods confined to pre-defined theoretical concepts.

- Finally, **innovation** is often associated with revolutionary proposals developed, for example, in the research laboratory or other specialized departments. This form of innovation admittedly constitutes an important part of change in general, but is just one extreme within a continuum of innovations. It can also take the form of mere renewals and improvements in daily business, e.g. process improvements.

Researchers are increasingly highlighting the importance of knowledge management for supporting efficiently managing innovation (Johannessen, et al. [46]; Perez-Bustamante [72]; Carneiro [20], Burgelman, et al. [19]). How knowledge is used, spread and stored by an organization's employees determines whether this organization has a culture of stimulating (or restraining) innovation. For a simplified view on how knowledge is created, applied and stored in a typical project, refer to Figure 3-7 below.
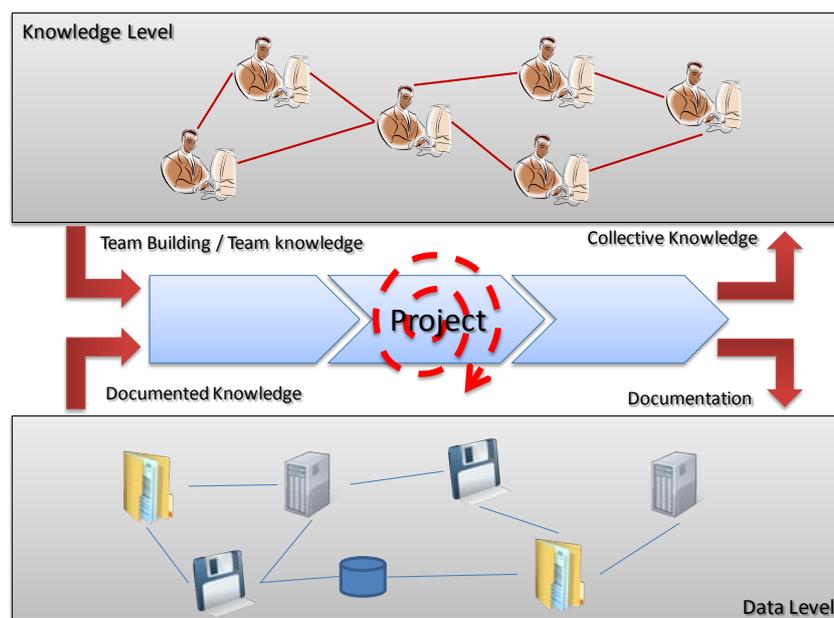
Figure 3-7: Projects as Framework for Knowledge Creation and Application

- Bornemann, et al. [16]

Innovation happens through the novel exploitation of existing internal and/or external knowledge. In order to innovate effectively and sustainably, existing knowledge should not only be captured, but also shared and integrated in context. By sharing best practices, inefficient redundancy in innovation is greatly reduced. The integration of knowledge helps to exploit complementarities among knowledge assets and to achieve coordination. Practices of this sharing and integration are currently not well understood (Leiponen [51]).

Focusing on explicit knowledge only, as well as taking a too narrow view of work, learning and innovation areas, involves the danger of erecting barriers of various kinds. These not only hinder the short-term flow of knowledge but in the long term prove detrimental to a company's innovation- and learning- ability.

Based on integrated knowledge management, networking knowledge may deliver a conceptual framework for rethinking a knowledge-management model. In this case, knowledge barriers should be overcome by ``networking'', and knowledge islands should be cross-linked in order to stimulate the evolution, dissemination and application of knowledge.

The integration of networking and knowledge management yields great benefits. The openness and richness of networks are believed to foster a fertile environment for the creation of entirely new knowledge, while also accelerating the rate of innovation.

Rather than trying to monopolize the returns from innovative activity and forming exclusive partnerships with only a narrow selection of organizations, successful enterprises positioned themselves as the hubs at the centre of overlapping networks, stimulating rewarding research collaborations among the various partner-organizations.

Reliance on networks has potentially transformative effects on all participants. Those positioned in a network of external relations adopt more administrative innovations, and do so earlier. The presence of a dense network of collaborative ties may even alter participants' views on competition. Inside a densely connected field, organizations must adjust to a novel perspective in which it is no longer necessary to have exclusive ownership of an asset in order to profit from it. Moreover, since a competitor on one project may become a partner on another, the playing field resembles less of a horse-race and more of a rugby match, in which players frequently change the colour of their jerseys. To summarize, regardless of whether networking is driven by gaining access to new knowledge, or by creating and transferring knowledge, connectivity to a network and competence at managing networks have become key drivers of a new business logic. (Seufert, et al. [89])

Innovation management entails finding the most appropriate solution to the problem of consistently managing this process. Park states that the relation between Knowledge Management (KM) and Research and Development (R&D) management is intrinsically close, because R&D processes can primarily be seen as KM processes. It involves transforming information on technological advances and market demands into the knowledge required for new product concepts and process designs (Park and Kim [71]). However, the link between KM and R&D management has been virtually non-existent in the past. Perez-Bustamante [72] explains different types of innovation as a flux of knowledge:

- Defensive innovation takes into account information about the competitive situation and the market demand.

- Offensive innovation exploits information about scientific and technical advances in order to reach a favourable position in the market.

- Radical innovation is the product of putting together unlikely bits of information in an irregular, serendipitous process which is not encouraged by bureaucratic and non-agile organizations. Agility and speed to innovate, responding to the environment may arise from: commitment to activities that create new knowledge bases, deployment of incremental innovations, exploitation of corporate intelligence, adoption of a horizontal management style that avoids unnecessary communication layers with management, and achieving a full integration and dissemination of knowledge within the organization while maintaining its flexibility.

Swan, et al. [94] concluded that KM initiatives that encourage active networking are key to interactive innovation processes, but warns that an over-emphasis on building IT-based network links may ironically undermine rather than increase this.

There is thus consensus that successful and sustainable innovation is dependent on the ability of innovators to use knowledge management tools and techniques to:

1. analyze market needs, trends and opportunities,

2. capture the outputs of innovation projects to preserve "corporate memory" for analysis and future use,

3. re-use the outputs from previous projects or other groups, to accelerate the current innovation efforts with the co-operative knowledge captured before, and

4. link innovation project members together and collaborate with other groups so as to expand the participating community, therefore expanding the ability to learn from others and innovate faster.
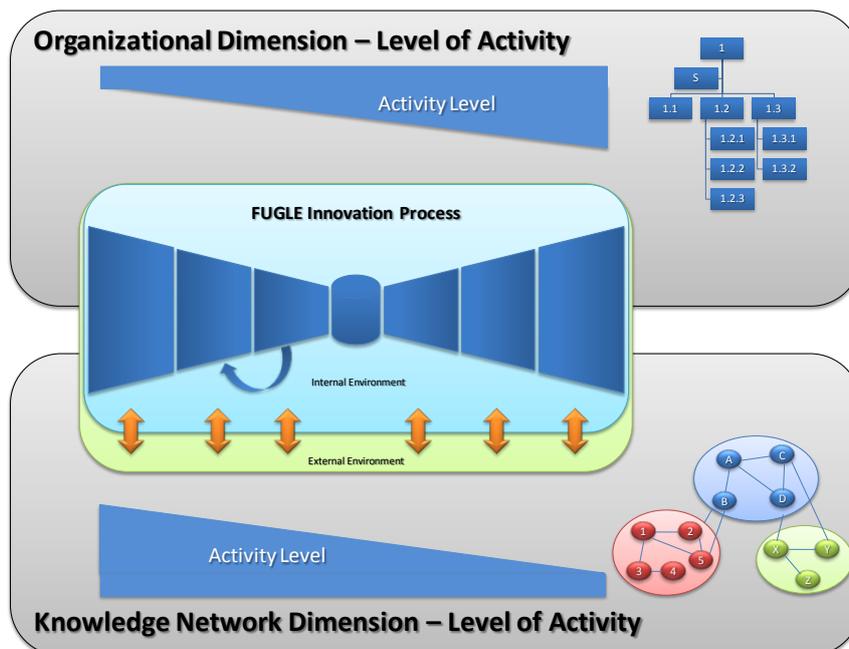
Figure 3-8: Dimensions of the Innovation Project Landscape

To relate this to the FUGLE model discussed in Par 3.3.4 on page 31, the innovation project environment is separated into two dimensions (see Figure 3-8):

- **Organizational Dimension**: The desire for structure and organization in an enterprise, during the execution of a project. When an innovation project progresses to the exploitation phase, the need for structure and formality becomes higher.

- **Knowledge Network Dimension**: The desire for knowledge mining, sharing and creation, flexibility, informality, freedom of association, networking etc is high (and necessary) during the inventive phases (funnel) of an innovation project.

These two dimensions are often in conflict. Tapscott and Williams [95] in "*Wikinomics*" described the old corporation as strongly hierarchical, with the boss being an authority on every part of the business. The Network Generation's concept of work is best described by a set of non-traditional attributes or norms. These N-Gen norms (speed, freedom, openness, innovation, mobility, authenticity, and playfulness) can form the basis of a revitalized and innovative work culture, but they also raise tough challenges for employers seeking to adapt to new expectations.

3.3.6 Relationship between Knowledge Creation and the Innovation Life Cycle

The traditional linear process of innovation describes this process as a journey from science to market with a clear beginning and end. On the contrary, the Perez-Bustamante [72] innovation model does not intend to represent a clear and continuous flow of innovative activities following a science- technology- market path, but shows an iterative innovation model which considers innovation as a learning process between and among research activities performed within and external to the boundaries of the knowledge creating organization. Refer to Figure 3-9.
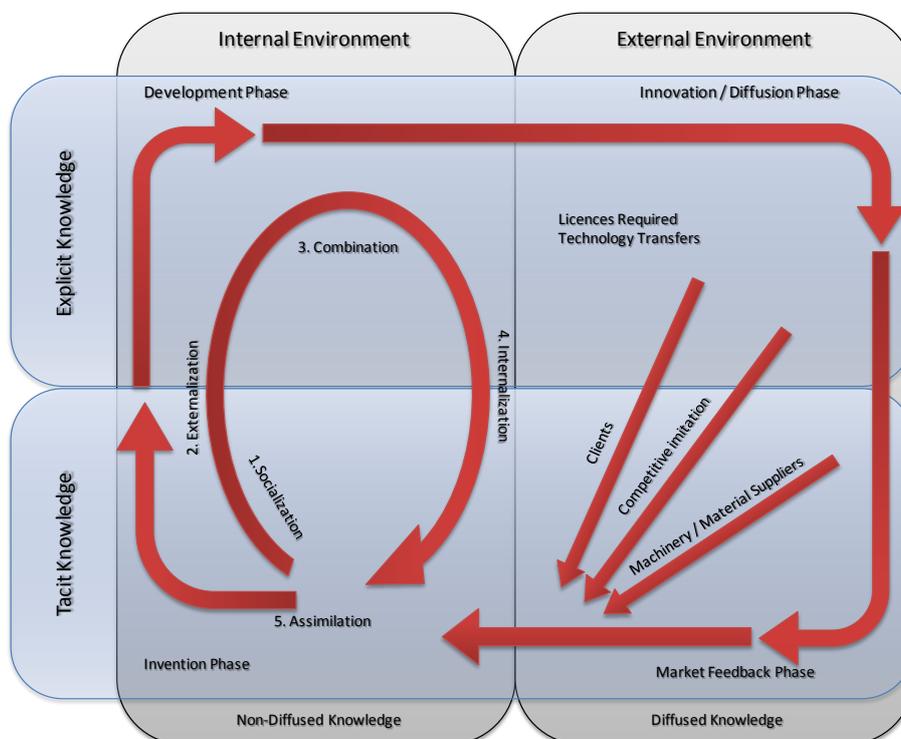
Figure 3-9: A Framework Model for Knowledge Innovation

- Adapted from Perez-Bustamante [72]

The links between these knowledge creation activities and the areas in the organization are activated in the different phases of the innovation chain. In fact, the innovation process may start at any point of the innovation chain and, before it reaches the market successfully – if at all – it gains insight and incorporates the advances in scientific research, commercial and market information and the learning by doing-knowledge developed in the production area.

This iterative innovation model considers that there is a multitude of interconnections between activities and different knowledge bases that contribute to a successful market implementation of a given innovation.

Thus, in any innovative activity, it is essential to establish a good communication link between the market and the R&D laboratories. In addition, as part of the learning process, knowledge links will connect the innovation chain with both the market and the scientific research environments. So, innovative organizations will demand specialized personnel who are capable of assessing and valuing the knowledge that is present in the above mentioned milieus: scientific, engineering, managerial and commercial.

The simultaneous synthesis of scientific and technological knowledge, market research information and learning by doing knowledge takes place in the central innovation chain. This chain covers the phases of invention, innovation and diffusion of technological knowledge and incorporates feedback of the different activities performed. The invention is the discovery that may result in a product/service launched onto the market or a new production process. Precisely, the first introduction of a product or service to the market or the first commercial use of a production process, regardless of their novelty to the market, is an innovation. The diffusion process is accomplished when the product is accepted by customers. This is the starting point for competitors to imitate the novel product or process.

In addition to the partial feedback for and between the activities in the innovation chain, the commercial diffusion of the product will provide market feedback to the innovation process and will allow for further research aiming to enhance those characteristics of the product that may better satisfy the diverse market needs. In fact, market feedback allows innovative and learning processes to be creative.

The innovation process is a locus of learning with outcomes varying according to the phase in which the learning activity is undertaken. Hence, in the first part of the innovation model, the invention locus, learning processes imply the acquisition of knowledge associated with natural laws. The purpose is to obtain commercial products based on knowledge bases previously developed. In the development area, the innovation and research processes undertaken, aim to discover the optimal characteristics of the product design that will satisfy market expectations better and will facilitate the production process. To culminate these development activities, it is essential to have access to commercial knowledge reservoirs or research activities, since they will incorporate, to the product design activities, information about those characteristics that are most valued and demanded by the market.

All in all, innovation is a learning process that takes place between scientific research and the market, through which the organization uses scientific and engineering knowledge bases to develop products with the characteristics demanded by the market.

3.3.7 Interdependencies between Knowledge and Innovation

As illustrated in Figure 3-10, Knowledge is the basis for all Innovation, and Innovation in turn ensures an organization's competitive advantage, thus leading to corporate longevity.

Perez-Bustamante [72] states that innovation is a process of acquisition, processing, storage and recovery of information that can be studied from five perspectives: general knowledge creation, R&D learning, manufacturing learning, commercial learning and survival learning.

The focus of organizational learning on these approaches does not refer to a linear process of innovation, which is characterized by a continuous flow of information within innovative activities that are either internal or external to the enterprise. Furthermore, it evokes the simultaneous information gathering and feedback of diverse innovative activities in a chaotic and continuous flux of information and knowledge transmission.

Competitive Advantage
Competitive Advantage ensures corporate longevity

Innovation
Innovation is the driving force behind long-term competitive advantage.

Knowledge
Knowledge is the basis for innovation.
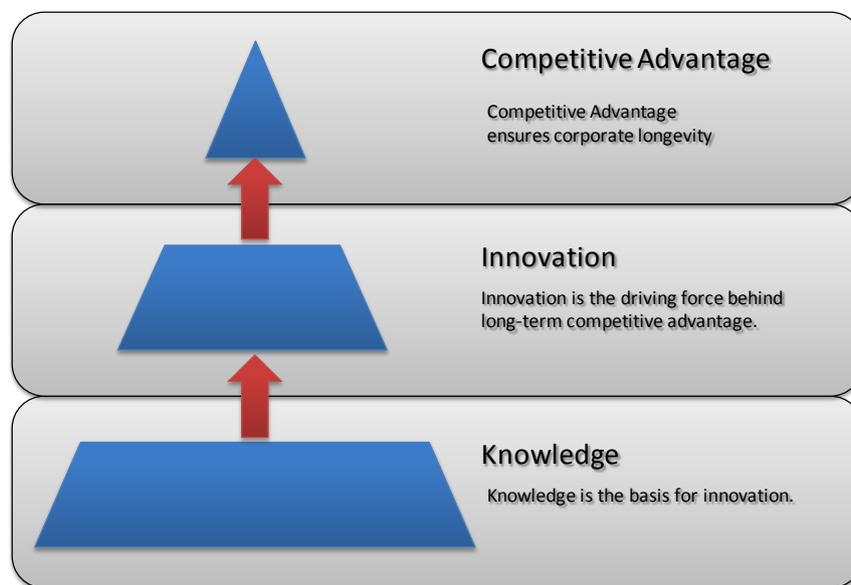
Figure 3-10: The Relationship between Knowledge, Innovation and Competitive Advantage
- Adapted from Bornemann, et al. [16]

This consideration supports the existence of an important correlation between technological innovation and knowledge management.

The Knowledge Life Cycle consists of the following phases:

1. **Identification and Extraction**: Knowledge is identified and extracted from other sources.

2. **Structuring and Formalization**: Knowledge is structured and formalized in the selected knowledge management tools.

3. **Refinement and Development**: Knowledge is analyzed, refined and further developed.

4. **Dissemination**: The distribution of applicable knowledge to the people that require it.

5. **Maintenance**: Maintaining the knowledge, to ensure it remains up to date and applicable to the domain.

An innovation project will typically incorporate more than one Knowledge Life Cycle.
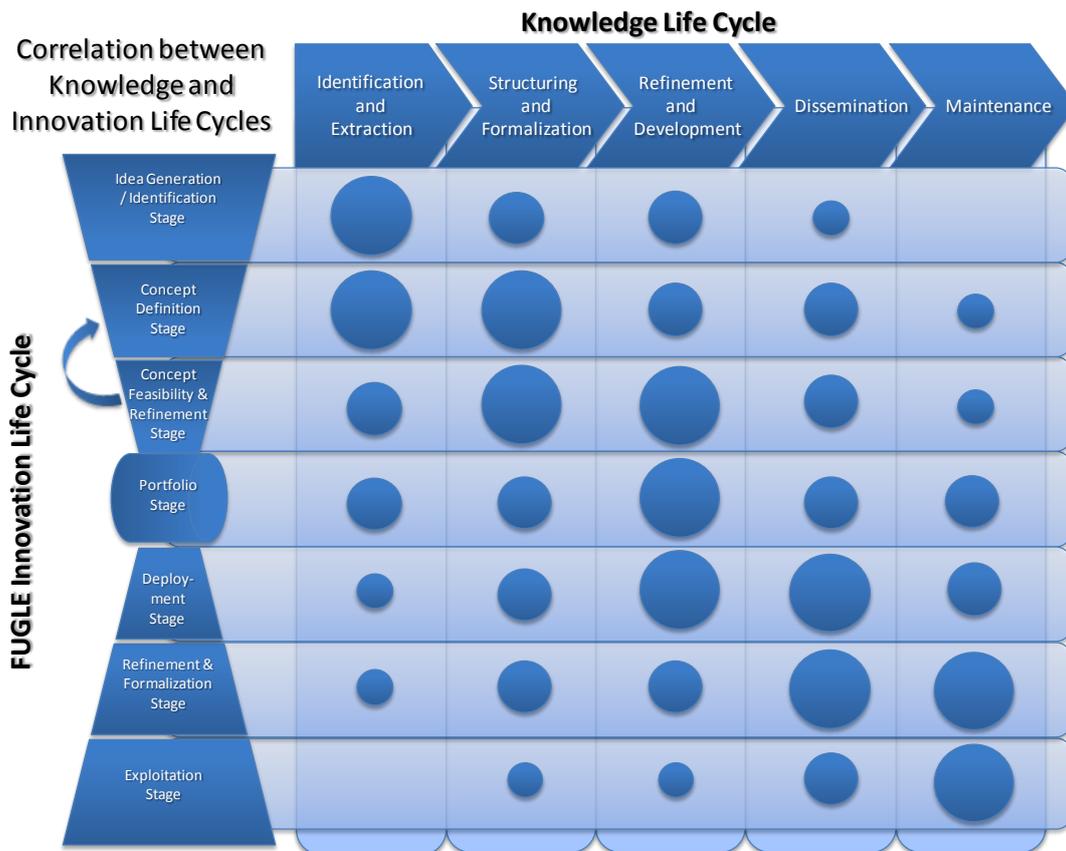
Figure 3-11: The Correlation between Knowledge and Innovation Life Cycles

- Adapted from Du Preez, et al. [27]

According to Du Preez, et al. [27], a Knowledge Life Cycle "spiral" supports the execution of an innovation project. Knowledge is repeatedly captured, refined, disseminated and maintained, depending on the progress and success of each phase of the innovation project including the knowledge sub-domains under investigation. An innovation management framework based on successful management of knowledge along the complete Knowledge Life Cycle is instrumental to the success of an innovation project.

3.4 The Innovation Project Landscape

"One might think that the money value of an invention constitutes its reward to the man who loves his work. But... I continue to find my greatest pleasure, and so my reward, in the work that precedes what the world calls success."
-Thomas Edison

In the strife to beat its competitors, an organization needs to participate in an innovation race, so as to beat its competitors to be in the market first with an innovative product. Based on discussions with Prof N du Preez and members of the research group, and combining concepts from publications of Du Preez and Louw [28] and Essmann [34], it is possible to describe an Innovation Project Landscape (refer Figure 3-12).
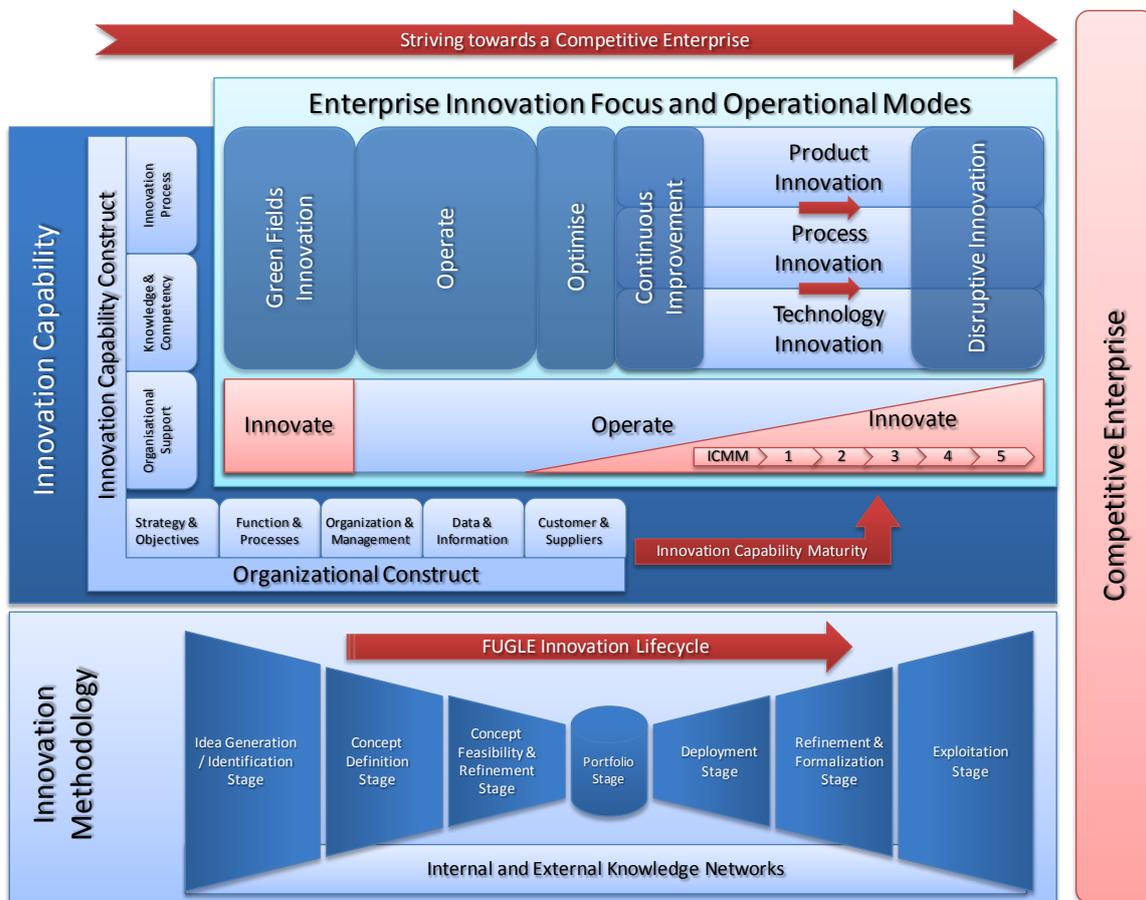
Figure 3-12: The Innovation Project Landscape

The Landscape Illustration consists of:

- A time dimension is presented horizontally at the top, to illustrate the strive of an enterprise to be a competitive enterprise.

- Depending on the status of the enterprise, it will require a certain innovation focus and operational modes to become a competitive enterprise.

- The ability of the enterprise to execute the required innovation projects, is illustrated by the Innovation Capability, consisting of two constructs (Essmann [34]):

  o Innovation Capability Construct, consisting of an Innovation Process, Knowledge and Competency, and Organizational Support.

  o Organizational Construct, consisting of Strategy and Objectives, Functions and Processes, Organization and Management, Data and Infrastructure, and Customer and Suppliers.

- At the bottom of the illustration, it is suggested that a formal Innovation Management Methodology is required to enable the enterprise to successfully execute innovation projects, with the focus again on the FUGLE method described in Par 3.3.4 on page 31.

It is important to note that Essmann [34] specifically identified Knowledge and Competency as key components in assessing the Capability Maturity of an enterprise.

3.5   The Case for Knowledge Networks

To excel, an enterprise must be able to generate new and re-usable knowledge through the development of new products and services. Innovation is a core capability in high tech enterprises and to merely focus on the re-use of existing knowledge does not create any sustainable competitive advantage.
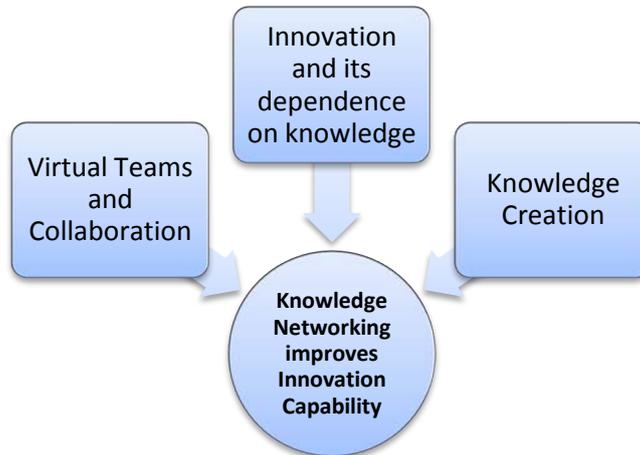
Figure 3-13: The Relationship between the Research Domains and Knowledge Networking

By networking key resources, the enterprise positions itself better to exploit tacit and explicit knowledge resulting in growth of the knowledge base and fostering new innovation. Seufert, et al. [89] states:

> *"We are convinced that in order to make effective use of knowledge, a network must be built up in which the knowledge and experience of employees are available. What is of prime importance is that creation- and sharing-processes are encouraged, not just the accumulation of data as in a data-warehouse."*

3.6   Chapter Conclusion: The Rationale for Integrated Knowledge Networks to support Innovation

> *"Creativity is allowing yourself to make mistakes.*
> *Art is knowing which ones to keep."*
> *- Scott Adams*

The innovation environment has changed through networking and collaboration from simple linear models to the more complex integrated network models (see par 3.3.1).

A recent study by the Economist Intelligence Unit [5] reported that:

> *"The traditional process of innovation, whereby a company maintains and funds a centralized research and development (R&D) department, is gradually being superseded.*

In its place, companies from a variety of sectors are seeking ways to disaggregate their R&D departments and distribute the innovation process across a network of external partners and offshore sites.

This enables them to allocate activities according to the strengths of particular countries and external organizations, and thereby make their R&D processes more effective and efficient."

Open innovations call for a new logic, prescribing openness and collaboration at its centre. Networked, online or webbed communities are the open and agile vehicles to pragmatically deploy open innovation concepts. In the new networked paradigm it is possible to exploit the linear and coupling processes in combination depending on the requirements. This will, however, require new ways of collaboration between enterprises whilst also competing concurrently.

In manufacturing, the automotive industry is representative of the evolution towards the networked organization, not only in a temporal respect, but also with regard to its macro-economic and over-all social (global) importance. In reducing manufacturing depth, more and more parts and components from stand-alone suppliers are linked into a system of industrial partnerships (Lodge and Walton [55]; Barreyre [15]).

Integrated Knowledge Networks (IKN) are defined by Du Preez, et al. [29] as:

"A Knowledge Network signifies a number of people and resources, and the relationships between them, that are able to capture, transfer and create knowledge for the purpose of creating value. An Integrated Knowledge Network spans all domains, communities, and trust relationships with the goal of fostering sustainable innovation that will continue to promote the competitiveness of its users."

Open Innovation (see par 3.3.2) assumes that enterprises have a joint need to innovate and it requires that enterprises share their abilities to innovate, in a controlled manner. The inter-organizational aspects of knowledge networking are therefore highlighted, and these are the main distinguishing characteristics that make a knowledge network an Integrated Knowledge Network as per the above definition.

As illustrated in Figure 3-14, the main conceptual components of an Integrated Knowledge Network are:

- a joint research interest,
- inter-organizational collaboration,
- formal alignment of systems and processes, and
- knowledge networking.
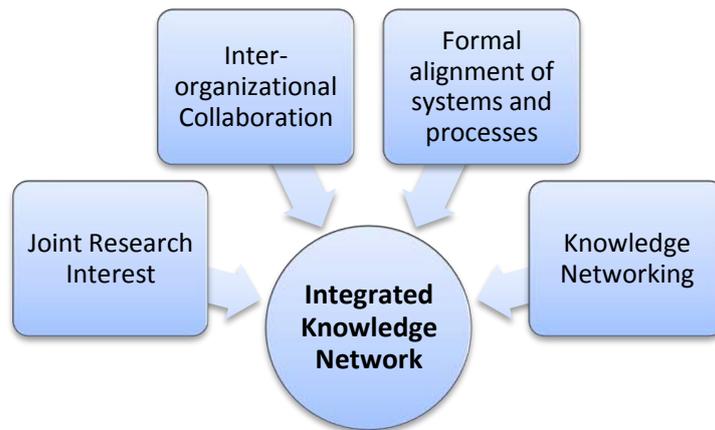
Figure 3-14: The Conceptual Components of an Integrated Knowledge Network

The use of an integrated knowledge network is important to enable inter- and intra-enterprise teams to *innovate* using their collective experience, and expanding their knowledge. This collective experience can be exploited only if explicit as well as tacit knowledge are created, refined and exchanged, and are captured and structured in a manner that is accessible to all members. This implies the deployment of inter-enterprise knowledge networks. It clearly poses a number of unique challenges. These challenges are further discussed in the following chapters.

Chapter 4: Understanding Knowledge Networks

In Chapter 2, Knowledge and Knowledge Creation were discussed. In Chapter 3, the rationale for using Knowledge Networks was discussed, and the importance of knowledge on the Innovation Process was highlighted.

This chapter focuses on exploring the nature of Knowledge Networks in more detail, so as to derive at a number of functional requirements to be considered when designing and deploying a knowledge network.

| Introduction | Knowledge and Expertise | Why Knowledge Networks? | **Understanding Knowledge Networks** | Knowledge Network Landscape | Knowledge Network Methodology Requirements | Integrated Knowledge Network Methodology | Verification and Validation | Conclusion |

Understanding Knowledge Networks

Knowledge Network Definition	• Definition of Networks • Definition of Knowledge Networks
Inter-organizational Network Requirement	• Why inter-organizational networks are becoming important.
A Framework for Knowledge Networks	• Describing the relationship between facilitating conditions, knowledge work processes, and the Knowledge Network Architecture
Knowledge Network Reference Types	• The definition of Knowledge Network Reference Types. • The relationship between SECI, and the different Knowledge Network Reference Types.
Knowledge Network Life-Cycles	• Life Cycle • Maturity
Barriers and Management Challenges	• Motivation • Value through Participation • Efficiency of Knowledge Transfers
Facilitating Conditions and Key Success Factors	• Facilitating Conditions • Key Success Factors
Knowledge Network Function Requirements	• Connect People and Organizations • Create and Share Knowledge

Figure 4-1: The Structure of Chapter 4 within the context of the Overall Navigation Structure

In the following sections, Knowledge Networks:

- are formally defined,

- the requirements for inter-organizational collaboration are revisited,

- a framework for knowledge networks is discussed, with a reference to Nonaka's SECI model, as embodied in Network Reference Types.

Thereafter, the management challenges associated with knowledge networks are discussed in more detail, concluding with a summary of the functional requirements of a knowledge network.

4.1 Formal Definition of Networks and Knowledge Networks

The term "**network**" can be interpreted as knowledge sharing between and among individuals, groups, or organizations, as well as between and among various groups of organizations. In all these cases, the "network" construct demands that description and analysis do not concentrate only on a section of the relationships existing between and among the network participants and network relationships, but also encompass the network in its entirety.

A social network can be defined as (Mitchell [58]; Lincoln [53]):

> "a specific set of linkages among a defined set of actors, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behaviour of the actors involved"

Consequently, the term "network" designates a social relationship between actors. Actors in a social network can be persons, groups, but also collectives of organizations, communities or even societies.

The relationships evolving between and among actors can be categorized according to:

- contents (e.g. products or services, information, emotions),

- form (e.g. duration and closeness of the relationship) and

- intensity (e.g. communication- frequency).

Typically, network relationships are characterized by a multiple mixture concerning form and contents, i.e. the relationships between and among actors are of various forms, which may consist of diverse contents to be exchanged.

IT networks have proved to be a limited means for disseminating tacit knowledge (Nonaka and Takeuchi [66]). Instead, the importance of human networks and networking to enable knowledge diffusion and integration in knowledge intensive organizations has been emphasized in the literature (Grant [41]; Liebeskind, et al. [52]; Okhuysen and Eisenhardt [68]; Seufert, et al. [89]). To exchange knowledge of different types from different individuals has been identified as an important prerequisite for innovation (Eisenhardt and Martin [33]; Seufert, et al. [89]). Knowledge networks and networking are important mechanisms that support product development and innovation as they enable cross-fertilization of tacit knowledge between and among individuals.

To create knowledge, networks have therefore been argued to be an important knowledge management activity (Büchel and Raub [18]).

Walsham [102] suggests three generations of knowledge management initiatives.

- The first generation of KM solutions focused on the creation of knowledge repositories, but these often failed, as much of the knowledge in these repositories was felt to be irrelevant to the personal circumstances of the knowledge user.

- The second generation of KM solutions focused on personalized or more specific types of knowledge to certain groups of users, e.g. technology push solutions, like newsletters and reports to sales people about key events and technological advancements. However, these solutions were only successful in the cases where the target group's needs had been successfully anticipated.

- The third (current) generation of KM solutions focuses on supporting communication between and among individuals, e.g. mentor relationships between new and experienced recruits, communities of practice, and so forth.

Knowledge networks are considered to be part of the third generation knowledge management initiatives.

Seufert, et al. [89] defines **Knowledge Networking** as:

> *"A number of people, resources and relationships among them, who are assembled in order to accumulate and use knowledge primarily by means of knowledge creation and transfer processes, for the purpose of creating value."*

If an enterprise wants to excel, it should be able to generate new knowledge through the development of new products and services. Innovation is a core capability in high tech enterprises and to merely focus on the re-use of existing knowledge does not create any sustainable competitive advantage. By networking these resources, the enterprise becomes better positioned to use tacit and explicit knowledge in a manner that will enable the knowledge base to grow, so as to foster innovation.

A Knowledge Network enables the teams to succeed, using their collective experience to expand their knowledge. This collective experience only becomes usable if it is contained, captured and/or structured in a manner that makes this knowledge and experience accessible to all members. This is especially a challenge for tacit knowledge.

Seufert, et al. [89] states:

> *"We are convinced that in order to make effective use of knowledge, a network must be built up in which the knowledge and experience of employees are available. What is of prime importance is that creation- and sharing-processes are encouraged, not just the accumulation of data as in a data-warehouse."*

4.2   The Requirement for Inter-organizational Networks

According to Seufert, et al. [89], the integration of networking into knowledge management yields significant benefits. The openness and richness of networks are believed to foster a fertile environment for the creation of entirely new knowledge, while also accelerating the innovation rate.

The choice to pool resources with other external organizations depends on calculating risk versus return (Powell, et al. [76]). Reliance on external partners involves risks. A lack of trust between and among the parties, difficulties in relinquishing control, the complexity of a joint project, and differential ability to learn new skills are all barriers to effective collaboration. Moreover, in those industries in which inter-organizational agreements are relatively frequent, there can be competitive confusion about who is an ally and who is not. The partnering decision thus depends on each partner's size and position in the "value-chain" and the level of technological sophistication, resource constraints, and prior experiences with alliances. The form of collaboration is purported to vary according to the specific types of skills and resources to be exchanged.

Powell, et al. [76] demonstrated a ladder effect, in which enterprises with experienced partners competed more effectively in high-speed learning races. Rather than trying to monopolize the returns from innovative activity and forming exclusive partnerships with only a narrow selection of organizations, successful enterprises positioned themselves as the hubs at the centre of overlapping networks, stimulating rewarding research collaborations among the various partner-organizations. Reliance on networks has potentially transformative effects on all participants. Those positioned in a network of external relations adopt more administrative innovations, and do so earlier. The presence of a dense network of collaborative ties may even alter participants' views on competition. Inside a densely connected field, organizations must adjust to a novel perspective in which it is no longer necessary to have exclusive ownership of an asset in order to profit from it. Moreover, since a competitor on one project may become a partner on another, the playing field resembles less of a horse-race and more of a rugby match, in which players frequently change the colour of their jerseys.

Regardless of whether networking is driven by gaining access to new knowledge, or by creating and transferring knowledge, connectivity to a network and competence at managing networks have become key drivers of a new business logic. A framework for knowledge networking could be helpful in order to give it structure and reveal interdependences.

4.3   St Gallen Framework for Knowledge Networks

"The more important the subject and the closer it cuts to the bone of our hopes and needs, the more we are likely to err in establishing a framework for analysis."
- Stephen Jay Gould

Seufert, et al. [89] from the Institute of Management, University of St Gallen, proposed a framework for knowledge networks comprising of the following components:

- actors (Individuals, Groups and Organizations);

- relationships between actors which can be categorized by form, content and intensity;

- resources, which may be used by actors within their relationships, and

- institutional properties (structure, culture, rules, processes, communication plans).
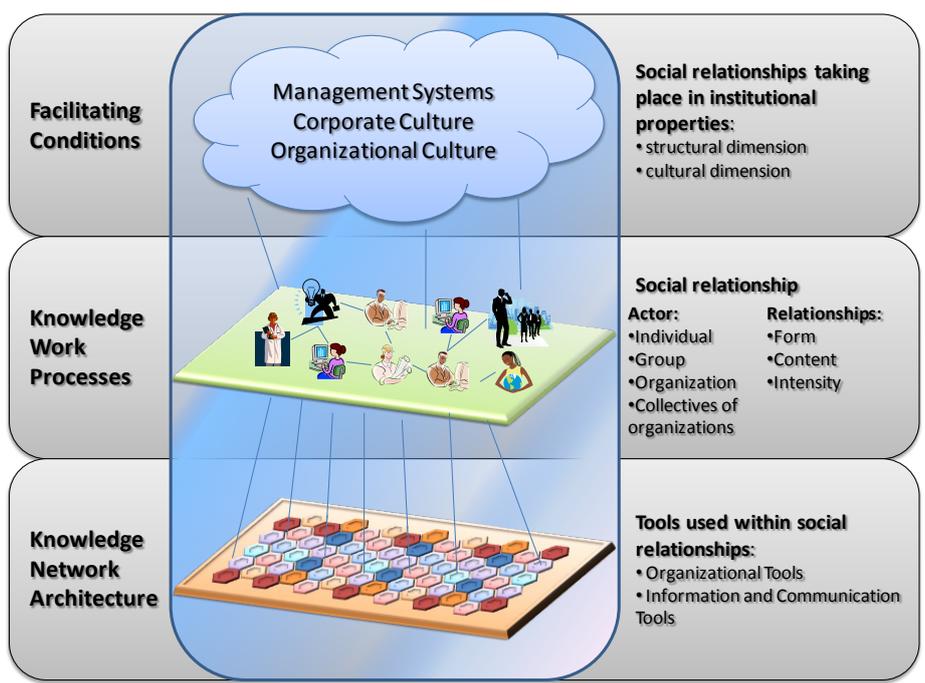
Figure 4-2: Framework for Knowledge Networks

- Seufert, et al. [89]

Figure 4-2 illustrates the three building blocks:

- **Facilitating Conditions:** The network's internal structural and cultural dimensions in which knowledge work processes take place. They define the enabling or inhibiting environment for knowledge creation and transfer. The organizational structure, management systems or network culture are aspects to be taken into account.
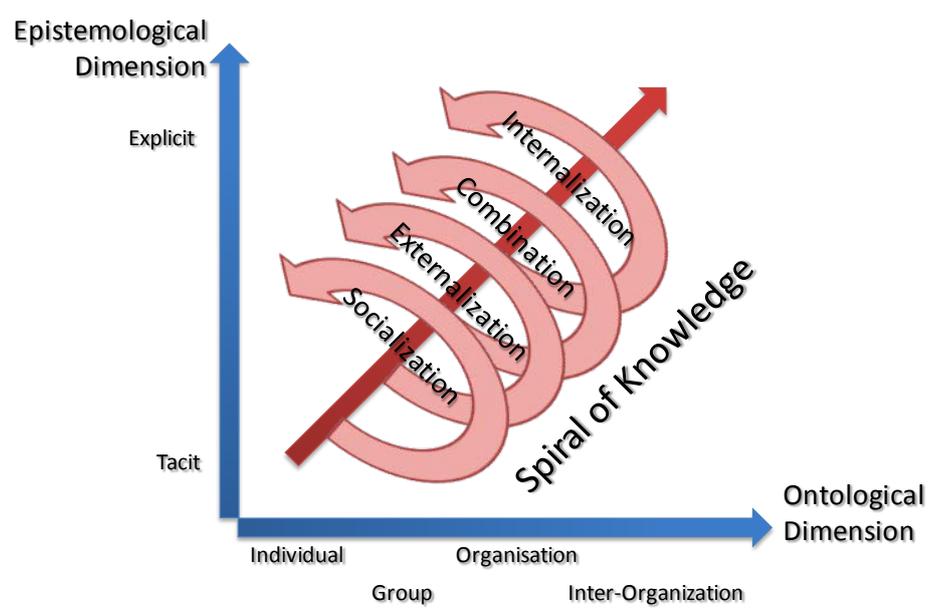
Figure 4-3: Knowledge Work Processes

- Nonaka and Takeuchi [66]

- **Knowledge Work Processes:** Social interaction and communication processes on an individual and group level, which can advance knowledge evolution to an organizational and inter-organizational level. Following Nonaka and Takeuchi [66] these processes can be conceptualized as a knowledge spiral, i.e. as a dynamic transformation-process between explicit and tacit knowledge on the different layers (see Figure 4-3). Refer to paragraph 2.4 for a definition of Socialization, Externalization, Combination and Internalization.

- **Knowledge Network Architecture**: the tool-set used within social relationships. These tools include organizational tools as well as information and communication tools.

4.4   Knowledge Network Reference Types

"We know more than we can tell"
Michael Polanyi, 1966

Figallo and Rhine [35] (Page 30) provide an important context for a knowledge network:

> *"A functioning knowledge network does not manage the knowledge. Rather, it manages the structure and composition of the networks that exchange the knowledge."*

A Knowledge Network revolves very little around the management of knowledge, but focuses much more on the networks and structures that use the knowledge.

Referring to Nonaka's SECI model (see par 2.4 on page 12), Back, et al. [14] defined Knowledge Network Reference Types, each pursuing one of the SECI main knowledge transformation processes (see also Figure 4-4):

- An **Experiencing Network** mainly pursues the knowledge process of transforming tacit knowledge from one knowledge body to tacit knowledge of another knowledge body. It supports the members to exchange their knowledge, best practices, and solutions through common experiences. In an experiencing knowledge network, sympathized knowledge, such as shared mental models and technical skills, is prevalent.

- A **Materializing Network** comprises the knowledge process of transforming tacit knowledge into explicit knowledge. It serves to motivate and stimulate people possessing tacit knowledge to externalize their experiences and thoughts. In a materializing network conceptual knowledge is created in the form of analogies or metaphors.

- A **Systematizing Network** mainly deals with transforming and refining explicit knowledge into more systemized explicit knowledge. In this type of knowledge network, existing explicit knowledge is systemized and refined in organizational textbooks, manuals, yellow pages, newsletters, and training materials, in order to reuse it more efficiently.

- A **Learning Network** comprises mainly of the knowledge process of transforming explicit knowledge ("know what") into tacit knowledge ("know how"). It supports the learning, embodiment, and application of existing explicit knowledge. As a result, new tacit knowledge is created.
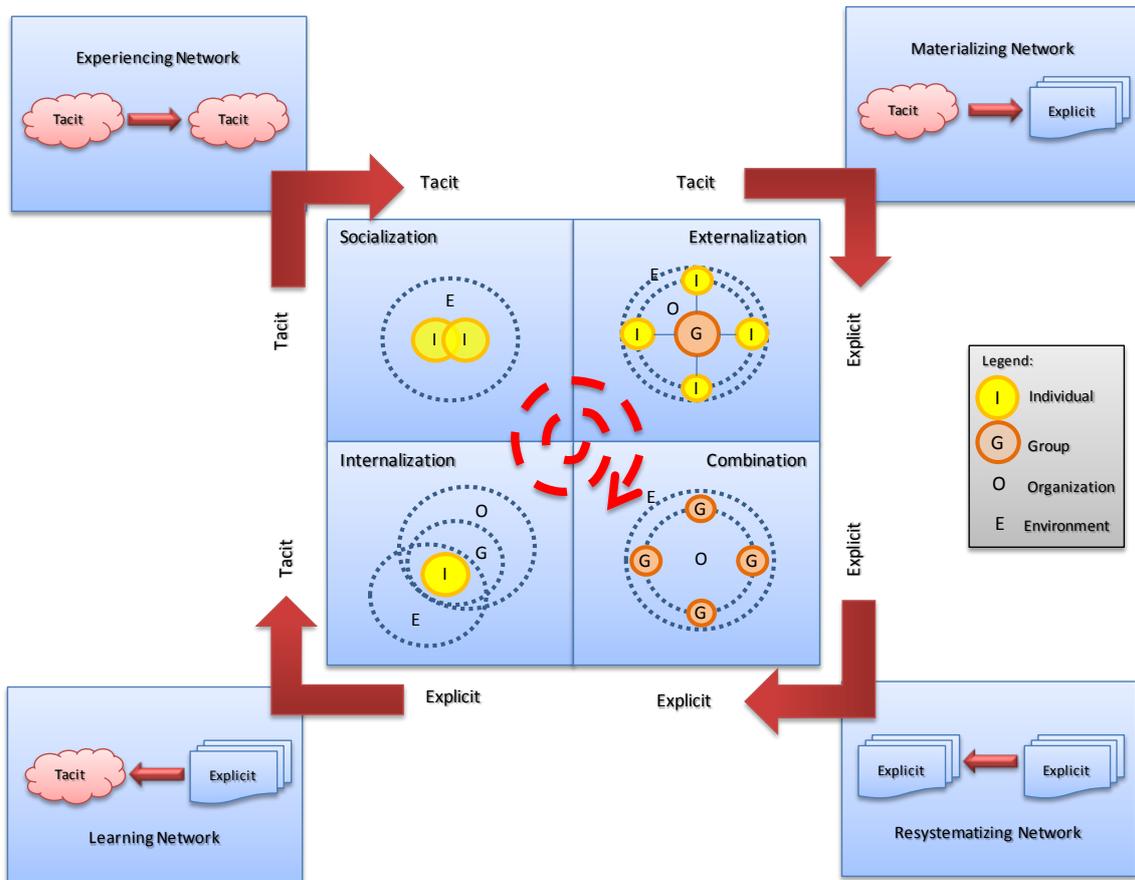
Figure 4-4: Knowledge Network Reference Types

- Adapted from Nonaka, et al. [65] and Back, et al. [14]

While knowledge network reference types suggest possible knowledge network configurations based on the most prolific knowledge work processes, these reference types do not imply that other knowledge work processes are not represented within the network. This is confirmed by the knowledge generation spiral presented in Figure 4-4, which suggests that knowledge work processes are linked and that the knowledge network would be incomplete without support for all the processes. By supporting all the available knowledge work processes within a 'balanced' knowledge network, a holistic approach to knowledge is ensured.

4.5 Knowledge Network Life-Cycles

The evolution of knowledge networks or communities-of-practice has been documented using different evolution cycles.

Büchel and Raub [18] have identified four stages in the creation of a knowledge network (Figure 4-5).
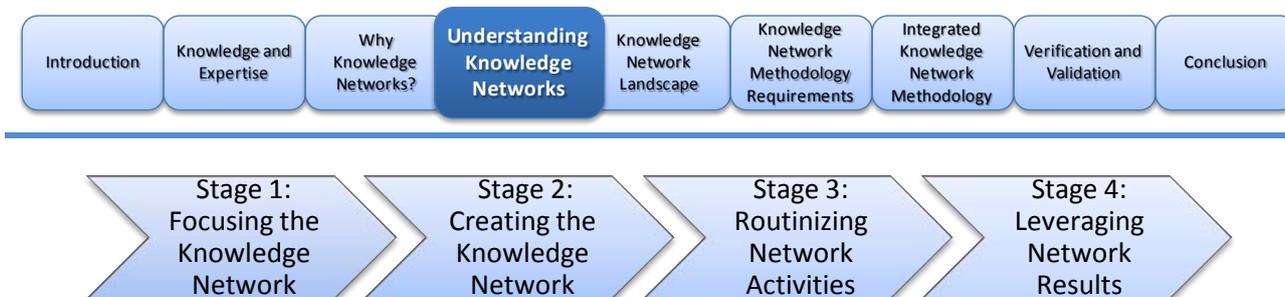
Figure 4-5: Knowledge Network Evolution Stages

- Büchel and Raub [18]

- **Focusing** the network includes activities such as aligning the network around important and common issues, finding management support and creating links between members.

- **Creating** the network context is a key activity for the network coordinator to establish a common ground for communication within the network. Network members must be given the opportunity to learn and understand each other's contexts.

- **Routinizing** network activities happens when the network defines roles and sets up a support structure. It is an activity where the network creates formal structures for the network's operations and includes for example the establishment of librarians for managing network websites and documentation.

- **Leveraging** network results takes place when the knowledge generated from the network is transferred to the organization as a whole.

Gongla and Rizzuto [40] presented a similar evolution cycle for the communities-of-practice at IBM. However, they also found that a community did not just move from one stage to another, but that they could actually move back and forth between the different stages. Sometimes the communities rested for a long time in one stage and suddenly rapidly moved to another.

This evolution cycle has evolved into a Maturity Model, as depicted in Figure 4-6.
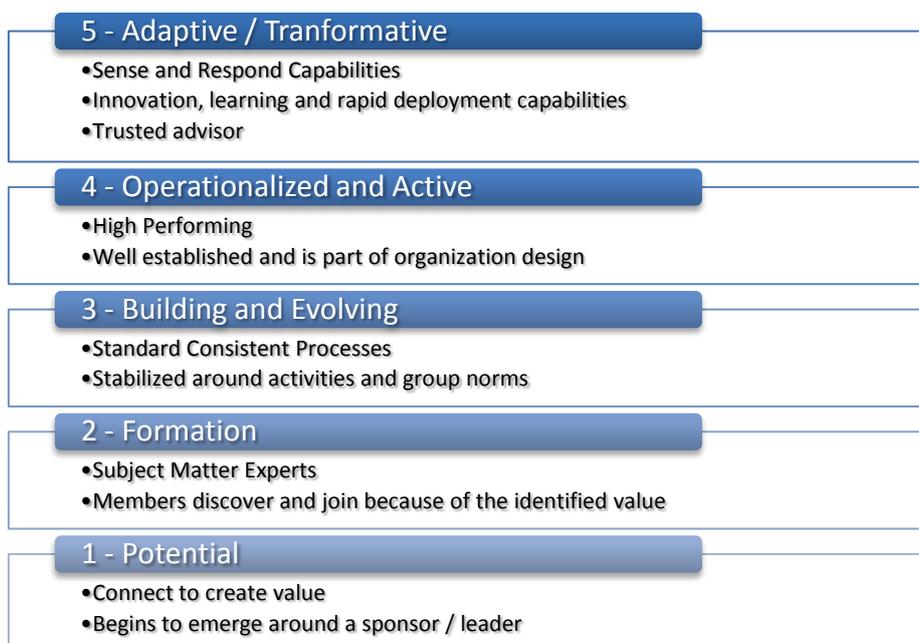
Figure 4-6: Community of Practice Maturity Levels

- Source, IBM

4.6   Facilitating Conditions and Key Success Factors

In order to successfully implement a Knowledge Network, a supportive environment is required.

4.6.1   Facilitating Conditions

What makes the topic of a Knowledge Network's performance and the assessment of the value of a community complex is the fact, that a number of enabling conditions inside and outside the community exist, which have an impact on the network's performance. According to Frederick Herzberg's Motivator-Hygiene Theory, such enabling conditions - on the one hand have an effect as "motivators" and on the other hand as "hygiene factors". When not present or not sufficiently fulfilled, they are deemed "barriers". These knowledge management barriers might be organizational, technical, corporate culture or even directly aspects of knowledge work processes. See Figure 4-7.
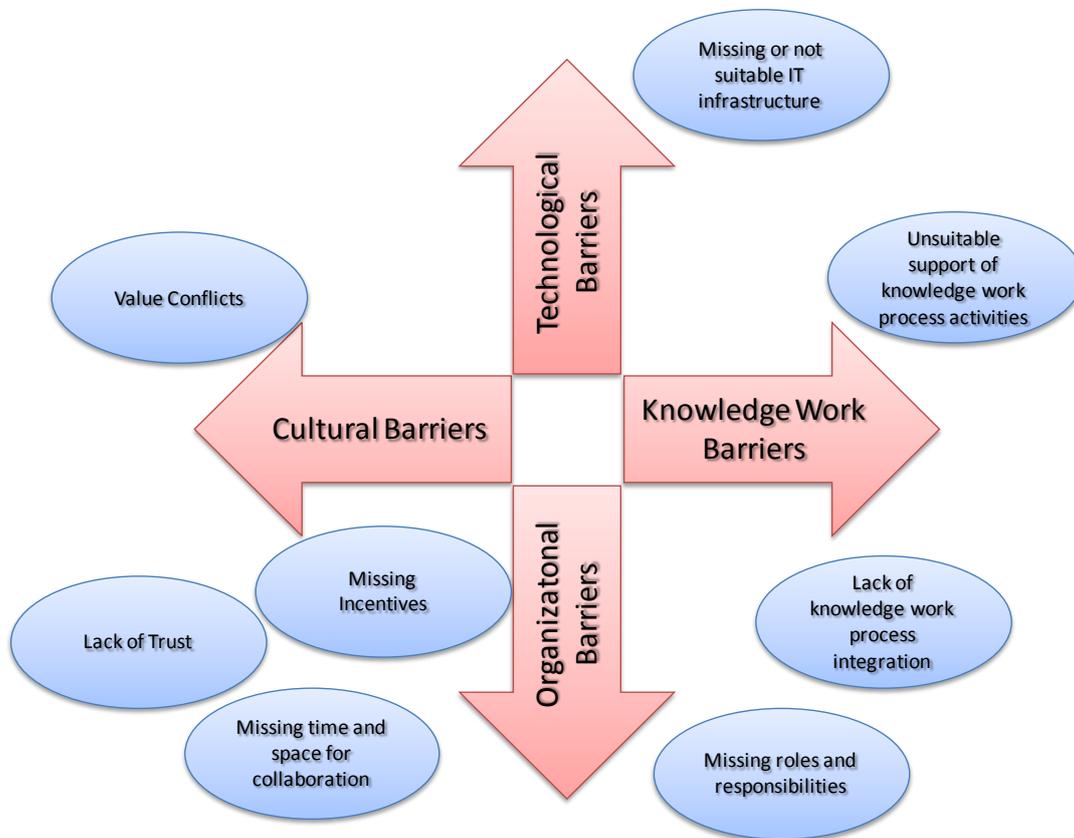
Figure 4-7: Knowledge Management Barriers

- Raimann, et al. [80]

If the enabling conditions are missing or fulfilled insufficiently, the performance of the network will probably be low. That is the reason why it is important to be aware of these enabling conditions for knowledge management in general but also with regard to the performance of communities. In order to keep the performance high, the measurement of the "enabling conditions" should form part of a comprehensive performance measurement system (see par 4.8).

4.6.2 Key Success Factors

According to the Forfás report [1], the following Key Success Factors are required:

- **A Clear Need**: An important condition for the development of a network is that the members perceive that there is a clear need to belong, in that the network can achieve something that the individual members cannot achieve on their own.

- **Objectives**: Related to the requirement that a network should have clear needs, there is also the requirement that it should have objectives that primarily reflect the needs of the member organizations.

- **Leadership and Vision**: Networks that have leaders who are able to articulate clear and concise goals are more likely to be successful then those networks whose members are unclear as to their network's future direction. The leader should not only be able to communicate the network's long term goals but must also be able to translate those goals into a realistic programme of action.

- **Early Successes**: The research has indicated the importance of achieving early successes in order to get member organizations to continue their involvement in the network. It is vital, therefore, that networks structure their objectives and work programmes to ensure that members can see a return for their investment in the short term.

- **Trust**: On paper, a grouping of companies in a sector might make the ideal candidates for a network. However, the successful development of networks has been found to be very dependent on the level of trust between and among member organizations. Since the network involves members who normally act on their own, the implementation of network activities requires a certain level of trust by the members. The gaining of trust is particularly important in those networks whose membership includes companies that compete against each other.

- **Ownership**: If the network is to succeed, it will be necessary for them to take ownership of the development process and drive the network forward. If the companies do not have ownership of the network they will not be committed to it. They will perceive that it will have an agenda that may not approximate to their own

- **Time**: The formation of a durable network can take time. A considerable period can elapse before the members have developed trust and confidence in the network to undertake joint activities. Member organizations need to interact socially before they can commit themselves to working with other members.

- **Critical Mass**: The lack of critical mass can delay the outputs from a network.

- **Key Player**: Related to the issue of critical mass, the presence of a major player with the vision and resources can be influential in driving the network forward.

- **Communication/Branding**: The development of a clear identity for a network can be critical for its longevity.

- **Facilitation**: To be successful, networks need on-going facilitation. The inputs of a network manager in terms of supporting the network, brokering the needs of individual members, coordinating what is a complex process and implementing the network's work programme can have a significant bearing on its long term viability.

- **Social Factors**: An aspect often over-looked in the development of networks is the importance of social interaction.

- **Top-Down Incentives or Pump Priming**: The provision of State funding where submissions involving two or more applicants can obtain higher scoring points has been found to be very helpful in the development of networks.

- **Process**: While the concept of networks is easy to grasp, operationally a network is both complex and challenging to operate. The key success factor is the process or the "how" factor i.e. how companies are attracted to participate in a network, how their commitment is gained, how the process of developing the network is managed, how it is structured, how decisions are made, how communication is handled, how action programmes are delivered, etc.

These Key Success Factors are used in later on in Chapter 8 to verify the knowledge network methodology (see par 8.1.2)

4.7   Barriers and Management Challenges of Knowledge Networking

"I am not discouraged,
because every wrong attempt discarded
is another step forward."
- Thomas Edison

It is a challenge to create intentional knowledge networks. Dyer and Nobeoka [31] present three dilemmas associated with knowledge sharing in a network setting, which are important to consider when setting up a network.

- Firstly, how are self-interested network members motivated to participate in the network and to openly share valuable knowledge with other network members?

- Secondly, in a group or network setting there is always a problem with free riders, who enjoy the benefit but without contributing any value themselves.

- Thirdly, how does a network maximize the efficiency of knowledge transfers among a large group of individual members? How can the network facilitate how network members find and access valuable knowledge within the network?

Dyer and Nobeoka found that these issues can be overcome by:

- the creation of a strong identity within the network;

- the creation of clear rules for the network and member participation; and

- the creation of strong ties and redundant relationships, which facilitate the transfer of both tacit and explicit knowledge.

Successful knowledge networks facilitate efficient communication between and among their members and the language aspect is therefore important. A common language that can be used by the network members will make communication more efficient. A knowledge network may involve members from different communities, who require a common language and a joint understanding of symbols.

4.7.1 Knowledge Network Management Challenges

It is difficult to create successful knowledge networks. It requires skilled managers that master social processes, and who understand how people learn and share knowledge. The limited empirical knowledge on how knowledge networks are set up in high-tech organizations may result in issues and problems encountered during the set up process becoming overwhelming. (Schönström [86])

Knowledge network management denotes a proactive, systematic approach to the planning and design of intentional, formalized networks for knowledge creation and transfer, and the establishment of conditions to cultivate emergent, informal networks. This includes the identification of existing knowledge networks, widening their scope, guiding them towards high performance, and transferring the best practices to other application contexts.

Schönström did research on a network implementation and concluded with the following lessons learnt:

- **Identify and support knowledge activists**: A pre-requisite for creating a successful knowledge network is the engagement of knowledge activists that can work as network coordinators. The network coordinators are the main driving force in the network, and it is important that they come from the community itself. If the network coordinators do not come from the community their role will be weakened. They will not have the knowledge or the understanding of community issues and will also have problems communicating with community members and to support the network, as they do not speak the same language as the rest of the community. The organization needs to identify knowledge activists before setting up a network.

- **Make knowledge networks part of your corporate knowledge management strategy**: The knowledge network is emphasized in the literature as one important enabler to innovation processes. The concept of knowledge network should be part of a company's strategy if it is to be implemented successfully. Without any understanding of knowledge networks, and what they can accomplish, networks will have difficulties to function.

- **Formal knowledge networks are not immune to organizational restructuring**: To build knowledge networks is a difficult matter and become even more difficult when the existence of the organization is threatened.

- **Create an understanding of how formal networks relate to the line organization**: The setting up of intentional knowledge networks create a structure that exists in parallel with the line organization. A formalized network can create an overlapping organization where some of the power from the line organization is transferred to the network. Depending on the actors in the network and management commitment for the networks there is a risk for suspicion from the line organization regarding the network.

4.7.2 Knowledge Network Barriers

According to the Forfás report [1], the following barriers typically hamper the success of a network:

- There is a general lack of awareness as to the benefits of networks (as distinct from networking) among the business community;

- There is a reluctance to commit time and resources to a process that is not well understood, or the results of which are not clear;

- Networks are too closely aligned with 'networking' in the mind of business managers and seen as a quasi-social activity rather than an important business function;

- There is a reluctance to share information and knowledge with other organizations, especially competitors;

- Enterprises are not always well placed to identify the opportunities for network relationships with other companies, since their knowledge and information base may be limited to their own contacts;

- Membership of a network may expose companies to the danger of "lock-in" where excessive focus is placed on the affairs of the network, to the detriment of events in the outside environment;

- Even where managers foresee a benefit in establishing a network relationship they may not have the skills or resources to facilitate or co-ordinate the actual implementation of the network. This has been referred to as the 'collective action problem', where a group of individuals or enterprises may frequently fail to achieve co-operation, even where it would be beneficial to every individual in the group.

These Barriers are used in Chapter 7 to verify the proposed knowledge network methodology – if a methodology is able to prevent the barriers, it will improve the success rate of the network.

4.8   Measuring Knowledge Networks

"What gets measured, gets done"

-Deming

It is increasingly understood that knowledge is fundamental for companies to operate and achieve their goals. Companies are starting to understand that knowledge is an important resource – embedded in employees, captured in procedures and tools, etc. – which can be converted into value. However, it is very hard to observe and to measure knowledge and related knowledge management activities, and how this is converted into real value. (Raimann, et al. [80])

Many attempts have been made to measure intellectual capital and the impact of knowledge. Some examples are: (Back, et al. [14], Raimann, et al. [80])

- **Tobin's q**: Tobin's q is based on observations that knowledge-intensive companies are valued higher on the market than they are valued on tangible assets and that the market recognizes the value of intangible assets. Therefore, Tobin's q calculates the difference between the book value of a company and the replacement cost of the company's assets, and expresses this with the value of intangible assets.

- **The management value added**: This measurement method by Strassmann stresses the importance of management activity. Strassmann defines the knowledge capital as the result of management value added (which is left after all costs are accounted for) in relation to the price of capital.

- **The calculated intangible value**: This method strongly builds on insights of brand equity calculations where the premium supplied by the brand equals the asset value of this brand. The calculated intangible value method builds on a seven step-process in which different ratios and measures are calculated and in which the calculation of intangible assets is based on the measures and ratios calculated before.

- **Various forms of the balanced scorecard**: This well-known method builds on insights of Kaplan and Norton [47]. Kaplan and Norton suggest a scorecard with four perspectives namely financial, customer, internal processes as well as learning and growth.

- **The intangible assets monitor**: This measurement method was developed by Sveiby. Sveiby distinguishes between tangible assets in companies like cash, accounts receivable and equipment, office and space and between intangible assets as external structure, internal structure and competence of the personnel. The Intangible Assets Monitor tries to measure these intangible assets: external structure, internal structure and competence of the personnel by using a further distinction of indicators of growth/renewal, indicators of efficiency and indicators of stability.

- **Deferred labour costs**: This method bases on the thinking that salaries are partly an investment (and not just costs) for the company.

A measurement method should fulfil several requirements in order to be usable and practical enough for those who want to use measures. Some of these measurement requirements are: (Raimann, et al. [80])

- Measurement should not stand in contradiction to enabling conditions.

- Measurement has to be transparent.

- Measurement should be based on realistic goals.

- Quantitative and qualitative measures should be considered.

- Measurement should be linked to skill building and reward and incentive systems.

Back, et al. [14] proposes that, since no direct measurement of knowledge is possible, a scorecard should be used in order to integrate both financial and non-financial performance measures, while explicitly taking knowledge into account. The merits of using this scorecard are:

- Measurements at elementary levels and most individual measures can be aggregated right up to the corporation level; it is possible to measure at the individual-, the network-, and the company level.

- Benchmarking is possible and a regular compilation of benchmarks can easily be done; thus, one can compare networks across a company as well as across companies.

The Balanced Scorecard (BSC) is a well-known management and performance measurement tool (Kaplan and Norton [47]), which provides executives with a comprehensive framework that translates a company's vision and strategy into a coherent set of performance measures, organized into four perspectives: financial, customer, internal business process as well as learning and growth. As illustrated in Figure 4-8, the four categories provide answers for managers to the following basic questions:

- How do customers see us? (customer perspective)

- What must we excel at? (internal perspective)

- Can we continue to improve and create value? (innovation and learning perspective)

- How do we look at shareholders? (financial perspective)
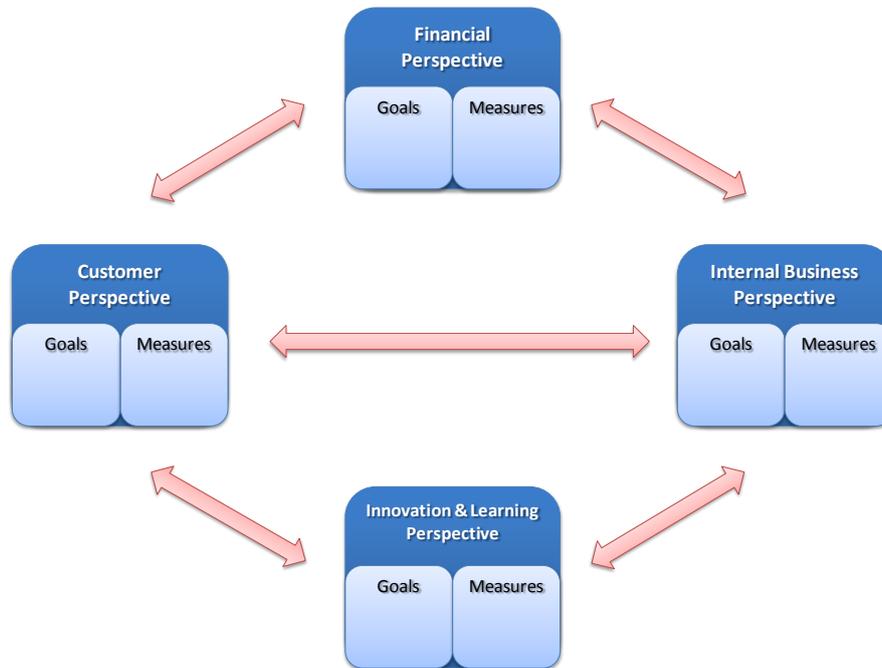
Figure 4-8: The Balanced Scorecard

- Kaplan and Norton [47]

The BSC retains financial management as a critical summary of managerial and business performance, but in addition, the BSC highlights a more general and integrated set of measurements that link current customer, internal process, employee and system performance to long-term financial success. In other words: the BSC expands financial accounting to incorporate the valuation of a company's intangible and intellectual assets, such as high-quality products and services, motivated and skilled employees, responsive and predictable internal processes, and satisfied and loyal customers.

The construction of a scorecard usually takes place in four steps:

1. The requirements of the four key perspectives - learning and growth, internal processes, customer and financial - must be defined.

2. The strategic objectives have to be transformed into quantifiable measures, which help to translate the knowledge management activities for networks.

3. The key persons have to be determined.

4. Activities have to be set up, which lead to the goals being determined.

The strategic orientation of the company will largely determine the goals that need to be focused on. Once the steps have been determined, the knowledge scorecard should pursue the following goals: (Raimann, et al. [80])

- Clarify and translate the vision and strategy.

- Communicate and link strategic objectives and measures.

- Plan, set targets, and align strategic initiatives.

- Enhance strategic feedback and learning.

- Complement financial figures and business goals with IC development.

- In terms of implementation, one has to take action on the following points:

  o breaking down the goals of the company to knowledge goals on the individual level,

  o making them measurable with adapted indicators,

  o developing the knowledge scorecard, including the relevant stakeholders in the development process,

  o developing a pilot of the knowledge scorecard,

  o not allowing counter-productive measures,

  o taking business and fundamental issues and constraints, which have a direct influence on the company and the network, into consideration.

According to Back, et al. [14], the measurement system consists of measurements done on three levels: company, network, and individual. Regarding the measurement on an individual level, one has to start with the social dynamics involved. In this respect, the individual measurements would perform a monitoring function. Also important is the knowledge flow within the network and how this contributes to the business goals, largely making the knowledge scorecard more of a reporting instrument. Research has shown that the following aspects have to be taken into account when implementing the knowledge scorecard:

- **On a company level**

  o The organizational and strategic assessment.

  o The portfolio assessment of all the knowledge networks within a company.

  o Breaking down business goals.

  o Reporting as a function for legitimizing networks.

  o The network manager must understand the reporting structure.

- **On a network level**

  o The measurement of network performance against goals.

  o Risk assessment based on social dynamics.

  o Discussing the performance within the network.

  o Measures for knowledge flow and for learning.

- **On an individual level**

  o Self-assessment for behavioural change.

- o Clarifying expectations.
- o Usage of the network in a wider context.

4.9 Functional Requirements Summary

Seufert, et al. [89] defines **Knowledge Networking** as follows:

"A number of people, resources and relationships among them, who are assembled in order to accumulate and use knowledge primarily by means of knowledge creation and transfer processes, for the purpose of creating value."

Based on the above definition, it is implied that a knowledge network has two main functions to perform (as depicted in Figure 4-9 below):

- Connect People and Organizations
- Create and Share Knowledge
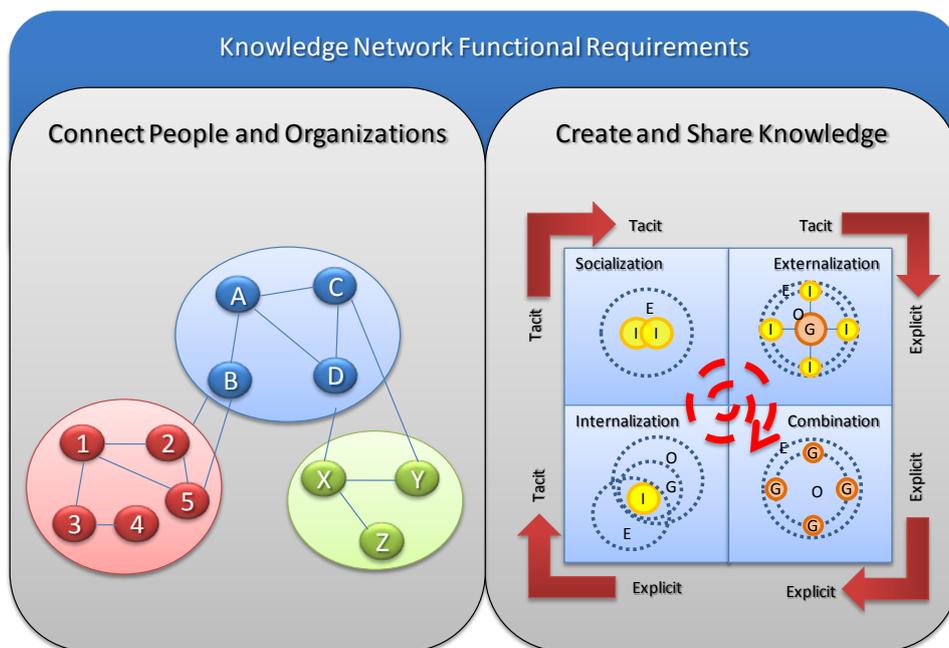
Figure 4-9: Functional Requirements Diagram

- Portions adapted from Nonaka, et al. [65]

This is confirmed by Anklam [13], who discusses two main aspects in Chapter 2:- the Collaboration Imperative, and the Economic Impetus, that is embodied in Intellectual and Social Capital.

Based on Nonaka, et al. [65], while the Create and Share Knowledge aspect of a knowledge network may vary over time, in order to contribute to an increase in knowledge in a domain, it is important that all four aspects of the knowledge creation spiral are addressed by a knowledge network in its life-cycle. The functional requirements thus need to address:

- Socialization
- Externalization

- Combination, and

- Internalization.

The functional requirements that were identified in a functional requirements analysis exercise are listed and summarized below:

- **Connect People and Organizations:** Inherent in the definition of network, to connect entities. Per the definitions of Back, et al. [14], Seufert, et al. [89], Du Preez, et al. [29], one of the main purposes of Knowledge Networks is to connect people and organizations. This is expanded as follows:

  o **Identify and Select Collaborators:** A knowledge network is comprised of collaborators sharing explicit and tacit knowledge and interacting with one another. Only the appropriate composition of collaborators ensures an effective and efficient knowledge sharing and collaboration within the knowledge network. The identification and selection of the appropriate knowledge network participants is thus crucial for its future performance.

  o **Gain Commitment of Top Management:** Since a knowledge network is a formally set-up structure, it implicates management acceptance and support. The commitment of management is crucial for the knowledge network's survival, as the management has to provide the required financial, personal as well as organizational resources.

  o **Mechanisms to gain Management Commitment:** There must be a requirement and a business purpose for a knowledge network before management will commit. It is important to sell the benefits to management.

  o **Connect Collaborators:** Mechanisms to introduce and connect the identified collaborators are required.

  o **Communication Mechanisms:** In order for people and organizations to connect and communicate, Communication Mechanisms need to be present. These can be ICT mechanisms such as Websites, Forums, VOIP etc, or also the more traditional mechanisms such as face-to-face meetings, telephone etc.

  o **Encourage Trust and Openness:** Especially in a Virtual Team environment, where geographically dispersed people and organizations are required to work together, Trust and Openness is a challenge. Trust and Openness must thus be encouraged, and also given time to develop.

  o **Face-to-Face Meetings and Forums:** In order to create the necessary opportunities for the socialization aspects of knowledge transfer, a knowledge network needs to make use of face-to-face meetings and forums.

  o **Gain Commitment of Members:** Barriers to the establishment of a knowledge network can be encountered on the level of the managerial hierarchy, but also on that of potential knowledge network participants, the latter covering a wide field. In addition, there might be organizational barriers, such as the geographical dispersion of the participants, but also personal barriers. These barriers must be kept in mind during the initial contact and this contact should be aimed at creating mutual understanding and a mutual knowledge base.

o **Recognition of Members:** In order to create the necessary motivation for network members, the network needs to recognize the contributions of members.

o **Protect Intellectual Property:** Mechanisms (organizational, procedurally and ICT) should exist to protect the intellectual property of individuals and organizations.

- **Create and Share Knowledge:** Per the definitions of Back, et al. [14], Seufert, et al. [89], Du Preez, et al. [29], one of the main purposes of Knowledge Networks is to create and share knowledge. This is further expanded as follows:

  o **Transfer Existing Knowledge:** The processes of socialization, externalization, combination and internalization, whereby knowledge is transferred.

  o **Share Knowledge:** Through communication mechanisms, knowledge is shared.

  o **Share Experience:** Sharing Tacit Knowledge through Socialization and Externalization.

  o **Share Literature:** Sharing explicit knowledge through Combination and Internalization.

  o **Share Research Outputs:** Sharing explicit knowledge through Combination and Internalization.

  o **Exploit Knowledge:** An aspect of the Knowledge Creation process is to seek new application for existing knowledge, and to use this knowledge in new innovations.

  o **Support Network Purpose:** The Knowledge that is created by the network must support the overall goal and purpose of the Knowledge Network.

  o **Identify Knowledge Gaps:** Depending on the purpose of the knowledge network, there will be a knowledge domain that needs to be explored. Depending on the tacit and explicit knowledge available to the network, Knowledge Gaps can be identified that can help to focus the activities of the network.

  o **Create New Knowledge:** New knowledge is created by ensuring that all four aspects of BA is present in the network. (Nonaka, et al. [65])

  o **Execute Research:** Research networks will create knowledge through research activities.

  o **Document Research Outputs:** The process of externalization.

  o **Explore Explicit Knowledge:** In order to conduct research activities, or to identify knowledge gaps, the explicit knowledge domains need to be explored (i.e. find all related knowledge in documents). This can be done through searches (Google, Intranet, Library searches), Text mining, Taxonomy searches etc.

  o **Explore Tacit Knowledge:** In order to ensure that there is an understanding of the tacit knowledge present in the network, it is important that the existence of tacit knowledge is captured in a manner that makes it searchable. The concept of Knowledge Profiles can be used to make this possible.

4.10 Chapter Conclusion: Knowledge Network Functions Identified

This chapter reviewed the functional aspects of knowledge networks, and how knowledge is created in such a network. Representative knowledge network functional requirements were identified in the process, as depicted in Figure 4-10 below.
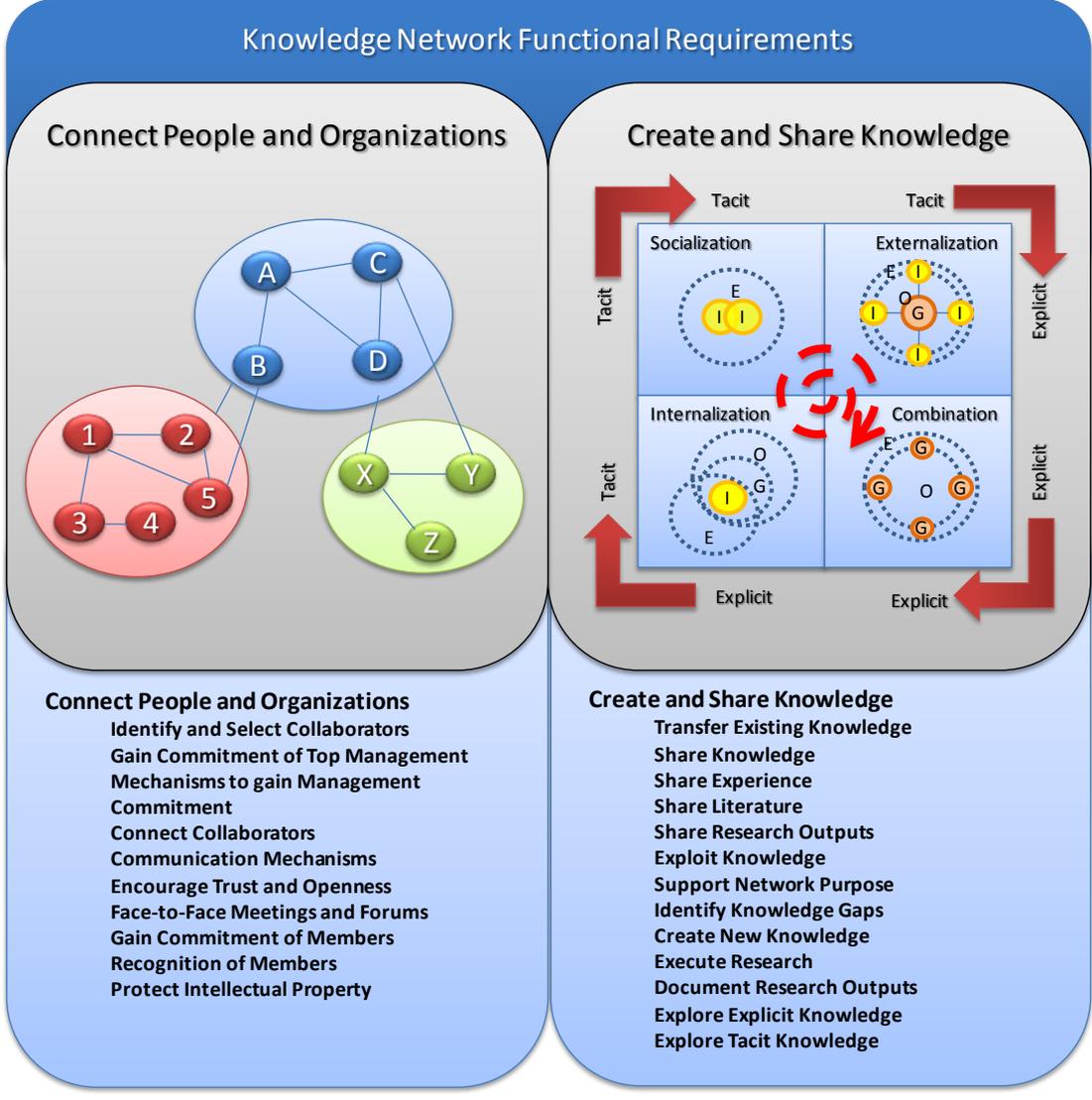
Figure 4-10: Functional Requirements Summary

The above functional requirements are used in Chapter 6 to summarize all requirements, and in Chapter 7 to validate the methodology against these requirements.

Chapter 5: The Knowledge Network Landscape

Knowledge Networks exist in different forms, and for different purposes. Different terminology is often used to describe these knowledge networks. It is important to understand subtle differences between network variants to ensure that a generic design framework will cater for most, if not all, variations.

This chapter revisits the reasons for existence of Knowledge Networks. It reviews the purposes and categorizes the Knowledge Networks into Knowledge Network Variants, similar to those categorized by Anklam [13]. Additional Knowledge Network Variants, as identified by the author, are then also presented, and brought into context in the conclusion of the chapter.

Lastly, each variant's contributions towards supporting different aspects of the innovation landscape is discussed, and in the conclusion, the possibility is discussed that the author's definition of an Integrated Knowledge Network is possibly a generic version of a knowledge network that will satisfy the purposes of all knowledge network variants discussed.
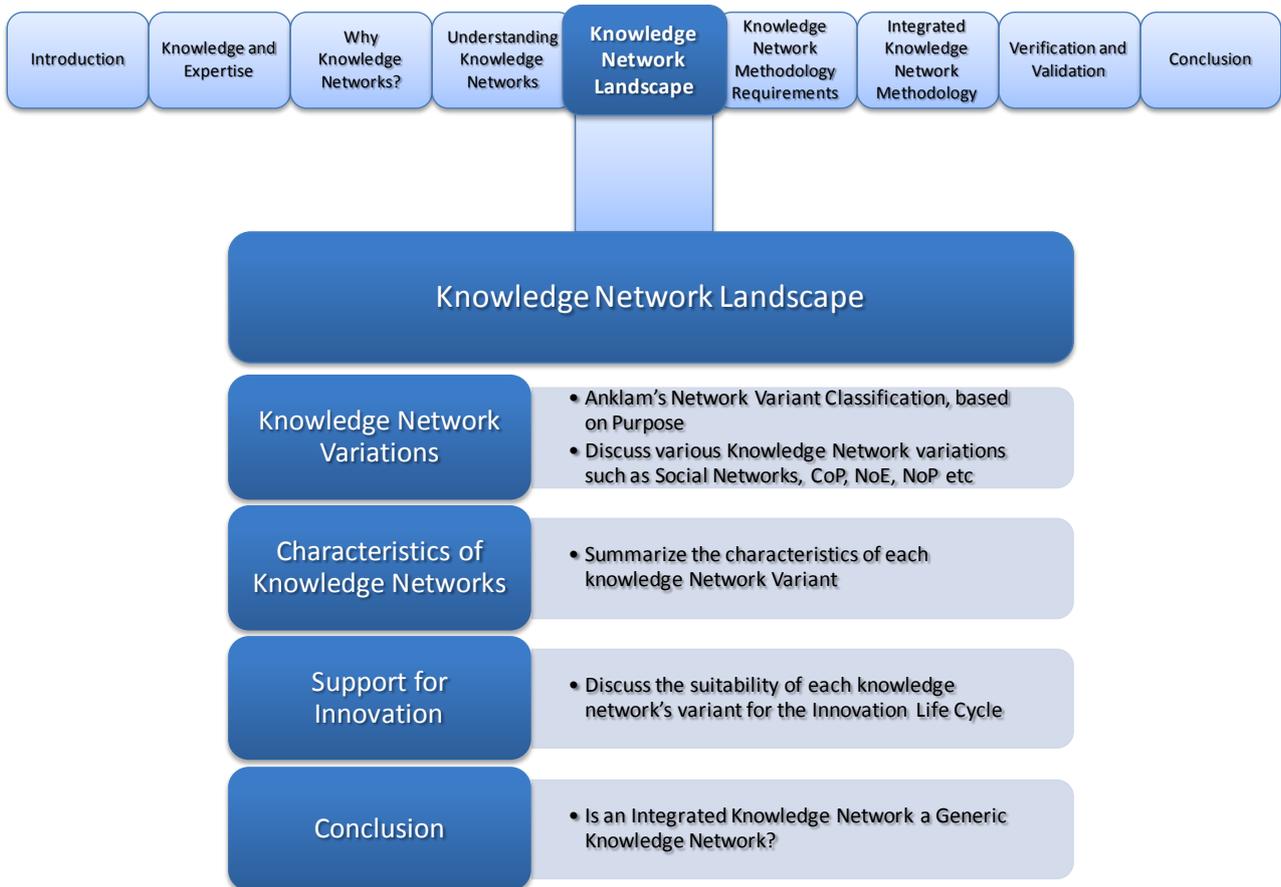
Figure 5-1: The Structure of Chapter 5 within the Context of the Overall Navigation Structure

5.1   Knowledge Network Variants as derived from Network Purpose

Based on the taxonomy of Anklam [13] (see paragraph 3.1 on page 24) the different network purposes can be decomposed into network types, as shown in Figure 5-2.
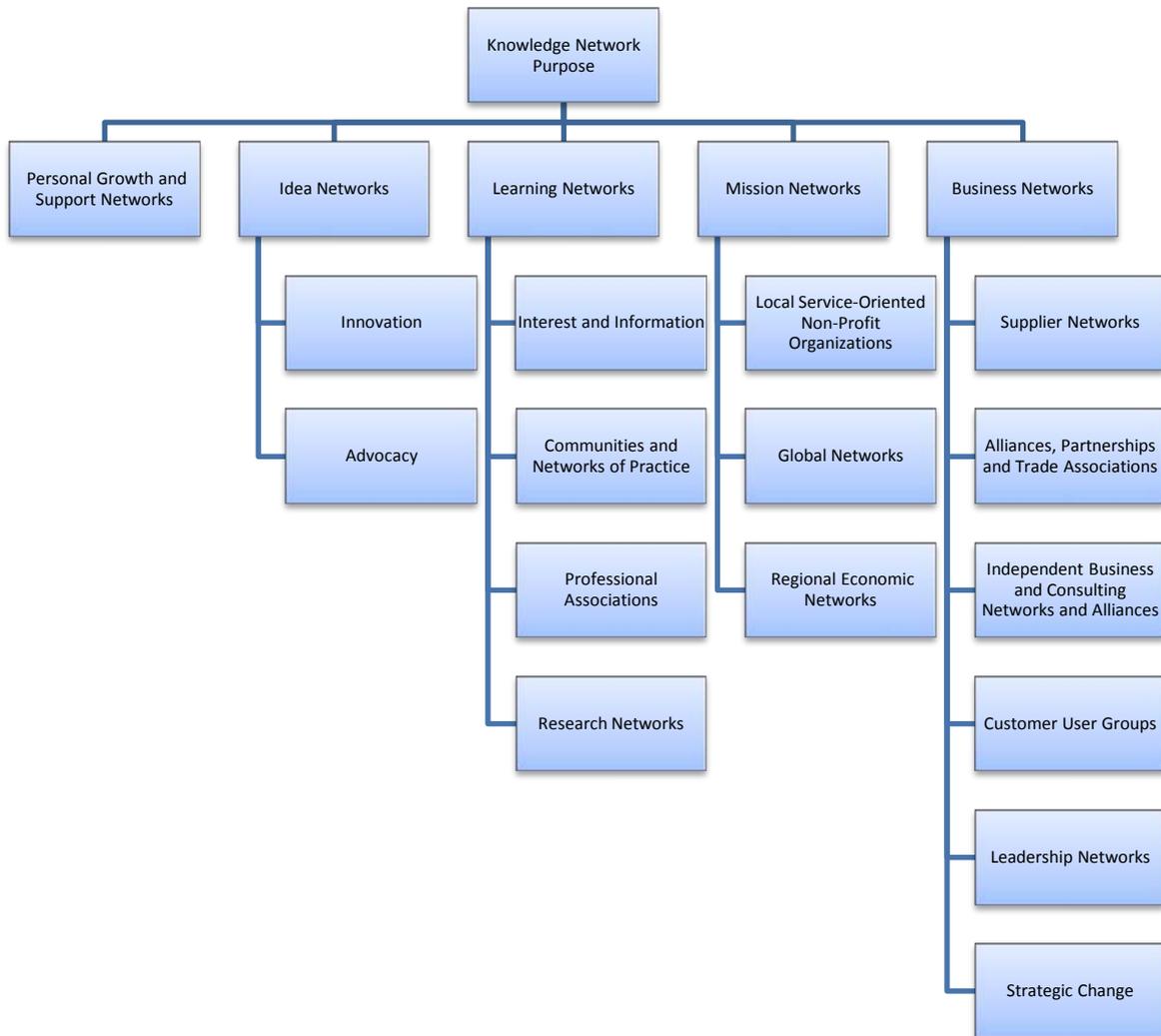
Figure 5-2: Knowledge Network Variants derived from Network Purpose

Each of these purposes and network types is briefly described in more detail below (Anklam [13]):

Personal Growth and Support Networks: Personal networks have many dimensions—families, schoolfriends, co-workers, neighbours, people individuals know through religious, civic, or wellness activities—all of which tend to be informal. Individuals leverage these networks when they need assistance looking for a job, a new car, or a good book to read. These networks grow organically and randomly as they meet people in their daily modus operandi. The sum of the people they know through their networks constitutes their personal network, those they are most likely to turn to when they have an idea, need advice, or desire fellowship.

Idea Networks: Idea networks are based on a creative exchange that facilitates ideas to build on each other. The results or outcomes of idea networks are emergent: when you enter an idea network's virtual space or enter a room where it is meeting, you do so knowing that you will not know where the conversation will lead.

- **Innovation Increase:** This network purpose correlates with one of the main purposes identified by Von Krogh, et al. [86]. This is also the most important focus of this research – refer to Chapter 3: Why Knowledge Networks? – The Innovation Focus

- **Advocacy:** An advocacy network takes the power of an idea and gives it legs; political and spiritual networks attract people of specific attitudes, opinions, and values who are passionate about a viewpoint and want to educate and persuade others to that viewpoint. Grassroot political campaigns and social movements have always used a network model to diffuse ideas, enrol membership, and lobby for change or reform. Today, bloggers of all stripes connect and interconnect using the power of the World Wide Web to meet, exchange, and build on one another's ideas.

Learning Networks: Learning networks focus on augmenting the personal capacity of an individual or a group in a particular area of skill, expertise, vocation, avocation, or knowledge.

- **Interest and Information:** Interest networks, often called "communities of interest," went mainstream with the availability of free services from Yahoo! and Google Groups. We pursue those most important to us through participation in learning networks. For business and civic topics, we rely on either formal structures (corporate communications, phone trees, newsletters), or word of mouth. If you need to know something, you need to trust that it will be made known to you by virtue of your membership in these groups.

- **Communities and Networks of Practice:** The most formally studied of the various types of learning network is the community of practice. Formal communities of practice are distinguished by three intentional characteristics:

  o a shared domain of interest and a desire to develop competency in that domain;

  o community activities through which one shares one's own learning experiences with others; and

  o the development of a shared repertoire of practice that includes resources, stories, techniques, and methods.

- **Professional Associations:** Professional associations exist to enhance the integrity of the practices on which they are based and to provide educational and reputation-building opportunities for members. Many associations are formal, incorporated organizations that provide learning and networking opportunities through newsletters, publications, and annual meetings. Within an association, special interest groups provide focus on individual topics.

- **Research Networks:** Research laboratories, both those dedicated to pure research and those doing applied research for product development, are looking for more and better ways to not only collaborate across internal boundaries but also be more active in bringing ideas from academic and professional networks into their companies.

Mission Networks: Mission networks are directed to the social good. Arts and culture, education, environment, health, human services, religion, and social justice are the primary categories of service to which non-profit organizations (NPOs) devote themselves. The networking strategy for these organizations is often dual: creating a network of organizations to develop and maintain the program; and creating networks in the target population.

- **Local Service-Oriented Non-Profit Organizations:** A local service organization begins with a person or small group who sees injustice in the distribution of wealth, the wrongful use of environmental resources, or an opportunity to enrich the personal lives of others through education, music, or the arts. These local networks produce value for their neighbourhoods' present and future.

- **Global Networks:** Global Networks, typically founded and funded by organizations such as the United Nations, are focused on human services, including disaster relief and healthcare, education, economic development, human rights, and the development and application of international law. More sets of prominent global networks are those devoted to environmental causes. Groups like Greenpeace and the World Wildlife Fund have embraced the network form of organization to enable local action in the face of threats to species and habitats (including human ones).

- **Regional Economic Networks:** Regional Economic Networks are focused on regional ecosystems to sustain healthy economies in their respective geographic areas. The flow of ideas, start-up creation, and partnering activities produce value for the companies and individuals involved, and also for the regions as a whole.

Business Networks: The goals of a for-profit business network are production and growth—growth of revenue, profit, and returns to shareholders through growth of market reach, product breadth, expertise and knowledge. In this category of business networks can be found non-profit organizations (including public and educational institutions) whose stakeholders demand accountability for financial and operational functions. All these types of business-based institutions are seeing the benefits of the network approach to growth—to partner rather than acquire, to work through alliances, to bring customers into the planning and assessment processes, and to reach out and reach within to leverage networks for strategic change.

- **Supplier Networks:** The traditional view of the supply chain as a linear flow of transformation, movement, and storage of goods has shifted with the growth in understanding of the important role of relationships in managing risk. When competitive advantage comes from delivering a quality product to a customer at the time it's needed, companies must focus not just on the ties to their suppliers but also on the strength of those ties. The company–supplier relationships are taking on a network approach to linking suppliers with one another through knowledge sharing, both online and face-to-face, involving employees and senior executives in their supplier companies through everything from planning and forecasting to improved quality and work methods.

- **Alliances, Partnerships and Trade Associations:** An **alliance** is an agreement between two or more parties, made in order to advance common goals and to secure common interests.

  o A **partnership** is a type of business entity in which partners (owners) share with each other the profits or losses of the business undertaking in which all have invested.

  o A **trade association** is an organization founded and funded by businesses that operate in a specific industry. An industry trade association participates in public relations activities such as advertising, education, political donations, lobbying and

publishing, but its main focus is collaboration between and among companies, or standardization.

- o A **joint venture** (often abbreviated JV) is an entity formed between two or more parties to undertake economic activity together. The parties agree to create a new entity by both contributing equity, and they then share in the revenues, expenses, and control of the enterprise. The venture can be for one specific project only, or a continuing business relationship. The creation and maintenance of such alliances is a delicate task of managing relationships between and among individuals at all levels of an organization.

- **Independent Business and Consulting Networks and Alliances:** The economic and demographic shift created a large pool of professionals joining the ranks of independent consultants. These consultants quickly understood the importance of networking, joining networks and being attached to connections within their geographical or topical areas of interest. These networks begin with a goal of tangible outcome: generating business. To survive and be successful, however, these networks must also offer opportunities for practice development and shared learning.

- **Customer User Groups:** A user group is a type of club focused on the use of a particular technology, usually (but not always) computer-related. User groups started in the early days of mainframe computers, as a way to share sometimes hard-won knowledge and useful software, usually written by end users independently of the factory-supplied programming efforts. SHARE, a user group originated by aerospace industry corporate users of IBM mainframe computers, was founded in 1955 and is the oldest computer user group still active. User groups have been a mainstay of technology companies to create educational programmes, provide an opportunity for professional networking, and influence the direction of the industry, which was at that time IBM. IBM now interacts with its users in a variety of communities, including Share. The model has worked well, and not just for IBM: Software companies of all sizes either host annual user group meetings or support member-led user groups.

  Purposes:

  - o Sustain a practice community among users;

  - o Provide a platform for the company to divulge future product plans or shifts in corporate strategy;

  - o Create social capital by having users come into direct contact with the employees and executives of the companies whose products they use;

  - o Create a channel for obtaining valuable customer feedback on current products and future plans.

- **Leadership Networks:** The value of developing personal networks has been on the leadership agenda since the early 1990's, when network building became a top priority for senior managers. The following are common characteristics of these networks:

  - o unlike task forces, these are not temporary, but are longstanding networks that sustain change in the organization;

- members identify with the network and with each other; the frequency and honesty of their dialogues reshape personal relationships;

- continuous interaction over time builds a shared understanding of the business;

- managers' performance and potential for promotion is evaluated against their contributions to the network and sometimes by the network itself; and

- networks are dynamic and take initiative, becoming the vehicle for redirecting the flows of information and decisions, the uses of power, and the sources of feedback within the hierarchy.

- **Strategic Change:** Social capital represents the bonds, norms, and trust that exist among people in an organization. A corporation that is high in social capital is a fertile breeding ground for networks: the more people know others and are comfortable connecting to them, the easier it is to form and work in networks. Informal networks have always operated in the spaces between business processes, in small teams or at the water cooler, baseball leagues, training courses, and cafeterias. Ties between and among people strengthen as people work together on projects and are drawn together by a common purpose. Networks emerge, self-organize around a purpose, and develop a unique structure and style that enable them to create value, often beyond their members' wildest dreams.

5.2   Knowledge Network Variations

The process of creating knowledge in networks to foster innovation has been labelled using different terminology. These terms are associated with slightly different meanings and characteristics. Since this research focuses on how integrated knowledge networks can improve the innovation process, the author therefore selected those knowledge network variants that are often used in the Innovation Landscape. Some of these Networks are also briefly reviewed in the categorization in par 5.1.

The networks investigated, are:

- Social Networks

- Communities of Practice

- Knowledge Networks

- Networks of Excellence

- Joint Ventures

- Community Based Participatory Research (CBPR)

- Innovation Networks

- Competence Networks

- Integrated Knowledge Networks

Each network is described in more detail in par A.2 in Appendix A.

The network variants discussed are shown in Figure 5-3 below, with the purpose, as per the Anklam [13] categorization, shown below each network.

Social Networks
- Purpose Category: Personal Growth and Support Networks

Communities of Practice
- Purpose Category: Learning Networks

Knowledge Networks
- Purpose Category: Learning Networks

Networks of Excellence
- Purpose Category: Learning Networks

Joint Ventures
- Purpose Category: Business Networks

Community Based Participatory Research (CBPR)
- Purpose Category: Learning Networks

Innovation Networks
- Purpose Category: Idea Networks

Competence Networks (Kompetenznetze)
- Purpose Category: Learning Networks

Integrated Knowledge Networks
- Purpose Categories:
  - Learning Networks
  - Idea Networks

Figure 5-3: Knowledge Network Variants, with Purpose Categories

5.3   Characteristics of each Knowledge Network Variant

It is a challenge to provide a comprehensive methodology that accommodates all variations of Knowledge Networks. If common characteristics or specifications of each knowledge network variant are identified, a methodology to address the common characteristics of each variant may be derived.

Table 5-1 on page 76 lists the main characteristics of each Knowledge Network Variant. From this list the common areas, and possible differences can be identified and categorized.

The following characteristics are:

- **Purpose**: A summary of the main purpose for the existence of the network variant.

- **Purpose Category**:   Refer to the purpose categorization proposed by Anklam [13], and discussed in paragraphs 3.1 and 5.1.

- **Individual Participant's Commercial Focus**: Networks are ultimately made up of individuals who participate in their individual or organizational capacity. This categorizes the individual participant's commercial focus while executing his network activities.

- **Openness of Association**: The openness and accessibility, allowing potential members to be associated with and participate in the network variant.

- **Member Synergy**: The main reason why there is synergy in the network.

- **Organizational Participation**: The organizational level of participation in the network.

- **Formalization**: The level of formality in the network.

Table 5-1: Main Characteristics of each Knowledge Network Variation

Network Variation	Purpose	Purpose Category (Anklam [13])	Individual Participant's Commercial Focus	Openness of Association	Member Synergy	Organizational Participation	Formalization
Social Networks	Social interaction with other members sharing the same interest	Personal	No	Open – members normally select themselves to join an interest group.	Group identification	Private individuals	Informal
Communities of Practice	Build member capabilities within a specific domain	Learning	Indirectly, in that each individual attempts to improve his personal knowledge, that is indirectly an advantage to the organization	Open – members normally select themselves within a single organization	Passion, commitment, group identification	Individuals normally within a single organization	Informal
Knowledge Networks	Collect and Distribute knowledge.	Learning	Yes	Normally by invitation	Mutual Needs, Job Requirements, common goals	Individuals normally within a single organization	Formal
Networks of Excellence	A common research goal and project	Learning	Yes - Research focus	By invitation.	Common research goal on organizational level	Trans-national organizations	Formal
Community-Based Participatory Research	A research partnership between domain experts and members of a research subject community.	Learning	Yes, from the participating organization's perspective. No, from the member community perspective	Normally closed. Domain experts are members of a parent organization. Community members are invited to participate because they are firstly a member of an existing community with certain characteristics.	Domain Experts: Common research goal. Community members: common characteristics	Researchers from one of more organizations, and members from a research subject community	Mostly formal. (Members fro the participating subject community have a more informal participation)
Joint Ventures	A risk and cost sharing agreement between organizations with a specific commercial purpose.	Business	Yes	Commercial Negotiation	Common commercial goal	Multiple Organizations	Formal
Innovation Networks	Ensuring the successful commercialization of new innovations	Idea and Business	Yes	Commercial Negotiation	Commercialization of an innovative idea.	Multiple Organizations	Formal

Network Variation	Purpose	Purpose Category (Anklam [13])	Individual Participant's Commercial Focus	Openness of Association	Member Synergy	Organizational Participation	Formalization
Competence Networks	Networks created to bring individuals and organizations together to share knowledge within a certain competence area.	Learning Mission	Yes	Open – often determined by region	Mutual need to share the knowledge associated with a certain skill or competence, so as to advance a specific region.	Normally on organizational level.	Formal
Integrated Knowledge Networks	Collect and Share common research knowledge in a specific domain between members of the same and different organizations	Learning Idea Business	Yes	Normally by invitation, and commercial negotiation.	Mutual Needs and Goals on Organizational Level	Individuals in Multiple Organizations (even Transnational)	Formal

5.4 Knowledge Network Variant's Support for the Innovation Life-Cycle

This research focused on how knowledge networks can improve innovation. It is important to understand the contribution that each of the network variants can make towards the innovation life cycle. For the purpose of comparison, the FUGLE innovation life cycle is again used, simply because it presents innovation as a sequential process that is easy to understand. (For more information about FUGLE, see par 3.3.4 on page 33.)
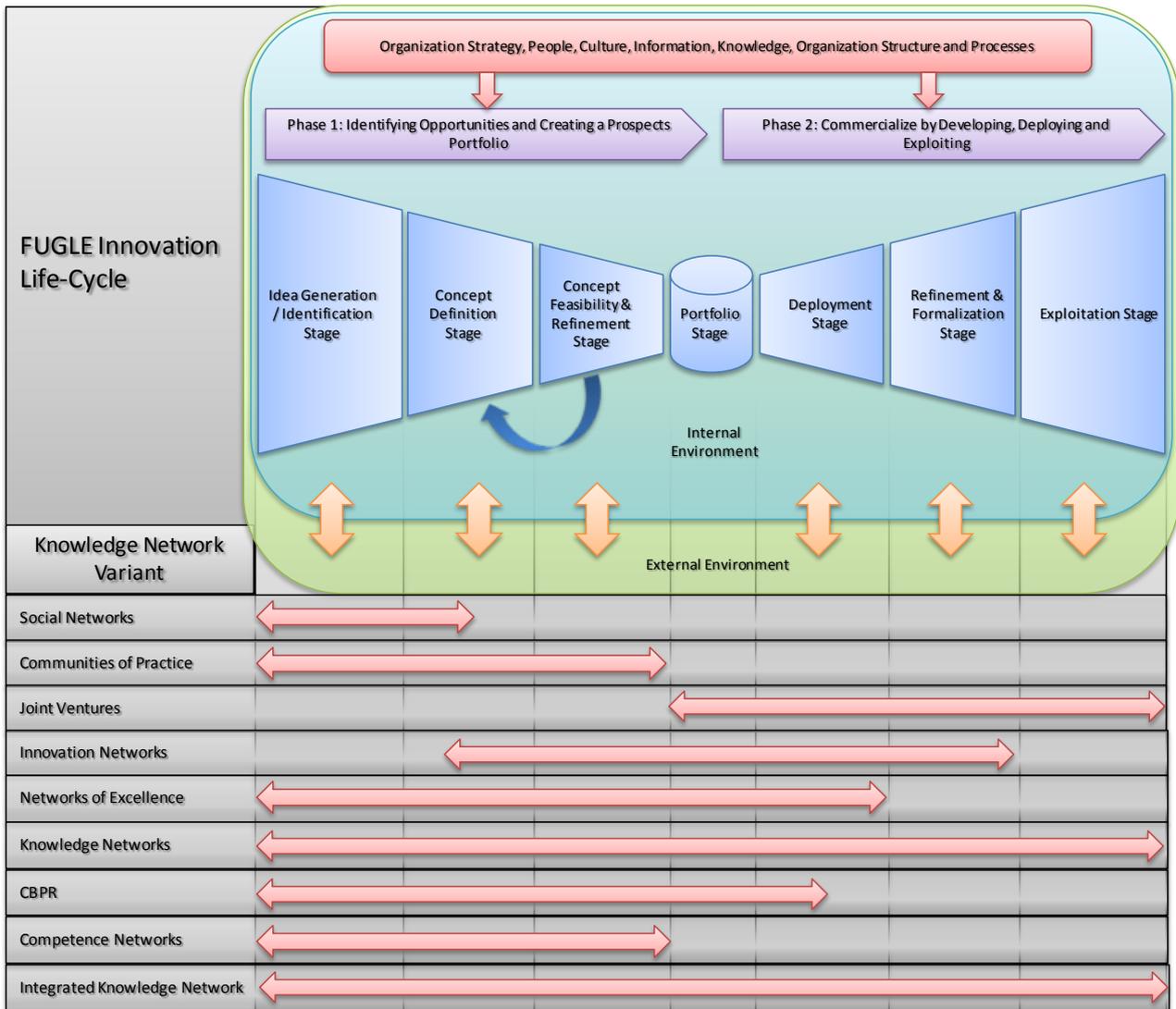
Figure 5-4: Knowledge Networks' Suitability for Supporting the Innovation Life Cycle

Based on the characteristics of each network variant, the author assessed and categorized the contribution of each variant to the different phases of the Fugle Life Cycle, as illustrated in Figure 5-4. The rationale for each network variant's innovation process support is as follows:

- **Social Networks**: Mostly focused on social interaction with possibly also focusing on a domain area. Ideas may be exchanges, thus supporting the Idea Generation and some aspects of the Concept definition phases.

- **Communities of Practice**: Since this network variant has a specific focus or domain, it brings together experts in that domain. While the main focus is normally not innovation, but simply the exchange of knowledge in the target domain, it does support the invention phases of the innovation process.

- **Joint Ventures**: Normally exist as a commercial risk sharing mechanism, and are therefore very suitable in the commercialization phases of an innovation process, where a single organization does not want to carry the risk of commercialization alone.

- **Innovation Networks**: Are often established after the initial invention has happened, with the inventor using the networks then to find a way to commercialize the invention.

- **Competence Networks**: Similar to Communities of Practice - mostly focused on exchanging information.

- **CBPR**: Since community members who have a personal stake in the specific topic of research, there is an interest to also see the research through to a commercial solution.

- **Knowledge Networks and Integrated Knowledge Networks**: The author's definition of an Integrated Knowledge Network is specifically focused on supporting the knowledge network requirements for the full innovation life cycle.

5.5 Chapter Conclusion: Integrated Knowledge Network Definition Describes all Network Variations

The definition proposed for an Integrated Knowledge Network is a generic definition that comprises most of the other Knowledge Network variants, in other words, if Seufert's definition (see par A.2.3) and the resulting methodology proposed by Back, et al. [14] is extended to include inter-organizational knowledge networks, it will be a suitable methodology for designing, operating and refining most, if not all, of these Knowledge Network Variants.
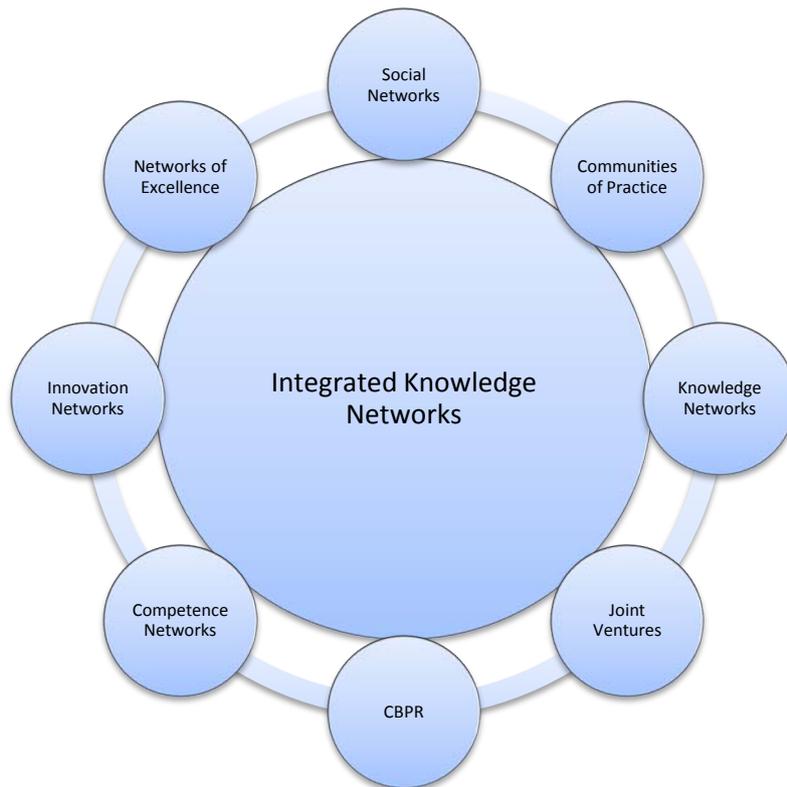
Figure 5-5: Integrated Knowledge Networks a Generic Version of all Variants

Chapter 6: Requirements for an Integrated Knowledge Network Methodology

In order to design and develop a credible methodology and design framework for an Integrated Knowledge Network, one first needs to identify and understand the requirements for such a methodology.

This chapter reviews all requirements, and presents it in a referenced requirements framework. This framework is used in Chapter 7 to develop the Integrated Knowledge Network methodology and design framework.

In addition, this chapter also briefly reviews other existing methodologies to show how information sources on existing methodologies contributed to the design of the proposed Integrated Knowledge Network Methodology.

The chapter concludes with a description how the requirements translate into a methodology.
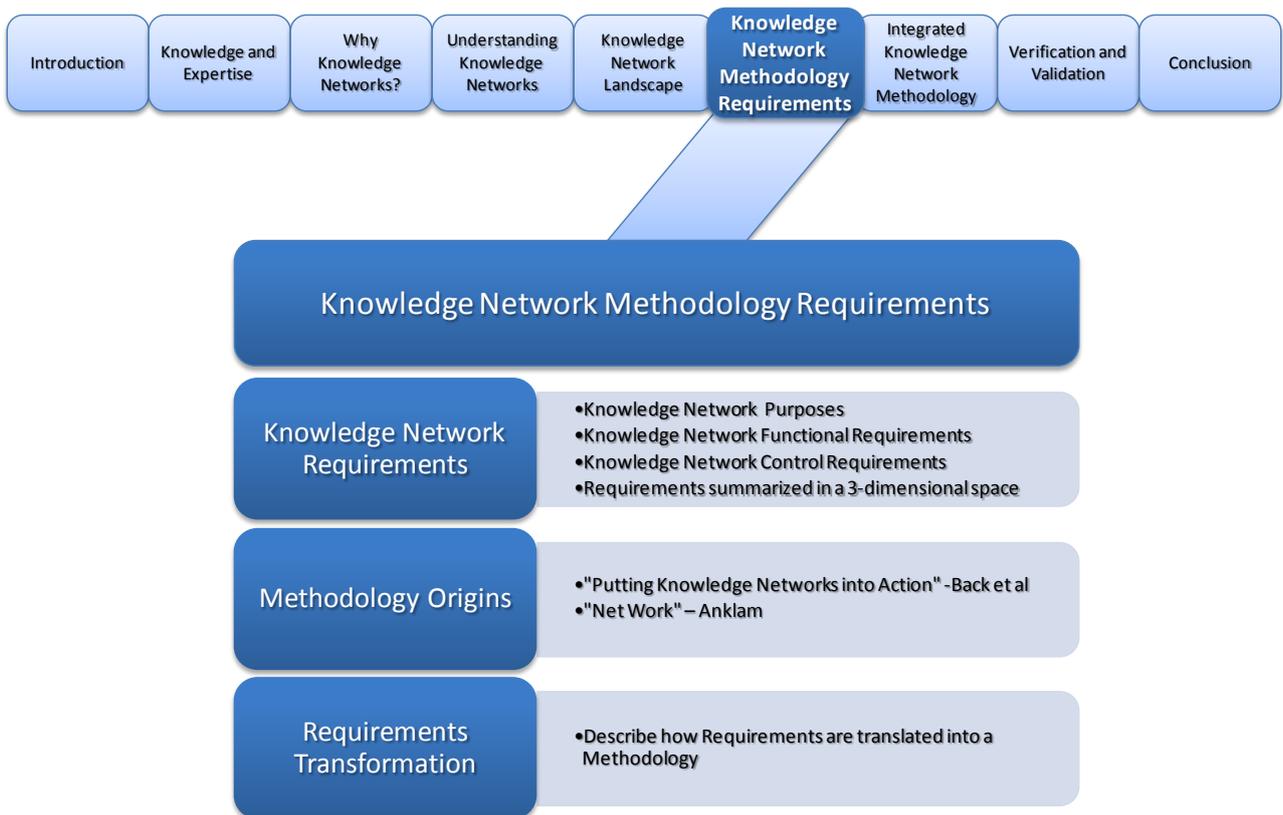
Figure 6-1: The Structure of Chapter 6 within the Context of the Overall Navigation Structure

6.1 Requirements Analysis

Requirements were collated from literature, and captured in a case tool repository. In analysing these requirements, three main requirement categories became apparent:

- **Knowledge Network Purposes**: Why does the network exist? (Purpose Objectives). See par 6.1.1.

- **Knowledge Network Functional Requirements**: What are the functions that the network needs to perform in order to satisfy its purpose. (Functional Objectives). See par 6.1.2.

- **Knowledge Network Methodology Requirements**: What is therefore expected from a methodology to design, create, implement, refine and phase out a knowledge network? (Control and Measure Objectives) See par 6.1.3.

These highest level requirements are illustrated in Figure 6-2. The illustration shows how each type of requirement was derived on a high level, and the reference number indicates the highest levels of the requirement hierarchy as used in the case tool for requirement mapping purposes. Each requirement type is discussed separately in this chapter.
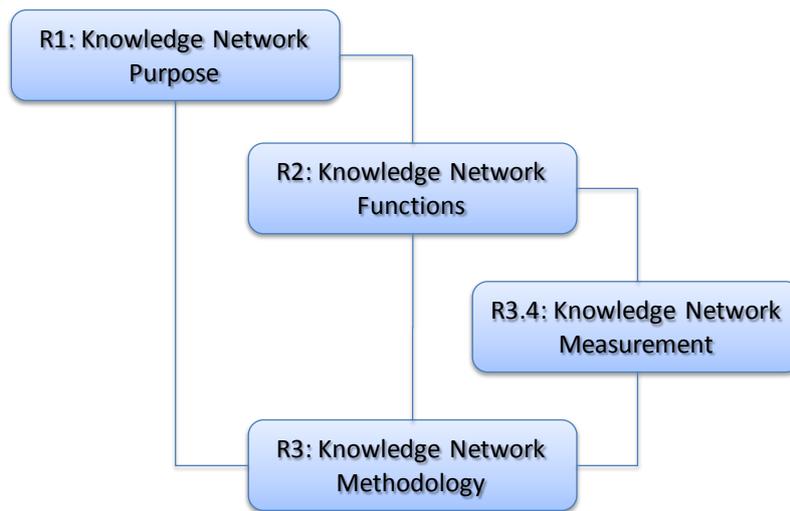
Figure 6-2: Requirements Diagram – Requirement Types

For each requirement category, a requirement analysis was performed, by starting off with a high level requirement, and deriving lower and peer level requirements from each requirement. The detailed requirement analysis, as exported from the Case Tool Repository, is included in Appendix B.

6.1.1 Knowledge Network Purpose (Objectives)

Figure 6-3 is a summary of the Network Purposes documented by Anklam, based at the highest level on the taxonomy shown in Figure 3-2, and discussed in detail in par 5.1, but expanded with the networks variants discussed in pars 5.2 - 5.4 (additions shown inverted). Each of these purposes, with requirement identifiers is listed in Table B-1 in Appendix B.
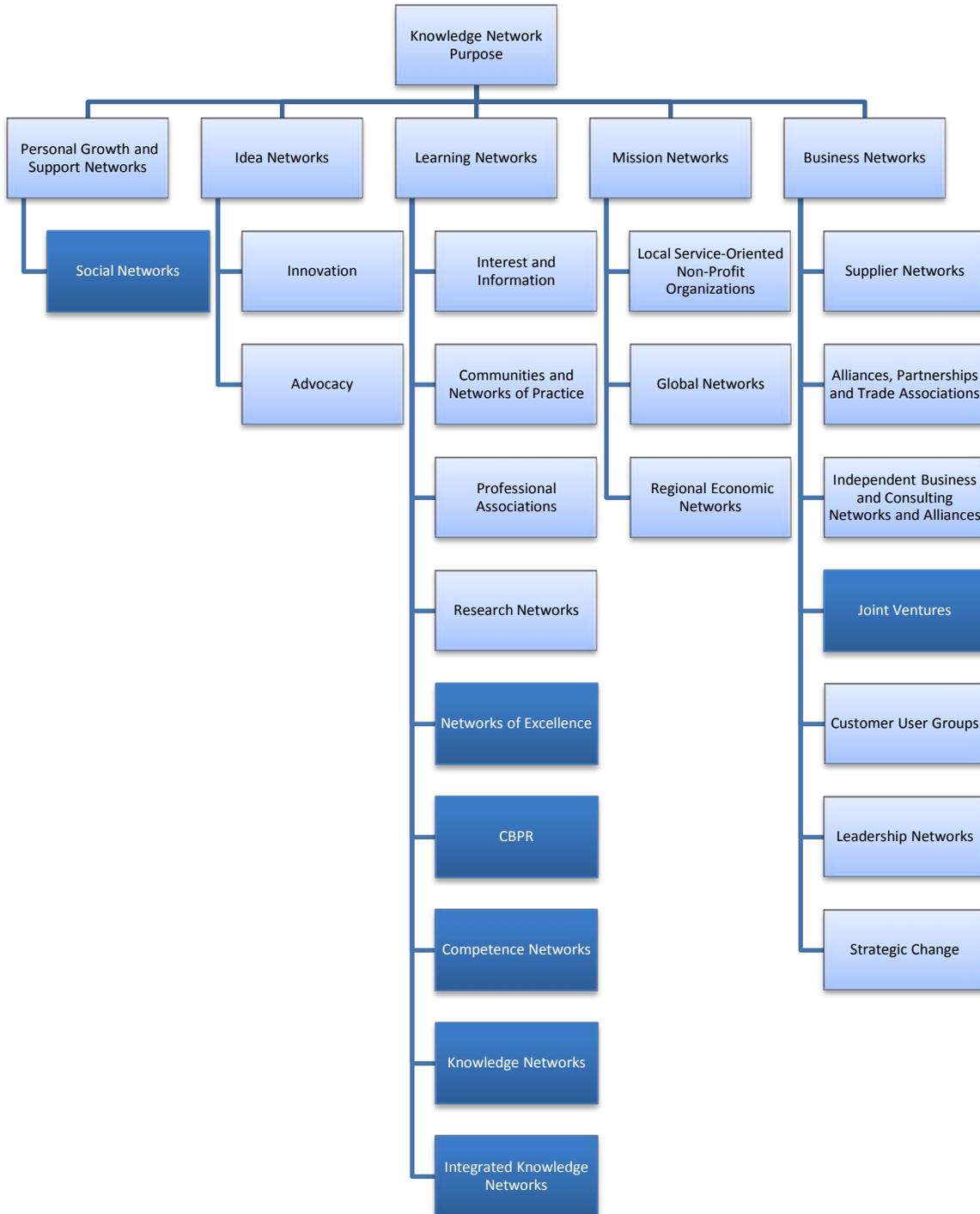
Figure 6-3: Hierarchical Presentation of the Purposes of a Knowledge Network
- adapted from Anklam [13]

6.1.2 Knowledge Network Functional Requirements

Knowledge Network functional requirements were discussed in detail in Chapter 4 (see par 4.9). However, the compact functional requirements, with Requirement Id's for requirement mapping purposes, are listed in Table B-2 in Appendix B.

6.1.3 Knowledge Network Control Requirements

"Control of an undertaking consists of seeing that everything is being carried out in accordance with the plan which has been adopted, the orders which have been given, and the principles which have been laid down."
- Henry Fayol

In generic terms, a process requires inputs, a methodology, and produces outputs. In order to control the process, feedback is required so that the inputs can be adjusted, or the process amended (see Figure 6-4).

Figure 6-4: Generic Process Model

A methodology thus should describe:

- the inputs required to make the process function,
- the process itself,
- the outputs that should be produced by the process, and
- how the process is controlled, through a feedback process.

To put the above into the context of a design or design framework methodology for a Knowledge Network, each of the above aspects must be considered. Von Krogh, et al. [86] describes a framework for a knowledge network (see Figure 4-2 on page 52). In simplified terms, if the methodology ensures that:

- **facilitating conditions** are put in place and developed,
- **knowledge work processes** are established, planned and executed, and
- a **knowledge network architecture** is provided,

the methodology will cater for the "process" aspect of the Knowledge Network.

The relationships between the generic process model, the knowledge network framework, inputs and outputs are illustrated in Figure 6-5. The related derived highest level Control and Measure Requirements are also shown in the same illustration on the right-hand side.
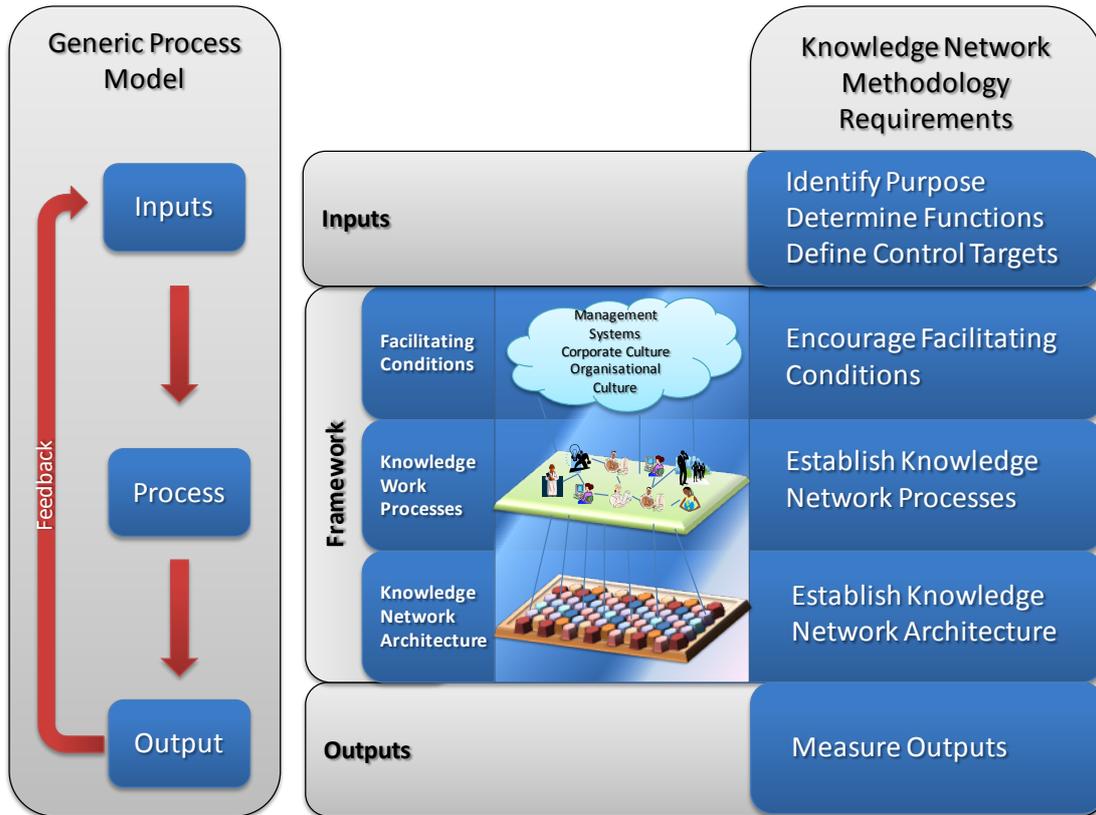
Figure 6-5: Control and Measure Objectives

The 5 high level requirements illustrated in Figure 6-5, was documented in a requirement analysis exercise in a CASE tool, with the following mapping on the highest level:

Control and Measure Objectives	Top Level Requirement Ids
Define Control Targets	R3.4: Control Targets and Measurements
Encourage Facilitating Conditions	R3.1: Facilitating Conditions
Establish Knowledge Network Processes	R3.2: Knowledge Processes
Establish Knowledge Network Architecture	R3.3: Knowledge Network Architecture
Measure Outputs	R3.4: Control Targets and Measurements

As part of the requirements analysis exercise performed in the CASE tool environment, each high level requirement was decomposed in lower level requirements as shown in Table B-3 (indicated up to the 3rd level) in Appendix B.

6.1.4 Requirement Framework Summary

To summarize the Requirements Analysis performed:- Three requirement dimensions were identified in the requirements phase (see Figure 6-6):

- Knowledge Network Functional Requirements.

- Knowledge Network Purpose.

- Knowledge Network Methodology Requirements.
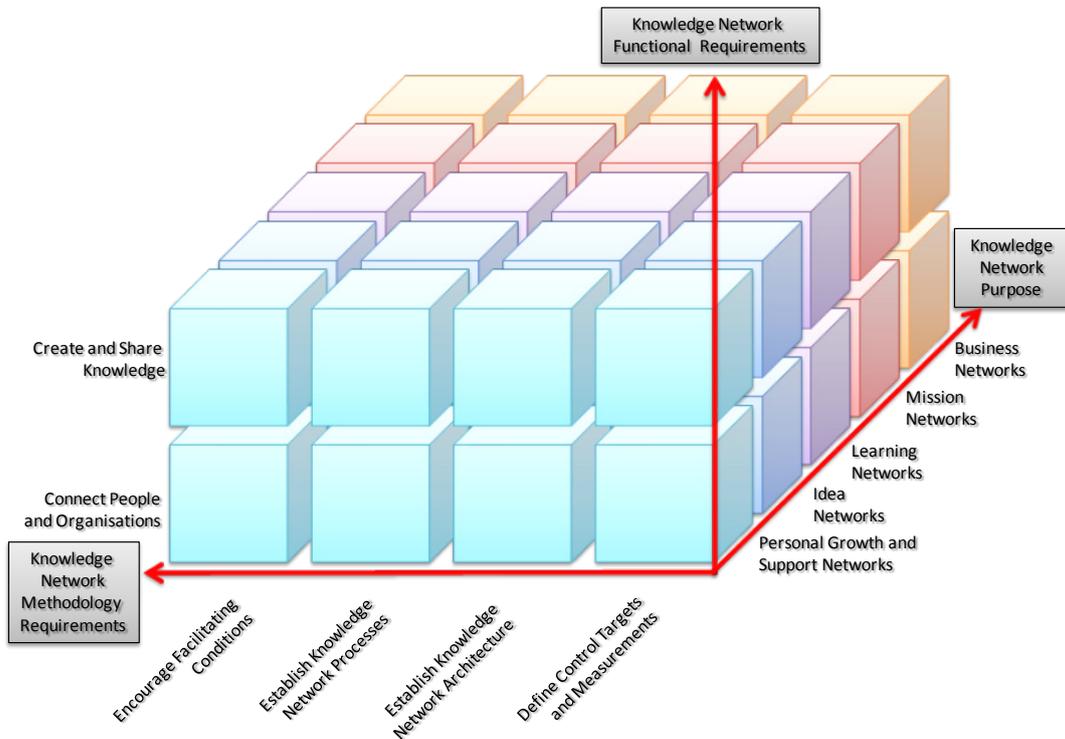
Figure 6-6: Requirement Framework

This framework is used in the verification to illustrate how the requirements were transformed into methodology processes.

6.2   Methodology Origins

"I never did anything by accident,
nor did any of my inventions come by accident;
they came by work."
-Thomas Edison

The Methodology proposed in chapter 7 has its origins in:

- "Putting Knowledge Networks into Action" by Back, et al. [14]

- "Net Work" by Anklam [13]

- Requirements Analysis (refer Chapter 6: Requirements for an Integrated Knowledge Network, starting on page 81)

6.2.1 "Putting Knowledge Networks into Action"

The work on knowledge networks described in Chapter 4: Understanding Knowledge Networks, done by Seufert, Back and Von Krogh evolved into a methodology, as documented in "Putting Knowledge Networks into Action", by Back, et al. [14]. Figure 6-7 presents the top level sequence of this methodology.
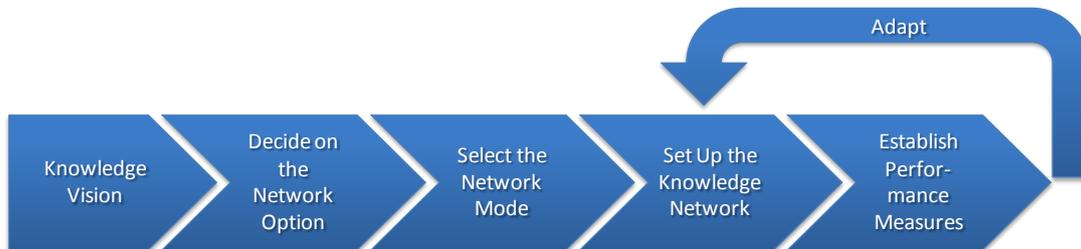
Figure 6-7: Putting Knowledge Networks into Action: Storyboard

- Back, et al. [14]

Due to the extensive knowledge network background considered by Back et al in compiling the methodology, the author considers this as an authoritative work on how a Knowledge Network is deployed and operated. The structure of this methodology is used as a framework in this section, to describe the creation, deployment and operation of an Integrated Knowledge Network.

The methodology of Back, et al. [14] was adapted to accommodate specific characteristics of Integrated Knowledge Networks. This section amends the methodology to cater for the specific peculiarities in inter-organizational knowledge networks (i.e. Integrated Knowledge Networks). For more detail on the amendments in the new methodology, see par C.4, appendix C, on page C-18.

When comparing Figure 6-8 with Figure 7-2, the similarities are clear, but the author followed a system engineering life cycle approach for defining the top level process.
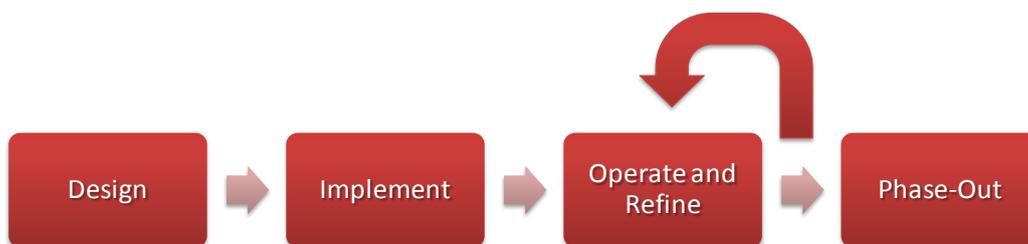
Figure 6-8: Amended Methodology – Top Level.

6.2.2 "Net Work"

In 2007, Patti Anklam published "Net Work" (Anklam [13]). While Back, et al. [14] focused more on knowledge networks with a purpose focus on Innovation, Risk Reduction and Process Enhancement, Anklam's work is more generic, and covers a wider range of knowledge networks. The Network Evolution is divided into phases (see Figure 6-9):

- The network may be convened intentionally by one or more constituents who have a clear purpose in mind. Alternatively the potential for a network may be discovered when a shared interest or concern surfaces in a conversation.

- In the design phase, the activities are focused on defining the network's purpose, identifying stakeholders, and initiating or strengthening relationships. Organizational tasks include putting in place a structure and governance model, establishing norms for participation and setting up the network's pace and its presence in real and virtual space.
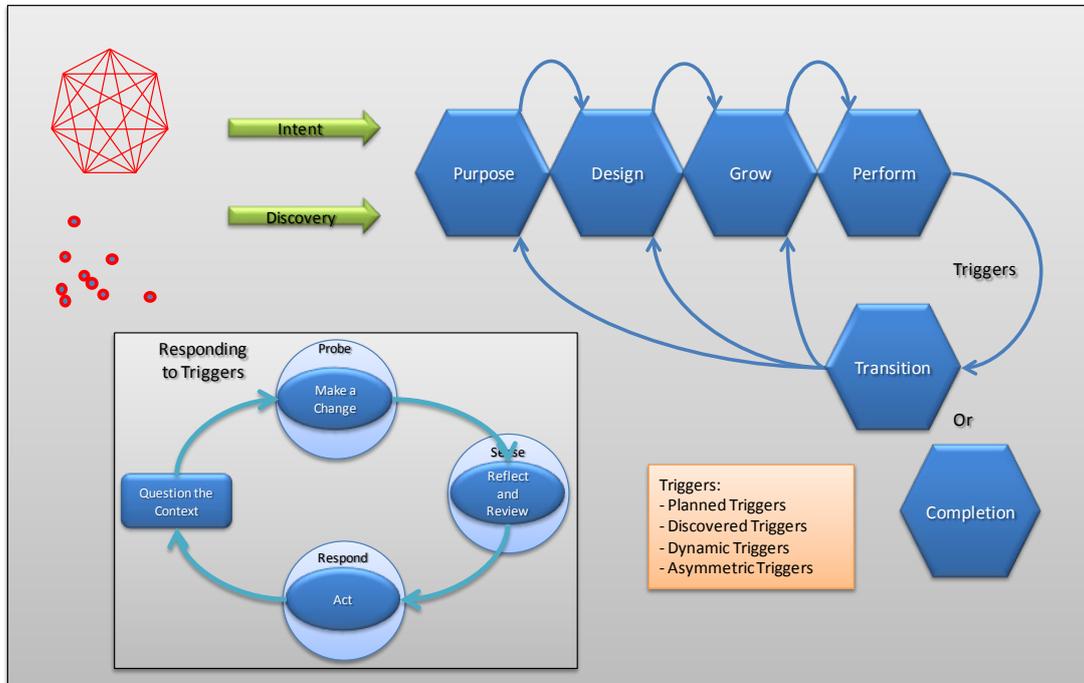
Figure 6-9: Pattern of Network Evolution

- adapted from Anklam [13]

- During the growth phase, the network works to build its capabilities, including structural, human, and relational capital, creates connections, and enhances its tensile strength as members work together toward the network's purpose and establish core values.

- During its performance phase, the network maintains its momentum and equilibrium as members interact in value producing activities and conversations, communicating across the network, managing problems and responding to new possibilities and opportunities as they arise.

The similarities are significant:-

- There is a creation phase, intentionally, or by discovery, similar to Back, et al. [14]

- Definition of the purpose is important, similar to the knowledge vision described by Back, et al. [14].

- There is a design phase, again similar to the proposed methodology.

- There is a growth phase. That is similar to the proposed methodology's refine phase,

- There is a perform phase, and that is again similar to the proposed methodology's operate phase.

6.3　Chapter Conclusion: Transformation of Requirements into a Methodology

Based on the Knowledge Network requirements documented in this chapter, it is possible to transform the requirements into a methodology, as illustrated in Figure 6-10.
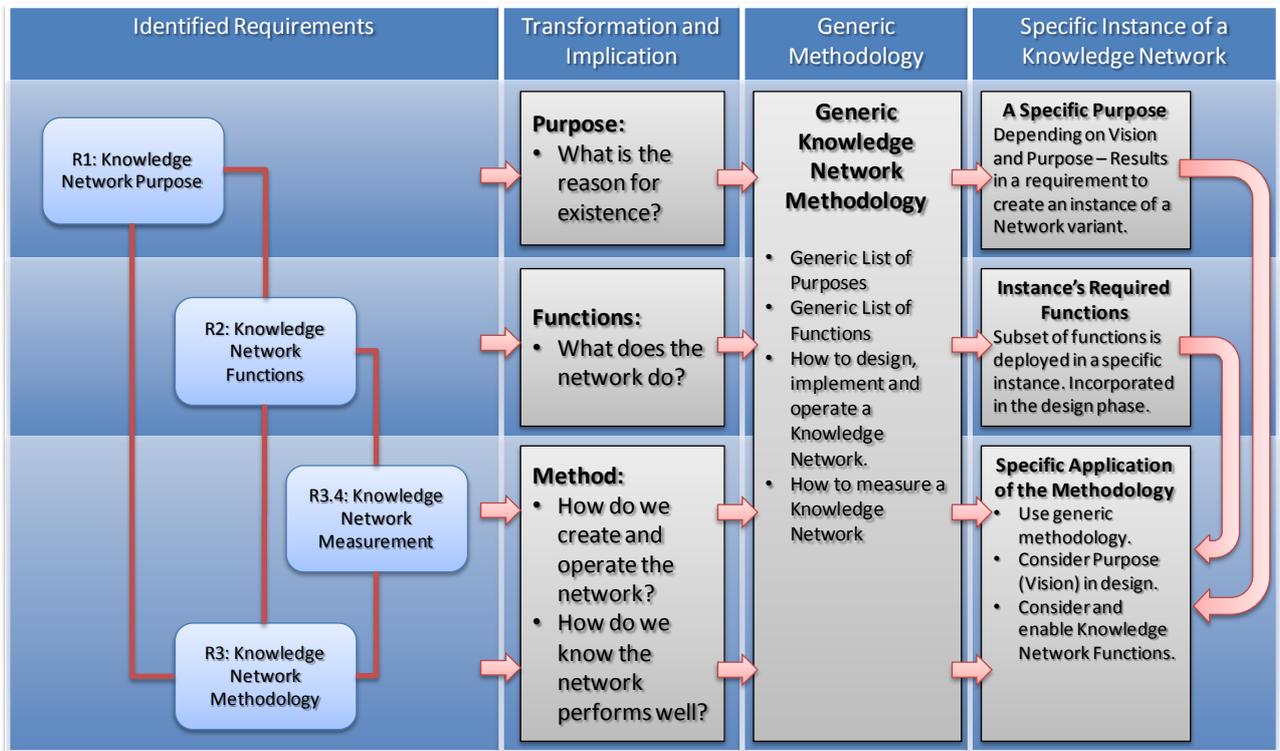
Figure 6-10: The Transformation of Purpose and Functional Requirements into a Methodology

- Knowledge Network Purpose was considered in the Knowledge Network Methodology. When a specific instance of a knowledge network is then created, it may then again result in a specific network variant.

- Knowledge Network Functions are embodied in the Knowledge Network Methodology.

- Knowledge Network Methodology and Measurement Requirements are addressed in the Generic Knowledge Network Methodology. When a specific instance is created, it may be required to adapt the methodology, based on the network's strategy and vision.

Chapter 7: Designing and Deploying Integrated Knowledge Networks - The Integrated Knowledge Network Methodology

This chapter discusses the Integrated Knowledge Network Methodology. The structure of the chapter is illustrated in Figure 7-1, and consists of:

- **The Methodology**: The proposed Integrated Knowledge Network Methodology is presented, by sequentially covering all the phases and steps in the methodology. (see par 7.1)

- **Generic Knowledge Network Framework**: Lastly, a framework is proposed to summarize the methodology, and to serve as a checklist for designing and evaluating knowledge networks. (see par 7.2)
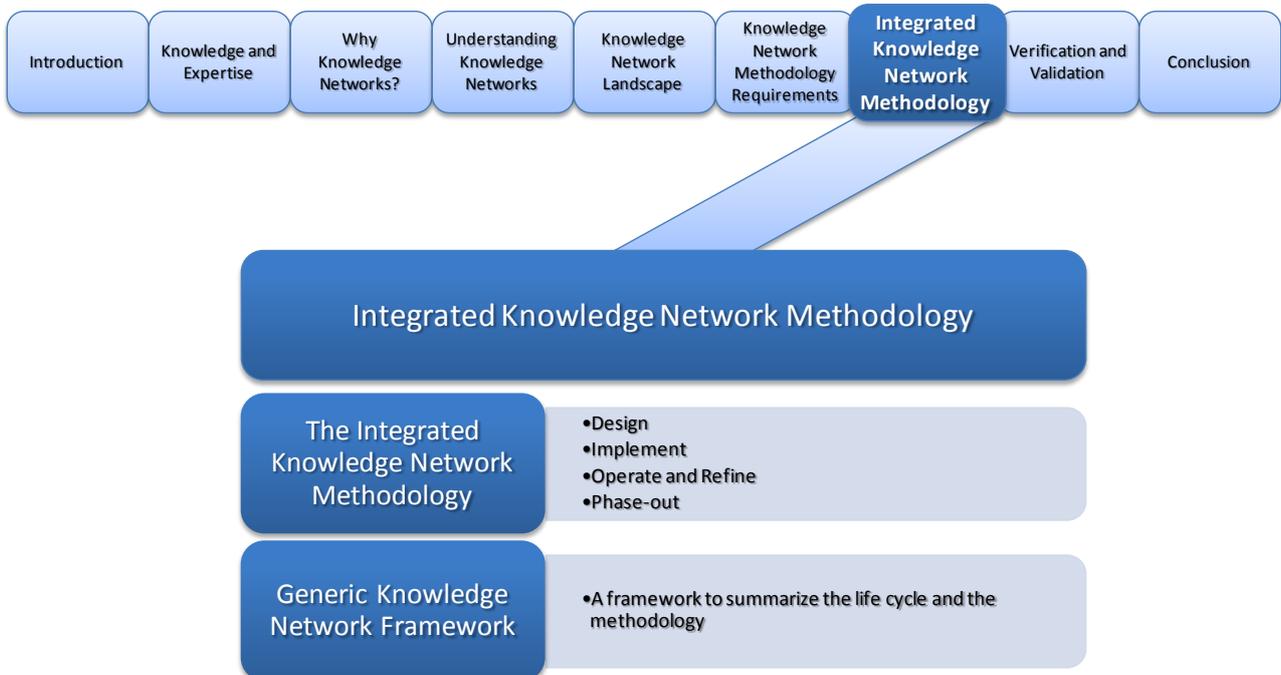
Figure 7-1: The Structure of Chapter 7 within the Context of the Overall Navigation Structure

7.1 The Integrated Knowledge Network Methodology

As described in 7.1, the Amended Methodology originated from work done by Back, et al. [14] and Anklam [13], as well as an extensive requirements analysis discussed in previous chapters, and feedback from Case Studies.
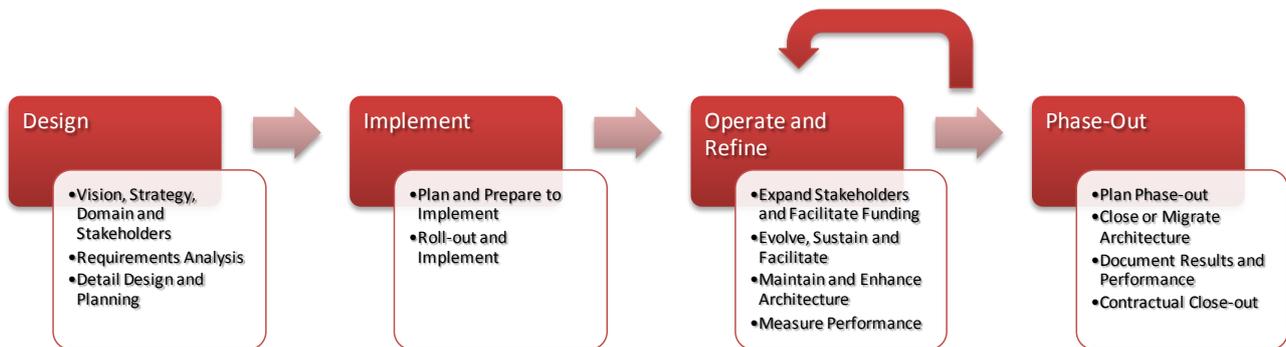
Figure 7-2: The Amended IKN Methodology

Figure 7-2 illustrates the highest level phases and tasks of the IKN Methodology. The Methodology is discussed in the next sections in more details, for each of the phases:

- Design Phase

- Implementation Phase

- Operation and Refinement Phase

- Phase-Out Phase

Each phase with all the sub-processes is described in more detail in the following paragraphs.

A generic template was used to describe each process and sub-process, consisting of:

- The Phase, Process or Sub-Process name

- A textual description of the process, explaining the context and need for the process.

- The reference for the process – this is used in Requirements and Verification Traceability in this document.

- A list of lower level processes.

The lowest level processes are not described in detail in this document, but are just listed for reference.

Note: A separate document navigation structure is used in this chapter, to guide the reader through the methodology. Components of the figures used to illustrate a phase of the methodology (e.g. Figure 7-3) are used with highlighting to create the context for the reader. (Since these navigation context diagrams are repetitive copies of components of earlier illustrations, these diagrams are not captioned.)

7.1.1 Design

The Design Phase is the most important phase in the establishment of a Knowledge Network – properly planning and designing a knowledge network, enables the stakeholders to optimize the benefits of a knowledge network.

The Design phase is divided in 3 sub-phases:

- Determine the Vision, Strategy, Domain and Stakeholders

- Establish the Requirements

- Do detail Design and Planning.

The Design Phase with all lower level processes is illustrated in Figure 7-3 on page 93.

Reference: M1: Design

Lower Levels: M1.1: Vision, Strategy, Domain and Stakeholders

M1.2: Requirements Analysis

M1.3: Detail Design and Planning

Design

Vision, Strategy, Domain and Stakeholders

Requirements Analysis

Detail Design and Planning

Define Need, Purpose and Strategy

| Knowledge Need | Knowledge Vision | Knowledge Strategy | Target Domain |

Identify and Select Stakeholders

| Identification | Analysis | Preliminary Selection |

Determine Financial Feasibility

| Expected Outputs and Benefits | Required Inputs |

IPR Strategy

| Public, Private or User Domain | Pre-Competitive vs Competitive Stages |

Network Variant

Concept Gate
- Vision and Strategy Agreed
- Stakeholders Identified
- Financial Feasibility Completed
- IPR Strategy Agreed
- Decide on Network Option

Knowledge Requirements Analysis

| Identify Required Knowledge | Knowledge Work Processes | Knowledge Deliverables |

Knowledge Network Reference Types

| Select Reference Types | Facilitating Conditions | Network Functions |

Define Control Targets

| Measures | Targets |

Financial Support Requirements

| Funding Model Requirements | High Level Budget | High Level Benefit Analysis |

Contractual Requirements

| Stakeholder Types | IPR Stages | Benefit Expectations | Participation Expectations |

Requirements Gate
- Knowledge Reqmnts Approved
- Network Reqmnts Approved
- Control Targets Approved
- Financial Reqmnts Noted
- Contractual Reqmnts Noted

Network Design

| Network Structure | Knowledge Processes | Organizatio-nal Tools | ICT Architecture |

Planning

| Deliverable Plan | Milestone Plan | Communica-tion Plan | Change Mgmnt Plan |

Performance Measures

| Measures | Targets | Corrective Actions | Incentives |

Financial Model(s)

| Funding Model | Detailed Budget | Cash Flow | Benefit Analysis |

Contractual Model(s)

| Stakeholder Responsibilities | IPR Protection | Access to Benefits |

Design Gate
- Design Approved
- Plan Approved
- Financial Model(s) Approved
- Contract Model(s) Approved

Figure 7-3: Designing an Integrated Knowledge Network

7.1.1.1 Vision, Strategy, Domain and Stakeholders

As illustrated in Figure 7-3, the first phase of the Design

phase is focused on defining the overall purpose, to identify potential stakeholders, determine the feasibility and ensuring that intellectual property complications are understood and planned for.

Reference: M1.1: Vision, Strategy, Domain and Stakeholders

Lower Levels: M1.1.1: Define Need, Purpose and Strategy

M1.1.2: Identify Stakeholders

M1.1.3: Financial Feasibility

M1.1.4: IPR Strategy

M1.1.5: Network Variant

Define Need, Purpose and Strategy

For a knowledge network to be successful there must be a need for creating and sharing knowledge - a purpose for the network.

The purpose of a network is that which animates it and causes its members to care about it. (Anklam [13])

Defining a knowledge vision beforehand is of particular importance because it helps to create the specific roadmap with which to support a knowledge activity.

Having a clear picture of one's present situation, as well as foresight into future events, reduces the risk of moving in the wrong direction, thereby developing knowledge that may not be important in future.

Establishing the task of a knowledge network can be done only after, and in conjunction with, the creation of a knowledge vision. This should foster employees' involvement in the company, and will motivate them to view their daily work in a larger context.

The knowledge vision should have a specific style (bold, creative, inspiring, and reflecting the "style" of the company). (Back, et al. [14])

Reference: M1.1.1: Define Need, Purpose and Strategy

Lower Levels: M1.1.1.1: Knowledge Need and Purpose

M1.1.1.2: Knowledge Vision

M1.1.1.3: Knowledge Strategy

M1.1.1.4: Identify Target Domain

Identify Stakeholders

The purpose of the stakeholder identification, analysis and selection is to understand the needs, priorities, and ideas for action of those who can or will influence the success of your knowledge management initiatives. Alternatively, to understand the needs, priorities, and ideas for action of those individuals affected by the activities including senior managers, business-unit leaders, functional and staff support groups, key external partners and suppliers, internal clients at various levels, and others. (Back, et al. [14])

Reference: M1.1.2: Identify Stakeholders

Lower Levels: M1.1.2.1: Stakeholder Identification

                        M1.1.2.2: Stakeholder Analysis

                        M1.1.2.3: Preliminary Selection of Stakeholders

Financial Feasibility

One of the measures of a knowledge network success will be its financial feasibility. An active knowledge network will require inputs (people, time, infrastructure and other resources), and this will often require an upfront investment by the stakeholders. The required investment needs to be considered against the potential outputs and benefits a knowledge network will create.

As part of the process of involving stakeholders and convincing participants of the necessity of the knowledge network, one thus needs to perform an initial financial feasibility study, so as to provide a baseline that can be used to convince participants, and also to measure future design activities, and the network's performance against a baseline.

Reference: M1.1.3: Financial Feasibility

Lower Levels: M1.1.3.1: Expected Outputs and Benefits

                        M1.1.3.2: Required Inputs

IPR Strategy

When knowledge is shared and created, especially when external stakeholders are involved, one of the primary concerns will be the ownership and protection of the intellectual property shared, and created in the network.

It is firstly important to understand the IPR domain the network will operate in. Most academic and government funded knowledge network activities will operate in a public user domain where knowledge is more freely shared within the accepted boundaries of academic publications, citations, etc. Commercial enterprises will operate in private domains, where intellectual property will have to be protected.

Related to the IPR Domain, is the IPR stage of collaboration. If the collaboration is expected to be in the public domain, it will normally indicate that the collaboration will be in a pre-competitive stage. (Du Preez and Louw [30])

Reference: M1.1.4: IPR Strategy

Lower Levels: M1.1.4.1: Public, Private or User Domain

M1.1.4.2: Pre-competitive vs Competitive Stage

Network Variant

As discussed in Chapter 5, knowledge networks are embodied in a number of network variants, often depending on the purpose of the network. The selection of a network variant is thus mostly a choice of using terminology that will be most descriptive and acceptable within the knowledge expectations and context of the stakeholders.

Reference: M1.1.5: Network Variant

Lower Levels: None
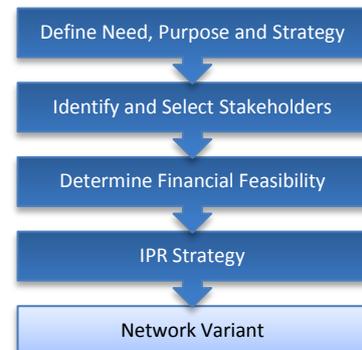
7.1.1.2 Requirements Analysis

As illustrated in Figure 7-3, the second phase of the Design phase is focused on gathering the requirements, identifying the required knowledge network reference types, defining the control targets, and establishing the contractual requirements.

|	
Reference:	M1.2: Requirements Analysis
Lower Levels:	M1.2.1: Knowledge Requirements Analysis
	M1.2.2: Knowledge Network Reference Types
	M1.2.3: Define Control Targets
	M1.2.4: Financial Support Requirements
	M1.2.5: Contractual Requirements

Knowledge Requirements Analysis

The identification of the necessary knowledge as well as its sources (such as the people or a group) with which to support the process or task to ultimately achieve the business objective, is critical. (Back, et al. [14]) To support the identified strategy of the knowledge network, knowledge activities must be focused on the business process or task identified in the target domain, where a knowledge gap or a leverage point to improve knowledge management activities has been identified.
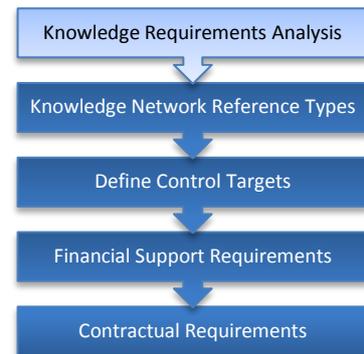
Thus, understanding the knowledge required to address the knowledge gap, is a fundamental basis for choosing the appropriate knowledge activity and work processes, and the resulting expected knowledge deliverables.

Reference:	M1.2.1: Knowledge Requirements Analysis
Lower Levels:	M1.2.1.1: Identify Required Knowledge
	M1.2.1.2: Knowledge Work Processes
	M1.2.1.3: Knowledge Deliverables

Knowledge Network Reference Types

In order to support the process or task of the network with regard to knowledge and the management of knowledge, choosing the appropriate network mode is key to determining the most prevalent type of knowledge in the process. Here the fact that the knowledge could either be explicit or tacit, plays an important role, since explicit knowledge is more schematic and easier to transfer systematically than tacit knowledge. In addition, the function of the network mode is determined by its operational knowledge task. In turn, the operational knowledge task has an impact on the appropriate facilitating conditions of the network. For example, if the knowledge network is mainly a network of experts supporting an innovation process by creating a new corporate innovation process description, the key operational knowledge task of the network would be to turn tacit knowledge into explicit knowledge by codifying it. It is thus made accessible to others. The network mode would be a materializing network. (Back, et al. [14])
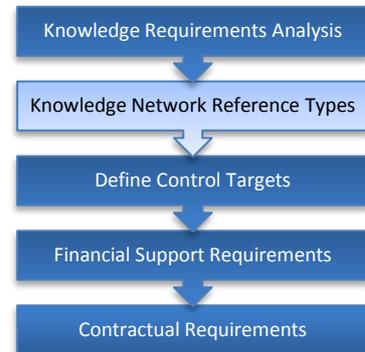
Based on the knowledge network spiral theory (Nonaka [64]), it is, however, important to realize that knowledge can only be sustainably created if all four knowledge work processes are present in the knowledge network.

Reference: M1.2.2: Knowledge Network Reference Types

Lower Levels: M1.2.2.1: Select Reference Types

              M1.2.2.2: Facilitating Conditions

              M1.2.2.3: Network Functions

Define Control Targets

In order to ensure that the expectations with regards to the knowledge network's original feasibility analysis are satisfied; the performance of the network needs to be monitored. It is therefore important to identify the performance measures and targets of the knowledge network during this stage, and to ensure that the design and operation of the network will make it possible to measure and achieve these performance targets.
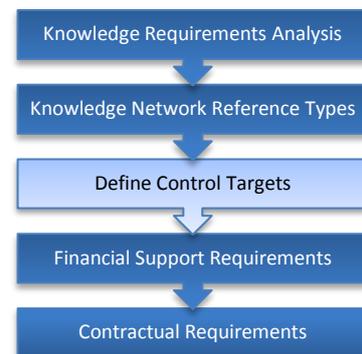
Reference: M1.2.3: Define Control Targets

Lower Levels: M1.2.3.1: Measures

              M1.2.3.2: Targets

Financial Support Requirements

Once the knowledge network required activities to achieve the required benefits are better understood, it becomes possible to identify and document the financial requirements of the network. This, in turn, will allow for a high level budget and a more detailed benefits analysis to be performed.

Knowledge Requirements Analysis

Knowledge Network Reference Types

Define Control Targets

Financial Support Requirements

Contractual Requirements
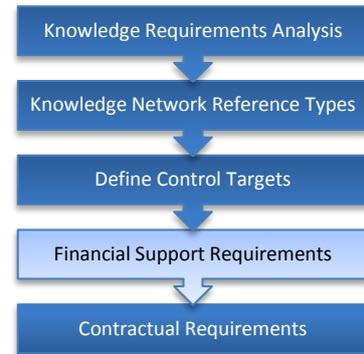
Reference: M1.2.4: Financial Support Requirements

Lower Levels: M1.2.4.1: Funding Model Requirements

M1.2.4.2: High Level Budget

M1.2.4.3: High Level Benefit Analysis

Contractual Requirements

Depending on the potential stakeholders, and the IPR stages and domains, the expected benefits for each type of stakeholder, and the expected and required participation of each stakeholder type, it is possible to determine the generic types of contractual agreements that need to be put in place between and among all stakeholders.

Knowledge Requirements Analysis

Knowledge Network Reference Types

Define Control Targets

Financial Support Requirements

Contractual Requirements
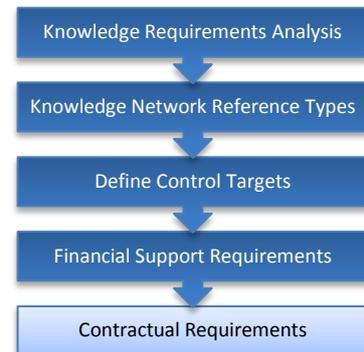
Reference: M1.2.5: Contractual Requirements

Lower Levels: M1.2.5.1: Stakeholder Types

M1.2.5.2: IPR Stages

M1.2.5.3: Benefit Expectations

M1.2.5.4: Participation Expectations

7.1.1.3 Detail Design and Planning

As illustrated in Figure 7-3, the third phase of the Design phase is focused on doing a detail design, planning all activities, determining the detail performance measures with corrective actions and incentives, establishing the financial models, and setting up the contractual models to be used.

Reference: M1.3: Detail Design and Planning

Lower Levels: M1.3.1: Network Design

M1.3.2: Planning

M1.3.3: Performance Measures

M1.3.4: Financial Model(s)

M1.3.5: Contractual Model(s)

Network design

The Network Design consists of a Network Structural Design, the design of all required Knowledge Work Processes, and the supporting infrastructure, embodied in the organizational tools and ICT architecture.

The **Network Structural Design** addresses mainly two aspects: the relationships between different types of stakeholders, as well as the knowledge network's organizational structure and management system.

The **Knowledge Work Processes** is a derivative of the Knowledge Reference Types identified in the Requirements Analysis phase. For each knowledge reference type, different knowledge work processes are applicable (Back, et al. [14]). For more detail on how the Knowledge Work Processes are designed, see Appendix C.2.1.

The design of the **Organizational Tools** needs to support the activities of each Knowledge Network Reference Type. For more detail on how the Organizational Tools are designed, see Appendix C.2.2.

ICT Architecture design includes Information and communication technology tools support processes that need to help fulfil the operational knowledge task and also influence, directly and/or indirectly, the network's facilitating conditions. For details, refer to Appendix C.2.3
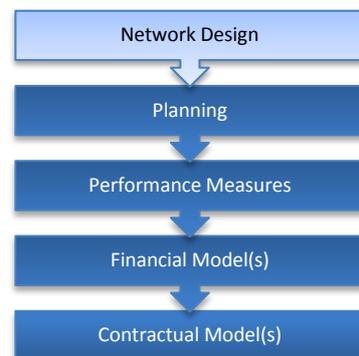
Reference: M1.3.1: Network design

Lower Levels: M1.3.1.1: Network Structure

M1.3.1.2: Knowledge Processes

M1.3.1.3: Organizational Tools

M1.3.1.4: ICT Architecture

Planning

Planning the Knowledge Network activities forms part of the Design Phase. In order to achieve the required knowledge outputs and benefits, one needs to identify a high level work breakdown structure, with deliverables and milestones. Project management literature from authors, such as Nicholas and Steyn [62], covers this process in a lot more detail than what is possible within the scope of this document. However, deliverable and milestone plans need to be addressed in the planning at this stage. A list of all knowledge deliverables must be envisaged during the life of the knowledge network. The contents of the deliverable plan will depend on the purpose of the Knowledge Network. Some knowledge networks will be established with a very specific purpose, that needs to be achieved within a set timeframe (for example, some Network of Excellence projects within the FP6 and FP7 EU frameworks), while others will have a much broader and more vague purpose, where a deliverable plan will have a relatively short term focus. However, it is important to establish a deliverable plan that is achievable within the short term, because, as will be illustrated later, one of the key critical success factors is the achievement of early successes. Planning, facilitating and encouraging early successes is thus critical for the continued success of the Knowledge Network.
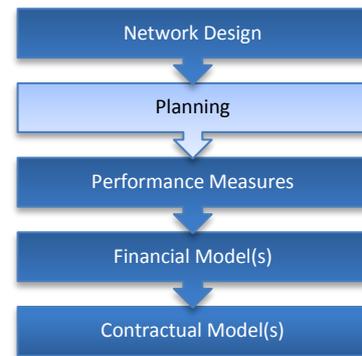
As part of the planning process, special attention must also be paid to:

- **Communication Plan**: This is a derivative of the designed Organizational Tools and often makes use of the ICT Architecture discussed before, and describes the detailed communication protocols and tools to be used within the execution of all knowledge network processes.

- **Change Management Plan**: Implementing a Knowledge Network will impose some changes in participating stakeholder organizations, and this needs to be planned in advance.

Reference: M1.3.2: Planning

Lower Levels: M1.3.2.1: Deliverable Plan

M1.3.2.2: Milestone Plan

M1.3.2.3: Communication Plan

M1.3.2.4: Change Management Plan

Performance Measures

The Knowledge Network's performance needs to be measured, so as to ensure that the intended goals and vision are satisfied. The design of Performance measures is often a complex task, and once individuals know how they or their outputs are measured, they will often behave so as to best reflect against the performance measures. If the measures are poorly selected, it can then actually have a negative impact on the overall goals. To design the Performance Measures, the following needs to be considered:
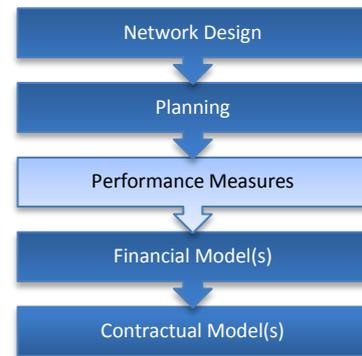
- **Measures**: Determine what must be measured in order to achieve the overall goals of the Knowledge Network. This often means that one needs to analyze the individual activities and intended deliverables of the knowledge network, to define a list of possible measures.

- **Targets**: For each measure identified, decide on realistic targets.

- **Corrective Actions**: If targets are not achieved, identify beforehand what the corrective actions should be.

- **Incentives**: Individuals and groups should be incentivised appropriately for achieving performance targets. If targets are consistently achieved, individuals or groups need to get some form of recognition.

Reference: M1.3.3: Performance Measures

Lower Levels: M1.3.3.1: Measures

M1.3.3.2: Targets

M1.3.3.3: Corrective Actions

M1.3.3.4: Incentives

Financial Model(s)

Once the Potential Benefits have been determined, the Financial Support requirements are known, and potential stakeholders have been identified, it becomes possible to compile financial models for each type of stakeholder, to specify how each stakeholder will participate financially in the Knowledge Network.

A financial model should consist of:

- A funding model, defining the source of the funding, and the overall business case.

- A detailed budget, broken down to a stakeholder level, defining the budget
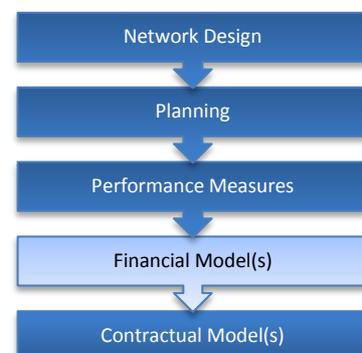
requirements for each stakeholder and all activities.

- A cash flow analysis, that is linked to the overall milestone plan.

- A benefits analysis, illustrating how stakeholders will be able to achieve the benefits, given their financial investments.

Reference: M1.3.4: Financial Model(s)

Lower Levels: M1.3.4.1: Funding Model

                    M1.3.4.2: Detailed Budget

                    M1.3.4.3: Cash Flow

                    M1.3.4.4: Benefits Analysis

Contractual Model(s)

Once the IPR Strategy is known, Contractual Requirements are defined, Financial Models have been defined and Stakeholders have been identified, it becomes possible to set up one or more contractual models or templates that will define the contractual relationships and obligations of different stakeholder types.

A contractual model needs to specifically address:

- **Stakeholder Responsibilities**: Financial and other resource contributions, responsible deliverables etc.

- **IPR protection**: Stakeholders will often expose their own IPR in the network activities, and protection must be provided so that each stakeholder's intellectual property is protected.

- **Access to Benefits**: It must be clearly defined how a stakeholder will receive access to the benefits that the Knowledge Network intends to provide. The ownership of newly created intellectual property must also be defined.
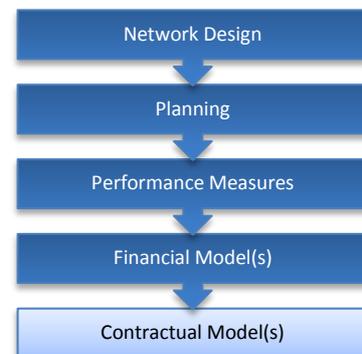
Reference: M1.3.5: Contractual Model(s)

Lower Levels: M1.3.5.1: Stakeholder Responsibilities

                    M1.3.5.2: IPR Protection

                    M1.3.5.3: Access to Benefits

Network Design → Planning → Performance Measures → Financial Model(s) → Contractual Model(s)

7.1.2 Implement

As illustrated in Figure 7-4, the Implementation Phase consists of:

- Planning and Preparing for the implementation of the Knowledge Network, and
- Rolling out and Implementing the Network.

Reference: M2: Implement

Lower Levels: M2.1: Plan and Prepare to Implement

   M2.2: Roll-out and Implement
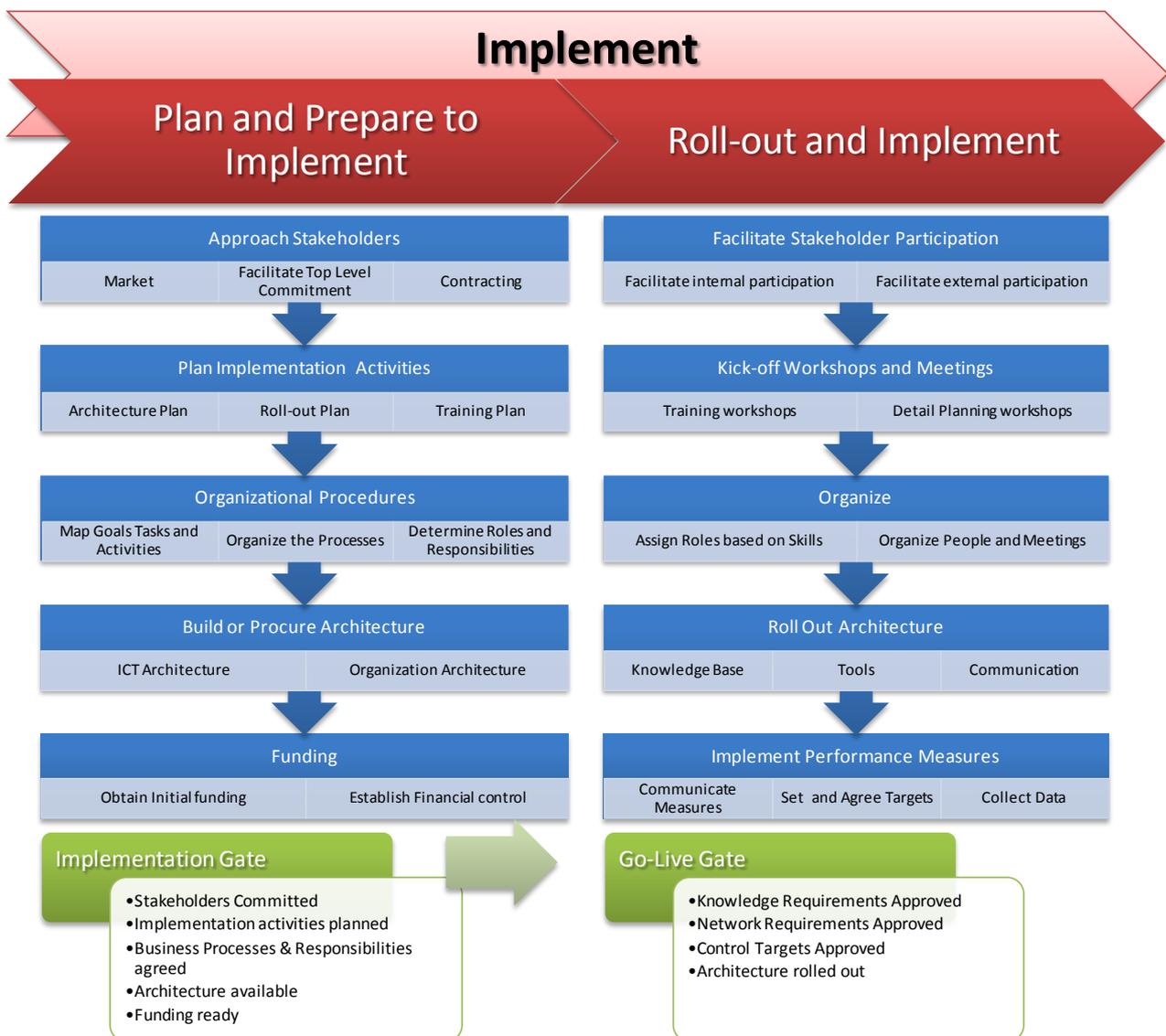
Figure 7-4: Implementing an Integrated Knowledge Network

7.1.2.1 Plan and Prepare to Implement

The Planning and Preparation Phase includes all activities required to prepare for the implementation of the knowledge network. These include:

- Approaching the final list of stakeholders, to get their commitment.

- Planning all activities required during implementation

- Defining the detail organizational procedures

- Building or Procuring the Organizational and ICT Architectures

- Ensuring that funding is available to implement the Knowledge Network.

Each of the planning steps is described below in more detail.

Reference: M2.1: Plan and Prepare to Implement

Lower Levels: M2.1.1: Approach Stakeholders

                    M2.1.2: Plan Implementation Activities

                    M2.1.3: Organizational Procedures

                    M2.1.4: Build or Procure Architecture

                    M2.1.5: Funding

Approach Stakeholders

During the Design Phase, potential Stakeholders were identified, the potential benefits were determined and financial and contractual models were defined.

During this phase, the identified stakeholders must be approached to firm up their intended participation in the network.

Activities include:

- Marketing the Knowledge Network to Stakeholders

- Facilitating Top Level Management's commitment at identified stakeholders' organizations

- Contracting the involvement of Stakeholders

Reference: M2.1.1: Approach Stakeholders

Lower Levels: M2.1.1.1: Market the Network

M2.1.1.2: Facilitate Top Level Commitment

M2.1.1.3: Contracting

Plan Implementation Activities

During the Design Phase, the operational activities of the Knowledge Network were planned. However, implementing a Knowledge Network requires a shorter term planning to determine how to establish the required architecture, how to roll out the knowledge network and how to train all stakeholders in the vision, goals, plans, and architecture of the knowledge network.

Reference: M2.1.2: Plan Implementation Activities

Lower Levels: M2.1.2.1: Architecture Plan

M2.1.2.2: Roll-out Plan

M2.1.2.3: Training Plan

Organizational Procedures

As soon as the stakeholders have been identified, and the overall plan and deliverables are known, it is possible to define the knowledge network's organizational procedures.

The Organizational Procedures include:

- Map all tasks and activities to the goals of the knowledge network. Having communicated the strategic need and business goal of the knowledge network, as well as the business processes supported by the network, the activities, tasks, and intermediate goals must be assigned.

- Determine and organize all the processes: in terms of capturing and locating, sharing and transferring, and finally creating knowledge within a particular knowledge network, the processes within a knowledge network need to be articulated. A full understanding of the specific processes is necessary before they can finally be organized or supported.

- Roles and Responsibilities: Assigning the roles and responsibilities in the knowledge network creates a minimal structure within the network and provides a starting point from which to achieve a high level of member commitment.

Reference: M2.1.3: Organizational Procedures

Lower Levels: M2.1.3.1: Map Goals, Tasks and Activities

                         M2.1.3.2: Organize the Processes

                         M2.1.3.3: Determine Roles and Responsibilities

Build or Procure Architecture

The operation of a knowledge network is also supported by a wide variety of organizational and ICT tools, which help to achieve the appropriate facilitating conditions.

The specific requirements of the Architecture have been defined in the Design Phase, and during the current phase, the required architecture must be procured or constructed so as to support the requirements identified.

Approach Stakeholders

Plan Implementation Activities

Organizational Procedures

Build or Procure Architecture

Funding

Reference: M2.1.4: Build or Procure Architecture

Lower Levels: M2.1.4.1: ICT Architecture

                         M2.1.4.2: Organizational Architecture

Funding

When Stakeholder participation has been contracted, it normally enables the Knowledge Network to receive funding for activities.

The Financial Cash Flow Plans need to ensure that the initial cash flow is sufficient to start off the network.

Since a knowledge network often makes use of third party provided funding, it is extremely important that the network establishes responsible and transparent financial controls.

Approach Stakeholders

Plan Implementation Activities

Organizational Procedures

Build or Procure Architecture

Funding

Reference: M2.1.5: Funding

Lower Levels: M2.1.5.1: Obtain Initial Funding

                         M2.1.5.2: Establish Financial Control

7.1.2.2 Roll-out and Implement

Once the implementation of the Knowledge Network has been planned and prepared, the actual roll-out of the Knowledge Network may begin.

Plan and Prepare to Implement → Roll-out and Implement

This phase consists of:

- Facilitation to ensure Stakeholder Participation.

- Kick-off Workshops and Meetings.

- Organization of all participants and activities.

- The Roll-out of the ICT and Organizational Architectures.

- The implementation of performance measures.

Reference: M2.2: Roll-out and Implement

Lower Levels: M2.2.1: Facilitate Stakeholder Participation

M2.2.2: Kick-off Workshops and Meetings

M2.2.3: Organize

M2.2.4: Roll-out Architecture

M2.2.5: Implement Performance Measures

Facilitate Stakeholder Participation

After solidifying and organizing the processes of the knowledge network, relationships within the knowledge network have to be developed. It is particularly important to find people with certain skills who represent different roles within the network, so that the spirit of the knowledge network can be brought to life. In order to ensure full commitment, these knowledge network members must be motivated and supported by appropriate and, most likely, different means. Stakeholders may be internal or external to the organization.

Facilitate Stakeholder Participation → Kick-off Workshops and Meetings → Organize → Roll Out Architecture → Implement Performance Measures

The commitment of all network members is the key in order to get the network up to speed and thus achieve a high performance. Without commitment of the network members, the network will most likely have a low level of activity.

Commitment of the stakeholders and network members can be achieved by two means:

- Show and let the participants explicitly experience the benefits of the network, thus telling them why they should invest time in the network. Additionally, provide them with some type of intrinsic motivation (e.g., a certain prestige attached to being a member).

- Propose and define clear responsibilities and duties within the network which members have to acknowledge by signing an appropriate document. The demand to participate must come from top management and with a certain extrinsic motivation (e.g., one cannot afford not to be part of the network).

Reference: M2.2.1: Facilitate Stakeholder Participation

Lower Levels: M2.2.1.1: Facilitate Internal Participation

     M2.2.1.2: Facilitate External Participation

Kick-off Workshops and Meetings

One of the important Critical Success Factors of a knowledge network is to have early successes. This means that stakeholders and knowledge network members need to be enabled to participate, and importantly, take part ownership by becoming involved in the detailed planning activities.

Facilitate Stakeholder Participation

Kick-off Workshops and Meetings

Organize

Roll Out Architecture

Implement Performance Measures

Reference: M2.2.2: Kick-off Workshops and Meetings

Lower Levels: M2.2.2.1: Training Workshops

     M2.2.2.2: Detail Planning Workshops

Organize

Organizing the knowledge network through public and private activities will help to develop a community. Public activities such as conferences and workshops, as well as private person-to-person discussions with potential members and external experts, will develop a community whose members have a common purpose. These activities help members learn together through one another's experiences and allow for discussions that build strong relationships and help to improve capabilities. This helps members to accelerate their own professional development and to learn new insights and methods that can be applied to solve particular problems.

Facilitate Stakeholder Participation

Kick-off Workshops and Meetings

Organize

Roll Out Architecture

Implement Performance Measures

Reference: M2.2.3: Organize

Lower Levels: M2.2.3.1: Assign Roles based on Skills

     M2.2.3.2: Organize People and Meetings

Roll-out Architecture

The ICT and Organizational Architecture procured or built must be rolled out to all stakeholders and knowledge network members.

Reference: M2.2.4: Roll-out Architecture

Lower Levels: M2.2.4.1: Knowledge Base

M2.2.4.2: Tools

M2.2.4.3: Communication

Implement Performance Measures

The choice of the appropriate incentives, as well as the appropriate awards presented in the initial part, is the first step to measurement. Incentives and rewards have the potential to steer the behaviour of the network in favour of the network performance.

The degree of the achievement of the targets of the individual or the role, as well as the network as a whole, has to be evaluated and overall measures established.

The key success factors for each individual network will help to identify whether the knowledge network is successful or not and to determine where action should take place. (Back, et al. [14])

Reference: M2.2.5: Implement Performance Measures

Lower Levels: M2.2.5.1: Communicate Measures

M2.2.5.2: Set and Agree Targets

M2.2.5.3: Start to Collect Data

7.1.3 Operate and Refine

After the knowledge network has been implemented, it enters the Operational Phase. During this phase, a knowledge network needs to continually assess and adapt or refine its operation. This phase is therefore divided in two subcategories:

- Operation
- Refinement

(Note that the two sub-phases are not necessarily in sequence, but can occur in parallel, and are often intertwined.)

Reference: M3: Operate and Refine

Lower Levels: M3.1: Operate

M3.2: Refine
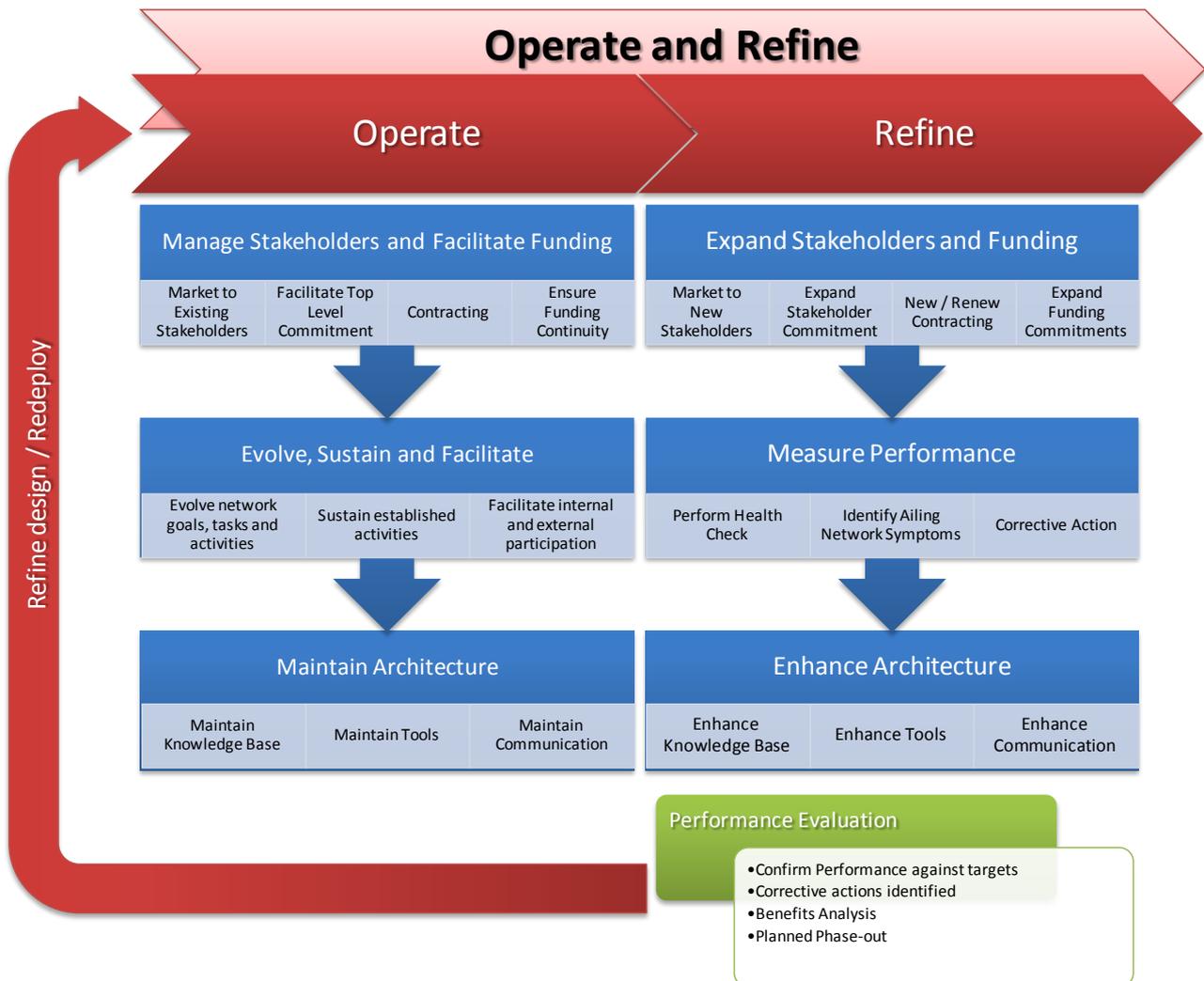
Figure 7-5: Operating and Refining an Integrated Knowledge Network

7.1.3.1 Operate

Operating a knowledge network requires that stakeholders' expectations and participation are managed, that continuous funding is available, to evolve, sustain and facilitate all network activities, and to ensure that the organizational and ICT architectures continue to operate.

Reference: M3.1: Operate

Lower Levels: M3.1.1: Manage Stakeholders and Facilitate Funding

M3.1.2: Evolve, Sustain and Facilitate

M3.1.3: Maintain Architecture

Manage Stakeholders and Facilitate Funding

The Knowledge Network Stakeholders will have certain expectations regarding their involvement in the Knowledge Network. These expectations need to be managed, to ensure that stakeholders remain involved in a constructive manner, and that their continuous participation is contracted. This means that marketing is a continuous activity, that top level commitment from participating organizations must be maintained, and that contracts need to be renewed as appropriate.
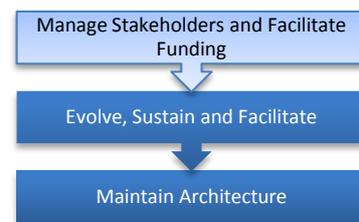
Knowledge Network activities also require a continuous source of funding, as determined by the funding planning activities in the previous phases. During the Operational Phase, these funding sources need to be realized and managed.

Reference: M3.1.1: Manage Stakeholders and Facilitate Funding

Lower Levels: M3.1.1.1: Market to Existing Stakeholders

M3.1.1.2: Facilitate Top Level Commitment

M3.1.1.3: Contracting

M3.1.1.4: Ensure Funding Continuity

Evolve, Sustain and Facilitate

The planning done in the first phase will require activities and milestones to be achieved, and the management of the Knowledge Network needs to monitor the achievement of these.

As the Knowledge Network progresses with the initial plans and
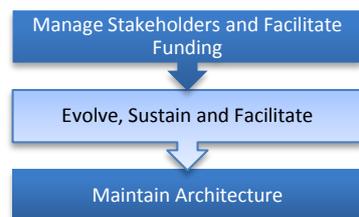
milestones, new discoveries will be made, requiring that the knowledge network's goals will start to evolve, and the tasks and activities will have to be adapted accordingly.

An important activity is to facilitate the continuous involvement of internal and external participants in the network, based on the roles and responsibilities identified earlier. The continued commitment of all network members is the key in order to achieve a high performance.

Commitment of the network members can be achieved by two means (Back, et al. [14]):

- Show and let the participants explicitly experience the benefits of the network, thus telling them why they should invest time in the network. Additionally, provide them with some type of intrinsic motivation (e.g., a certain prestige attached to being a member).

- Propose and define clear responsibilities and duties within the network which members have to acknowledge by signing an appropriate document. The demand to participate must come from top management and with a certain extrinsic motivation (e.g., one cannot afford not to be part of the network).

Reference: M3.1.2: Evolve, Sustain and Facilitate

Lower Levels: M3.1.2.1: Evolve Network Goals, Tasks and Activities

M3.1.2.2: Sustain Established Activities

M3.1.2.3: Facilitate Internal and External Participation

Maintain Architecture

One of the key enablers of the Knowledge Network is its Architecture, consisting of the ICT and Organizational Architectures. These architectures are often required for documenting, storing and categorizing knowledge, searching new knowledge, communicating with other network members, sharing experience etc, and it is thus critical that this architecture is maintained.
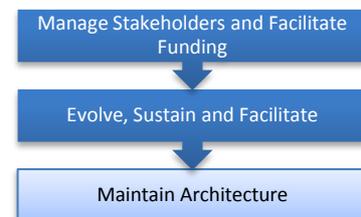
Maintenance thus involves not only the ICT level maintenance, but also the organization of organizational events where network activities can occur.

Reference: M3.1.3: Maintain Architecture

Lower Levels: M3.1.3.1: Maintain Knowledge Base

M3.1.3.2: Maintain Tools

M3.1.3.3: Maintain Communication

7.1.3.2 Refine

As described in the Design phase, a knowledge network will have a vision, with derived goals, and it is important that the achievement of these goals is assessed, and the operation of the network is adjusted and refined to improve the achievement of these goals.

Operate → Refine

The Refine phase can thus include Performance Measurement, Expansion of Stakeholder and Funding, and the Enhancement of the Architecture.

Reference: M3.2: Refine

Lower Levels: M3.2.1: Expand Stakeholders and Funding

M3.2.2: Measure Performance

M3.2.3: Enhance Architecture

Expand Stakeholders and Funding

As the goals of the network evolve, due to the discovery of new knowledge and successes, the requirements for additional stakeholders, as well as the attractiveness of the network to potential stakeholders, will increase.

Expand Stakeholders and Funding → Measure Performance → Enhance Architecture

The Knowledge Network can therefore be successfully marketed to additional potential stakeholders, stakeholder commitment can be expanded, new contracts can be negotiated and existing contracts renewed, and the funding can also be expanded.
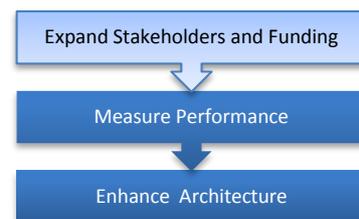
Reference: M3.2.1: Expand Stakeholders and Funding

Lower Levels: M3.2.1.1: Market to New Stakeholders

M3.2.1.2: Expand Stakeholders Commitment

M3.2.1.3: New / Renew Contracting

M3.2.1.4: Expand Funding Commitments

Measure Performance

It is necessary to Measure the Network's performance so as to assess the impact of the knowledge network on the achievement of the business goals.

Expand Stakeholders and Funding → Measure Performance → Enhance Architecture

Measuring the impact is important for:

- Justification of the knowledge network approach.
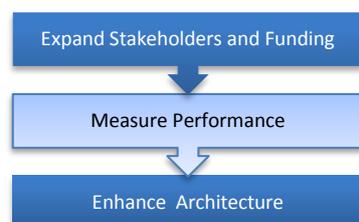
- Optimal allocation of resources within the company, and for ultimately judging whether the network is high performing or not.

The impact of knowledge management initiatives has to be assessed across the network participating organizations. Assessments should be both systematic and sufficiently sensitive to the dynamic nature and social aspects of knowledge management in action. This provides valid and usable results. It is impossible to assess the true impact of knowledge management and to identify useful lessons learned without the committed involvement of the knowledge workers who build, share, and apply the knowledge.

The following needs to be done:

- **Assess the health of the network**: The health check demonstrates how the performance of the network can be viewed from the network perspective, and how specific outcomes can be linked to concrete actions in order to achieve improvements. Starting with the network perspective, one can also view the overriding issues on a company level. (Back, et al. [14])

- **Identify Ailing Network Symptoms**: Having identified failures/mistakes that can occur within networks, as well as disadvantageous variables that cannot be directly influenced by the networks, the signals and symptoms of failure should then receive attention. These symptoms are often related to: (Back, et al. [14])

  o Task Orientation / Role issues

  o Skills and Experience issues

  o Relationship issues

  o Perceived benefit and value to participant problems

  o Lack of shared objectives

  o Communication Style issues

  o Commitment problems

  o Boundaries and openness problems

  o Size and geographic issues

- **Corrective Action**: Once the health of the network is assessed, one can then decide on possible corrective actions.

Reference: M3.2.2: Measure Performance

Lower Levels: M3.2.2.1: Perform Health Check

                       M3.2.2.2: Identify Ailing Network Symptoms

                       M3.2.2.3: Corrective Action

Enhance Architecture

As the activities of the Network are refined, more sophisticated requirements on the architecture of the network will emerge, thus requiring architecture enhancements.

Expand Stakeholders and Funding

Measure Performance

Enhance Architecture
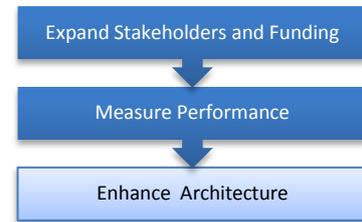
Reference: M3.2.3: Enhance Architecture

Lower Levels: M3.2.3.1: Enhance Knowledge Base

M3.2.3.2: Enhance Tools

M3.2.3.3: Enhance Communication

7.1.4 Phase-Out

Networks with a decreasing activity level and registering a poor performance during a health check might decide to end their activities. If a Knowledge Network has achieved its goals or the network is failing and corrective actions have failed to restore it, the network needs to be phased out. Both the phases of the decreasing activity level, as well as the possible "dying" of the network, should be closely managed.

Reference: M4: Phase-Out

Lower Levels: M4.1: Plan Phase-Out

                      M4.2: Execute Phase-Out
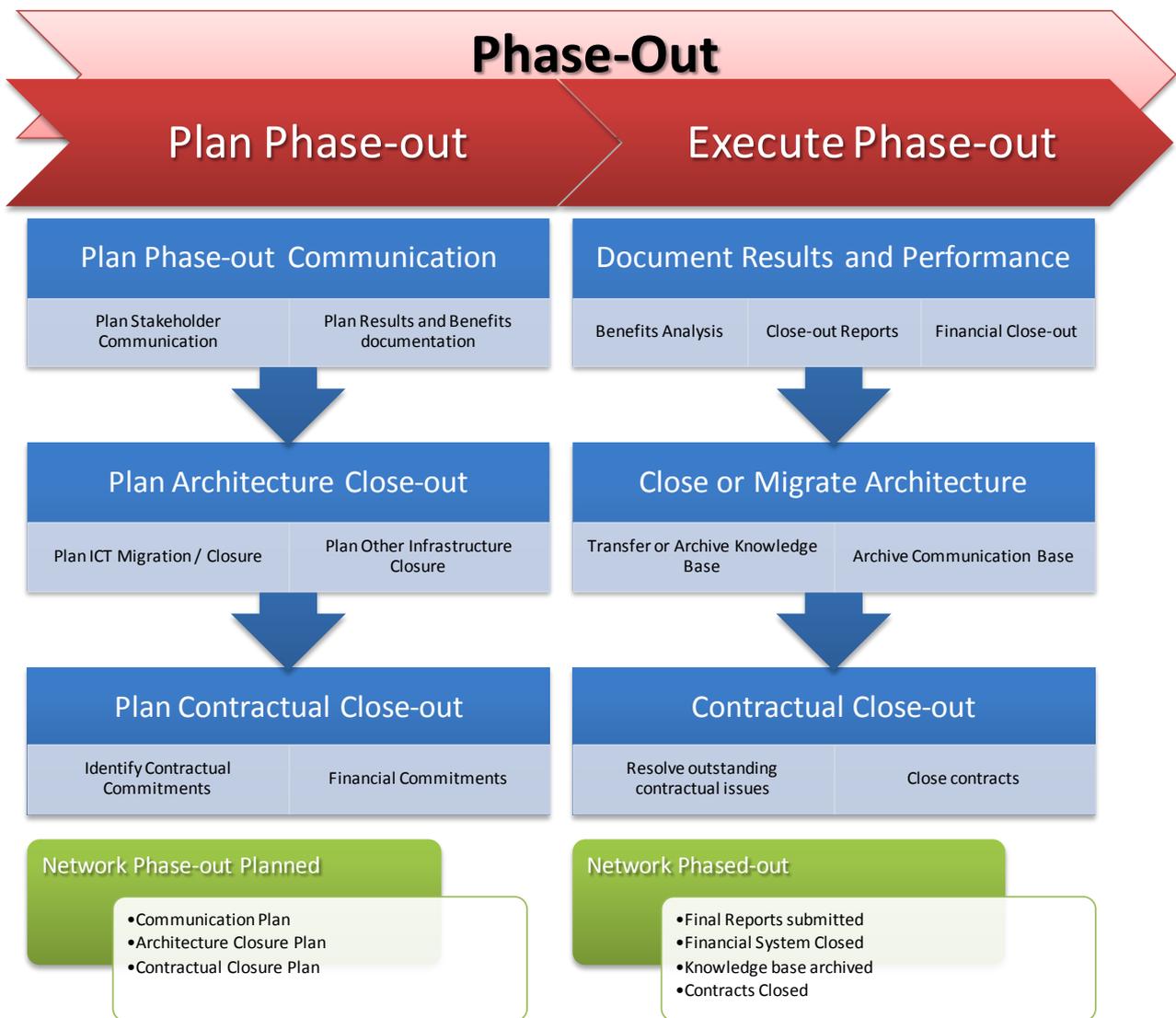
Figure 7-6: Phasing Out an Integrated Knowledge Network

7.1.4.1 Plan Phase-Out

When it is realized that a network needs to be phased out, the phase-out activities need to be planned.

Even if a network is not built around a common task that has to be fulfilled, but around a common theme, its lifecycle can end. A network's topic might no longer be relevant; thus, the members and/or the management's commitment decreases.

Due to the fact that stakeholders from various organizations are often involved in Knowledge Network, and that there may be contractual agreements in place, a phase out needs to be planned carefully.

Reference: M4.1: Plan Phase-Out

Lower Levels: M4.1.1: Plan Phase-Out Communication

M4.1.2: Plan Architecture Close-Out

M4.1.3: Plan Contractual Close-out

Plan Phase-Out Communication

This Phase-out phase may be associated with wistful feelings by and fond memories of its members. Resignation, disappointment, and/or conflicts may also arise.
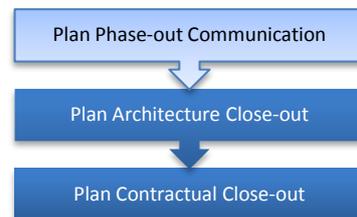
How the phase-out is communicated is therefore an important factor. Involve the key stakeholders in this decision. Award achievements, and provide participants with alternative mechanisms and involvements.

It is important to realize that the knowledge and experiences created in the network do have value, and that the results and benefits realized must be carefully documented and archived as part of the phase-out process.

Reference: M4.1.1: Plan Phase-Out Communication

Lower Levels: M4.1.1.1: Plan Stakeholder Communication

M4.1.1.2: Plan Results and Benefits Documentation

Plan Architecture Close-Out

The architecture often contains the captured benefits and knowledge created, and planning a controlled close-out of the architecture is thus crucial to ensure that this value is not lost, but will remain accessible to the stakeholders for future knowledge activities.
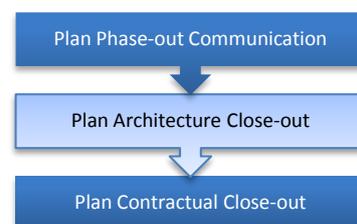
The Architecture Close-out plan thus needs to include archiving and future accessibility of the knowledge base.

Reference: M4.1.2: Plan Architecture Close-Out

Lower Levels: M4.1.2.1: Plan ICT Migration / Closure

M4.1.2.2: Plan Other Infrastructure Closure

Plan Contractual Close-out

Most participating stakeholder organizations will have existing contracts in place that control their participation and expected benefits from the knowledge network.

Each of the contracts needs to be examined to determine the nature and extent of any outstanding obligations from the parties involved, and the closure of each contract needs to be negotiated and planned.

Plan Phase-out Communication

Plan Architecture Close-out

Plan Contractual Close-out
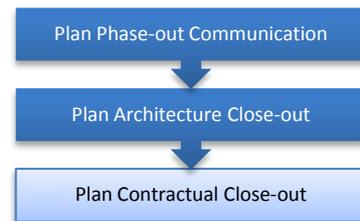
Reference: M4.1.3: Plan Contractual Close-out

Lower Levels: M4.1.3.1: Identify Outstanding Contractual Commitments

M4.1.3.2: Identify Outstanding Financial Commitments

7.1.4.2 Execute Phase-Out

Once the Phase-out has been planned, the actual phase-out can be executed according to plan.

Plan Phase-out → Execute Phase-out

The Phase-out consists of:

- Documenting the results and performance of the network.

- Archiving, closing or migrating the architecture.

- Closing all contracts.

Reference: M4.2: Execute Phase-Out

Lower Levels: M4.2.1: Document Results and Performance

M4.2.2: Close or Migrate Architecture

M4.2.3: Contractual Close-out

Document Results and Performance

The knowledge network was created with a specific mission and set of goals in mind, and based on this, stakeholders invested funding and effort in the network. As a final close-out report, the network needs to document how the network managed to satisfy these expectations:

Document Results and Performance

Close or Migrate Architecture

Contractual Close-out
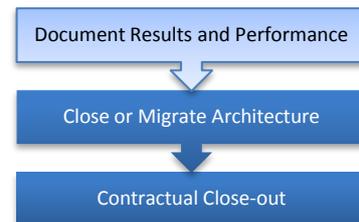
- Benefits Analysis: Were the envisaged benefits achieved? What were the benefits of the network?

- Financial Close-out: Document any outstanding financial obligations, and close off the financial system.

- Other Close-out Reports: Outstanding actions, possible migration of some aspects of the network, etc.

Reference: M4.2.1: Document Results and Performance

Lower Levels: M4.2.1.1: Benefits Analysis

M4.2.1.2: Close-out Reports

M4.2.1.3: Financial Close-Out

Close or Migrate Architecture

As described in the previous phase, the knowledge created in the network is an important asset that belongs to the stakeholders of the network. This asset needs to be protected, archived, and documented, and the best way is often through the architecture archive and migration process. Since knowledge has been captured in the network's knowledge base, by archiving this knowledge base, and then migrating the access to some or all of the stakeholder organizations, this knowledge is protected and will remain accessible to the stakeholders for as long as there is a need to access it.
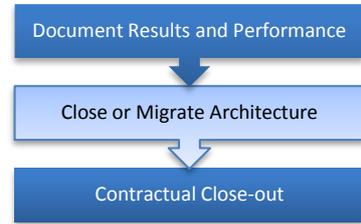
Reference: M4.2.2: Close or Migrate Architecture

Lower Levels: M4.2.2.1: Transfer or Archive Knowledge Base

M4.2.2.2: Archive Communication Base

Contractual Close-out

Based on the Contractual Phase-out Planning done in the Phase-out Planning Phase, all contracts need to be closed as a final activity, by:

- Resolving any outstanding contractual issues that may still exist, and

- Closing the contracts.
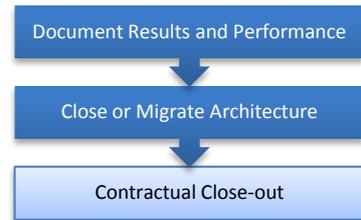
Reference: M4.2.3: Contractual Close-out

Lower Levels: M4.2.3.1: Resolve Outstanding Contractual Issues

M4.2.3.2: Close Contracts

7.2   A Generic Knowledge Network Framework

Based on:

- the Knowledge Creation process, as defined by Nonaka, et al. [65], and embodied in Network Reference Types and a Knowledge Network Framework by Back, et al. [14];

- the Key Success Factors, Barriers and Benefits [1];

- the Knowledge Domains and IPR (Du Preez and Louw [30]); and

- the Knowledge Network Lifecycle described in par 7.1;

it is possible to define a General Knowledge Network Framework to describe the Knowledge Network Methodology within a two-dimensional matrix (See Figure 7-7):

- **Horizontal Axis**: the Knowledge Network's Life Cycle, as described in par 7.1, representing the methodology in each phase.

- **Vertical Axis**: the Knowledge Network Process divided into Input, the Knowledge Network Process, and Outputs.
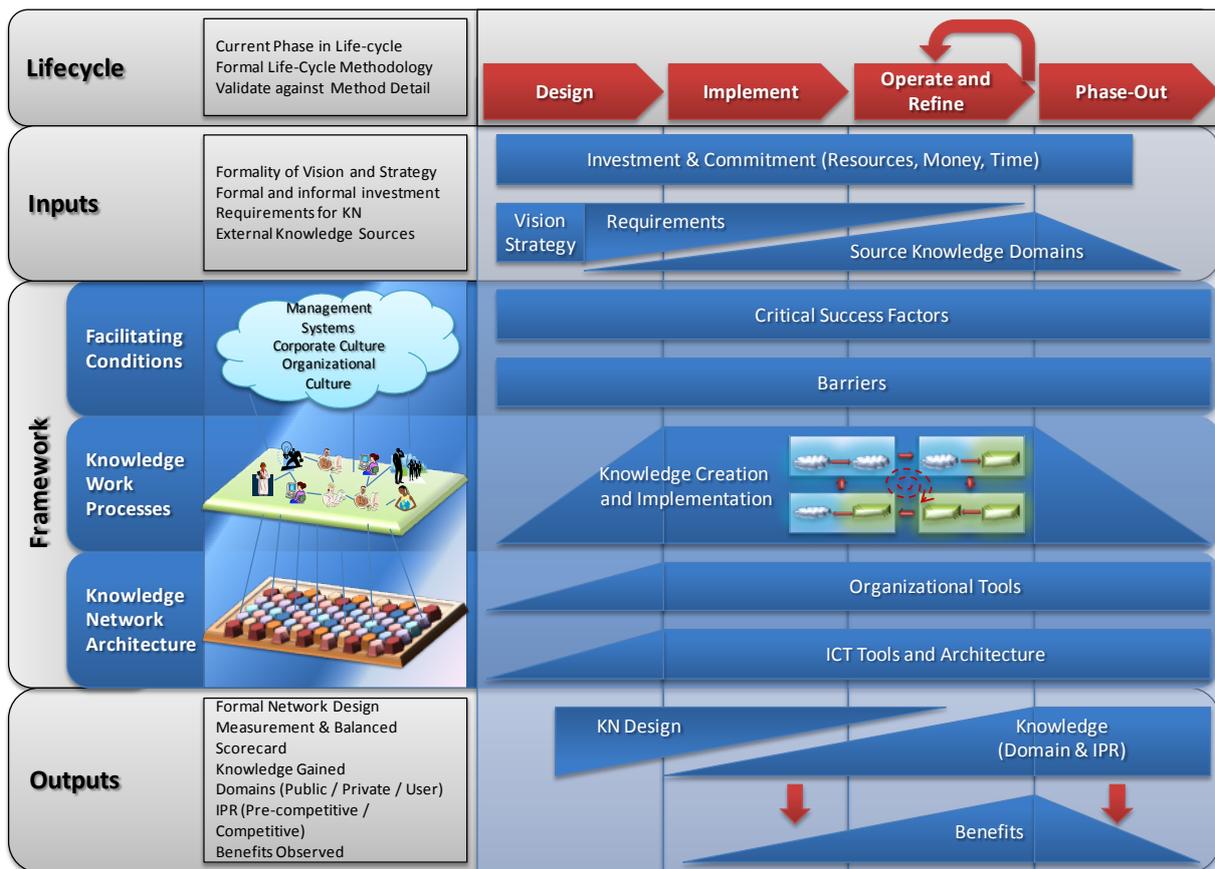
Figure 7-7: Generic Knowledge Network Framework

The different aspects of a generic knowledge network are illustrated, with an indication of the relevance or presence in each life cycle phase.

The following aspects are illustrated in the Generic Knowledge Network Framework:

- **Lifecycle**: As described in detail in par 7.1, consisting of Design, Implement, Operate and Refine, and Phase-out phases.

- **Inputs**: In order to make a Knowledge Network function, it requires a number of inputs:

  o **Vision & Strategy**: Without a Vision, Strategy and Purpose, the Knowledge Network will have no direction. This needs to be set up during the initial design stages, as described in the methodology by "Define Need, Purpose and Strategy" in par 7.1.1.1.

  o **Requirements**: As a derivative of the Vision and Strategy, the Network's Requirements must be defined. While this needs to happen primarily during the Design Phase, Requirements will be amended and refined through-out the life of the Knowledge Network.

  o **Investment & Commitment**: The activities in the Knowledge Network will require resources, money and time through all phases in the lifecycle. This investment needs to be balanced against the Benefits. This is covered in the methodology – see "Determine Financial Feasibility" in par 7.1.1.1, "Financial Support Requirements" in par 7.1.1.2, and "Financial Models" in par 7.1.1.3.

  o **Source Knowledge Domains**: For knowledge to be created, knowledge needs to be sourced from other domains. The IPR Strategy needs to define the boundaries and accessibility of the Source Knowledge Domains. (See "IPR Strategy" in par 7.1.1.1.)

- **Framework**: This incorporates the Knowledge Framework as described by Back, et al. [14], consisting of:

  o **Facilitating Conditions**: The facilitating conditions are embodied in the presence of Key Success Factors (see 8.1.2) and the minimization of Barriers (see 8.1.3). Both will be present and play a role through-out the lifecycle of the Knowledge Network. The way in which the Knowledge Network methodology addresses the success factors and barriers, was discussed in pars 8.1.2 and 8.1.3.

  o **Knowledge Work Processes**: The work processes and network reference types are described in detail in earlier chapters. (See also "Network Design" in par 7.1.1.3)

  o **Knowledge Network Architecture**: The architecture consists of the ICT and organizational tools required in order to operate the Knowledge Network. The design (see "Network Design" in par 7.1.1.3), procurement (see "Build or Procure Architecture in par 7.1.2.1), roll-out (see "Roll Out Architecture" in par 7.1.2.2), maintenance (see "Maintain Architecture" in par 7.1.3.1) and refinement (see "Enhance Architecture" in par 7.1.3.2) are all covered by the Knowledge Network Methodology.

- **Outputs**: The Knowledge Network, and the execution of the Knowledge Network Methodology will result in a number of outputs:

  o **A Knowledge Network Design**: This is the output from the Design Phase in the Knowledge Network Methodology. (See "Network Design" in par 7.1.1.3).

o **Created Knowledge**: A successful knowledge network will create new knowledge through the knowledge work processes. This creation process needs to be measured (see "Performance Measures" in par 7.1.1.3 and "Measure Performance" in par 7.1.3.2). Created knowledge also needs to be captured (refer to the Knowledge Base elements of the Architecture), and needs to be protected (refer to the contractual and IPR aspects discussed).

o **Benefits**: The primary reason why stakeholders will participate in a knowledge network, is to receive some or other benefit from their participation. Benefits are planned from the initial stages (see "Determine Financial Feasibility" in par 7.1.1.1), need to be monitored (see "Measure Performance" in par 7.1.3.2), and need to be analyzed when the network is phased-out (see "Document Results and Performance" in par 7.1.4.2).

Chapter 8: Verification and Validation

The validation of the methodology discussed in Chapter 7 is presented in this chapter. A Case Study approach has been used, whereby respondents from selected networks were interviewed, guided by a compiled survey questionnaire.

The purpose of the validation is to test whether the framework proposed in chapter 7 is valid, and whether the methodology would contribute to an improved process for managing such networks.

The structure of the chapter, depicted in Figure 8-1, is as follows:

- **Verification**: The Integrated Knowledge Network Methodology verified, by comparing it with the requirements, as well as the facilitating and preventive conditions identified in literature. (see par 8.1)

- **Validation**: the Methodology and Generic Knowledge Network Framework is validated by means of a survey and analysis.

   o   The structure of the survey is presented in par 8.1

   o   The six networks analyzed are described in par 8.2.2

   o   A detailed analysis, based on the 14 aspects identified in the survey, is presented in par 8.2.3.
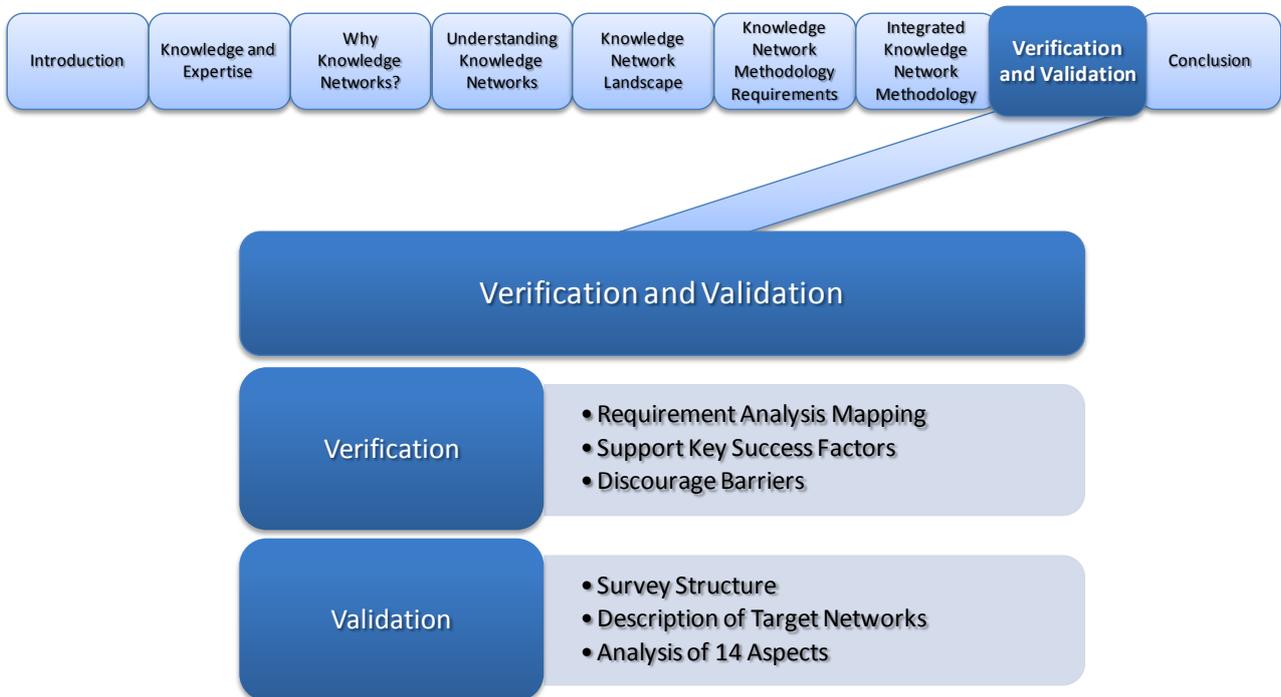
Figure 8-1: The Structure of Chapter 8 within the context of the Overall Navigation Structure

8.1 Verifying the Integrated Knowledge Network Methodology

The methodology has been verified as follows:

- Requirements Analysis Mapping

- Ability to encourage key success factors

- Ability to discourage barriers

Each verification analysis is discussed in more detail below.

In addition, the Integrated Knowledge Network Methodology has also been compared and verified against the "Putting Knowledge Networks into Action" (Back, et al. [14]). This verification cross-reference is shown in par C.4, appendix C, on page C-18.

8.1.1 Requirements Analysis Mapping

In order to ensure that the methodology satisfies all identified requirements, a requirements mapping has been done, and where gaps were discovered, the methodology and requirements have been refined, as illustrated in Figure 8-2.
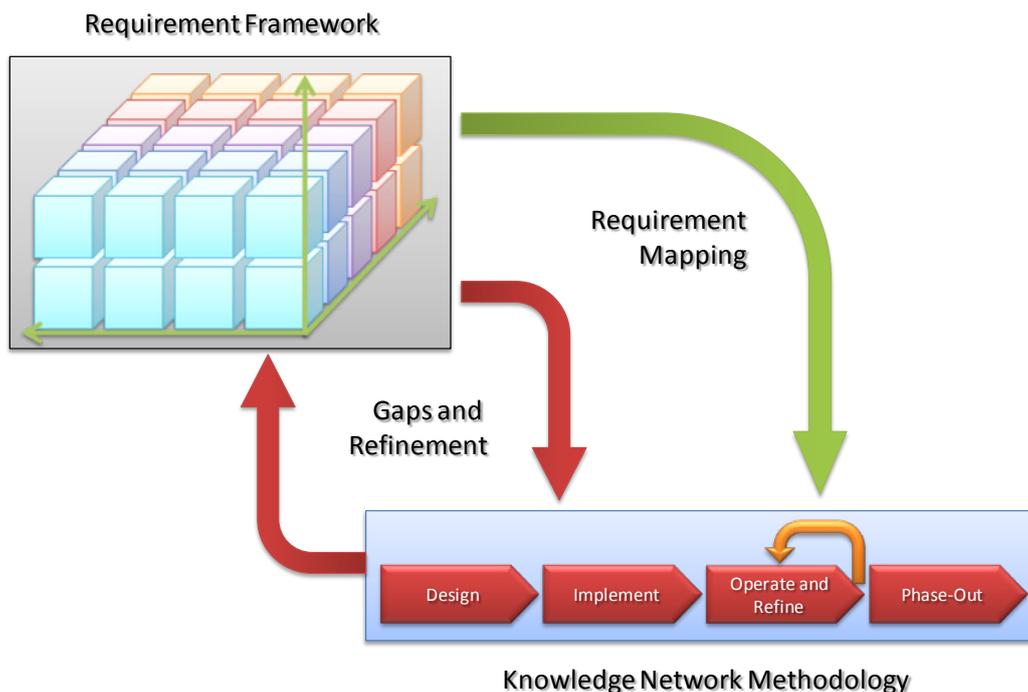
Figure 8-2: Requirement Mapping Process

The results of the final mapping are documented in Table C-2 in Appendix C.

The mapping illustrates that all identified requirements have been addressed by the methodology. This implies that if the methodology is applied, Knowledge Networks created in this manner will satisfy the Purpose, Functional and Control requirements, identified in this research.

8.1.2 Key Success Factors

A Knowledge Network methodology should create, allow and encourage identified Key Success Factors.

The Forfás Innovation Network Report [1] lists a number of key success factors in the formation of networks. Since this is focused on the creation of inter-organizational innovation networks, the authors judged it a sound list of factors against which to verify the methodology.

Table 8-1: Methodology Verification against the Key Success Factors

Key Success Factor	Addressed	Notes
Clear Need: An important condition for the development of a network is that the members perceive that there is a clear need to belong i.e. the network can achieve something that the individual members cannot achieve on their own.	Yes	Addressed in Knowledge Vision and Strategy – see 7.1.1.1
Objectives: Related to the requirement that a network should have clear needs, there is also the requirement that it should have objectives that primarily reflect the needs of the member organizations.	Yes	Addressed in Knowledge Strategy and Stakeholder Identification and Selection. (see 7.1.1.1)
Leadership and Vision: Networks that have a leader, who is able to articulate clear and concise goals, are more likely to be successful than those networks whose members are unclear as to its future direction. The leader should not only be able to communicate the network's long term goals but must also be able to translate those goals into a realistic programme of action.	Yes	Vision addressed (see 7.1.1.1) Leadership Addressed in Organizational Procedures (see 7.1.2.1) and Organize (see 7.1.2.2)
Early Successes: The research has indicated the importance of achieving early successes in order to get member organizations to continue their involvement in the network. It is vital, therefore, that networks structure their objectives and work programmes to ensure that members can see a return for their investment in the short term.	Yes	Tasks need to be sequenced so as to enable early successes for all members. See Planning in par 7.1.1.3
Trust: On paper, a grouping of companies in a sector might make the ideal candidates for a network. However, the successful development of networks has been found to be very dependent on the level of trust between and among member organizations. Since the network involves members who normally act on their own, the implementation of network activities requires a certain level of trust by the members. The gaining of trust is particularly important in those networks whose membership include companies that compete against each other.	Yes	Through mutual goals and objectives, but with contractual protection. Contractual protection in IPR Strategy (see 7.1.1.1) and Contractual Models (see 7.1.1.3)
Ownership: If the network is to succeed then it will be necessary for them to take ownership of the development process and drive the network forward. If the companies do not have ownership of the network they will not be committed to it. They will perceive that it will have an agenda that may not approximate to their own	Yes	At stake holder and top level management level. (See "Facilitate Stakeholder Participation" in par 7.1.2.2) Also required at participating individual level. (See "Organize" in par 7.1.2.2)
Time: The formation of a durable network can take time. A	Yes	The planning and benefit analysis need to

8.1.2   Key Success Factors

A Knowledge Network methodology should create, allow and encourage identified Key Success Factors.

The Forfás Innovation Network Report [1] lists a number of key success factors in the formation of networks. Since this is focused on the creation of inter-organizational innovation networks, the authors judged it a sound list of factors against which to verify the methodology.

Table 8-1: Methodology Verification against the Key Success Factors

Key Success Factor	Addressed	Notes
Clear Need: An important condition for the development of a network is that the members perceive that there is a clear need to belong i.e. the network can achieve something that the individual members cannot achieve on their own.	Yes	Addressed in Knowledge Vision and Strategy – see 7.1.1.1
Objectives: Related to the requirement that a network should have clear needs, there is also the requirement that it should have objectives that primarily reflect the needs of the member organizations.	Yes	Addressed in Knowledge Strategy and Stakeholder Identification and Selection. (see 7.1.1.1)
Leadership and Vision: Networks that have a leader, who is able to articulate clear and concise goals, are more likely to be successful than those networks whose members are unclear as to its future direction. The leader should not only be able to communicate the network's long term goals but must also be able to translate those goals into a realistic programme of action.	Yes	Vision addressed (see 7.1.1.1) Leadership Addressed in Organizational Procedures (see 7.1.2.1) and Organize (see 7.1.2.2)
Early Successes: The research has indicated the importance of achieving early successes in order to get member organizations to continue their involvement in the network. It is vital, therefore, that networks structure their objectives and work programmes to ensure that members can see a return for their investment in the short term.	Yes	Tasks need to be sequenced so as to enable early successes for all members. See Planning in par 7.1.1.3
Trust: On paper, a grouping of companies in a sector might make the ideal candidates for a network. However, the successful development of networks has been found to be very dependent on the level of trust between and among member organizations. Since the network involves members who normally act on their own, the implementation of network activities requires a certain level of trust by the members. The gaining of trust is particularly important in those networks whose membership include companies that compete against each other.	Yes	Through mutual goals and objectives, but with contractual protection. Contractual protection in IPR Strategy (see 7.1.1.1) and Contractual Models (see 7.1.1.3)
Ownership: If the network is to succeed then it will be necessary for them to take ownership of the development process and drive the network forward. If the companies do not have ownership of the network they will not be committed to it. They will perceive that it will have an agenda that may not approximate to their own	Yes	At stake holder and top level management level. (See "Facilitate Stakeholder Participation" in par 7.1.2.2) Also required at participating individual level. (See "Organize" in par 7.1.2.2)
Time: The formation of a durable network can take time. A	Yes	The planning and benefit analysis need to

Key Success Factor	Addressed	Notes
considerable period can elapse before the members have developed trust and confidence in the network to undertake joint activities. Member organizations need to interact socially before they can commit themselves to working with other members.		take this into account.
Critical Mass: The lack of critical mass can delay the outputs from a network.	Yes	The Stakeholder selection processes need to ensure that Critical Mass is achieved as soon as possible.
Key Player: Related to the issue of critical mass, the presence of a major player with the vision and resources can be influential in driving the network forward.	Yes	
Communication/Branding: The development of a clear identity for a network can be critical for its longevity.	Yes	Yes – the communication plan (see 7.1.1.3) and Marketing (see 7.1.2.1and 7.1.2.2) need to include branding.
Facilitation: To be successful, networks need on-going facilitation. The inputs of a network manager in terms of supporting the network, brokering the needs of individual members, coordinating what is a complex process and implementing the network's work programme can have a significant bearing on its long term viability.	Yes	Strong leader(s), Organizational Tools, and an Appropriate ICT Architecture.
Social Factors: An aspect often over-looked in the development of networks is the importance of social interaction.	Yes	Face-to-face meeting, conferences, etc. Use of ICT Architecture to create virtual meetings.
Top-Down Incentives or Pump Priming: The provision of State funding where submissions involving two or more applicants can obtain higher scoring points has been found to be very helpful in the development of networks.	Yes	Yes – Performance measures with incentives need to be planned for in the beginning. (see "Performance Measures" in par 7.1.1.3)
Process: While the concept of networks is easy to grasp, operationally, a network is both complex and challenging to operate. The key success factor is the process or the "how" factor i.e. how companies are attracted to participate in a network, how their commitment is gained, how the process of developing the network is managed, how it is structured, how decisions are made, how communications are handled, how action programmes are delivered, etc.	Yes	Generic Network Process / Methodology Training for Leader(s) and Stakeholders Member Training in: - ICT Architecture Tools - Organizational Tools - Network Structure, Goals, Plans etc.

Since all Key Success Factors are addressed by the Knowledge Network Methodology, it illustrates that the application of this methodology will create knowledge networks where the Key success Factors are present, thus increasing the success rate potential of the Knowledge Network.

8.1.3   Barriers

Forfás [1] lists a number of factors militating against the spontaneous and successful formation of networks. The methodology was also cross-referenced against these barriers to identify possible gaps (Table 8-2).

Table 8-2: Methodology Verification against the Barriers

Barriers	Addressed	Notes
There is a general lack of awareness as to the benefits of networks (as distinct from networking) among the business community;	Yes	The expected benefits and access to benefits are defined early on in the design phase. (See "Determine Financial Feasibility" in par 7.1.1.1 and "Contractual Models" in par 7.1.1.3)
There is a reluctance to commit time and resources to a process that is not well understood, or the results which are not clear;	Yes	Stakeholder Responsibilities need to include the time requirements – see "Contractual Models) in par 7.1.1.3.
Networks are too closely aligned with 'networking' in the mind of business managers and seen as a quasi-social activity rather than an important business function;	Yes	Stakeholder expectations need to be managed at a top management level. See "Approach Stakeholders" in par 7.1.2.1.
There is a reluctance to share information and knowledge with other enterprises, especially competitors;	Yes	The IPS strategy and Contractual Models need to create an environment where participants will freely share within the bounds of the required domains. (See "IPR Strategy" in par 7.1.1.1 and "Contractual Models" in par 7.1.1.3)
Enterprises are not always well placed to identify the opportunities for network relationships with other companies since their knowledge and information base may be limited to their own contacts;	Yes	The Network's key player needs to market to and approach potential Stakeholders. See "Approach Stakeholders in par 7.1.2.1.
Membership of a network may expose companies to the danger of "lock-in" where excessive focus is placed on the affairs of the network to the detriment of events in the outside environment;	Yes	The Vision and Strategy needs to be agreed with all Stakeholders. See "Define Need, Purpose and Strategy" in par 7.1.1.1.
Even where managers foresee a benefit in establishing a network relationship they may not have the skills or resources to facilitate or co-ordinate the actual implementation of the network. This has been referred to (Dixit and Nalebuff, 1991) as the 'collective action problem', where a group of individuals or enterprises may frequently fail to achieve co-operation, even where it would be beneficial to every individual in the group.	Yes	The Knowledge Network methodology enables Managers to better utilize Knowledge Networks.

Since all identified Barriers are addressed by the Knowledge Network Methodology, it illustrates that the application of this methodology will create knowledge networks where the Barriers are minimised, or early on identified, thus increasing the success rate potential of the Knowledge Network.

8.2   Validation

The Integrated Knowledge Network Methodology and Generic Knowledge Network Framework are validated by means of a survey and analysis.

- The structure of the survey is presented in par 8.2.1.

- The six target networks analyzed, are described in par 8.2.2.

- A detailed analysis, based on the 14 aspects identified in the survey, is presented in par 8.2.3.

8.2.1   Survey Structure

The Generic Knowledge Network Framework described in paragraph 7.2 on page 122 is used as the basis for the case study evaluation process.
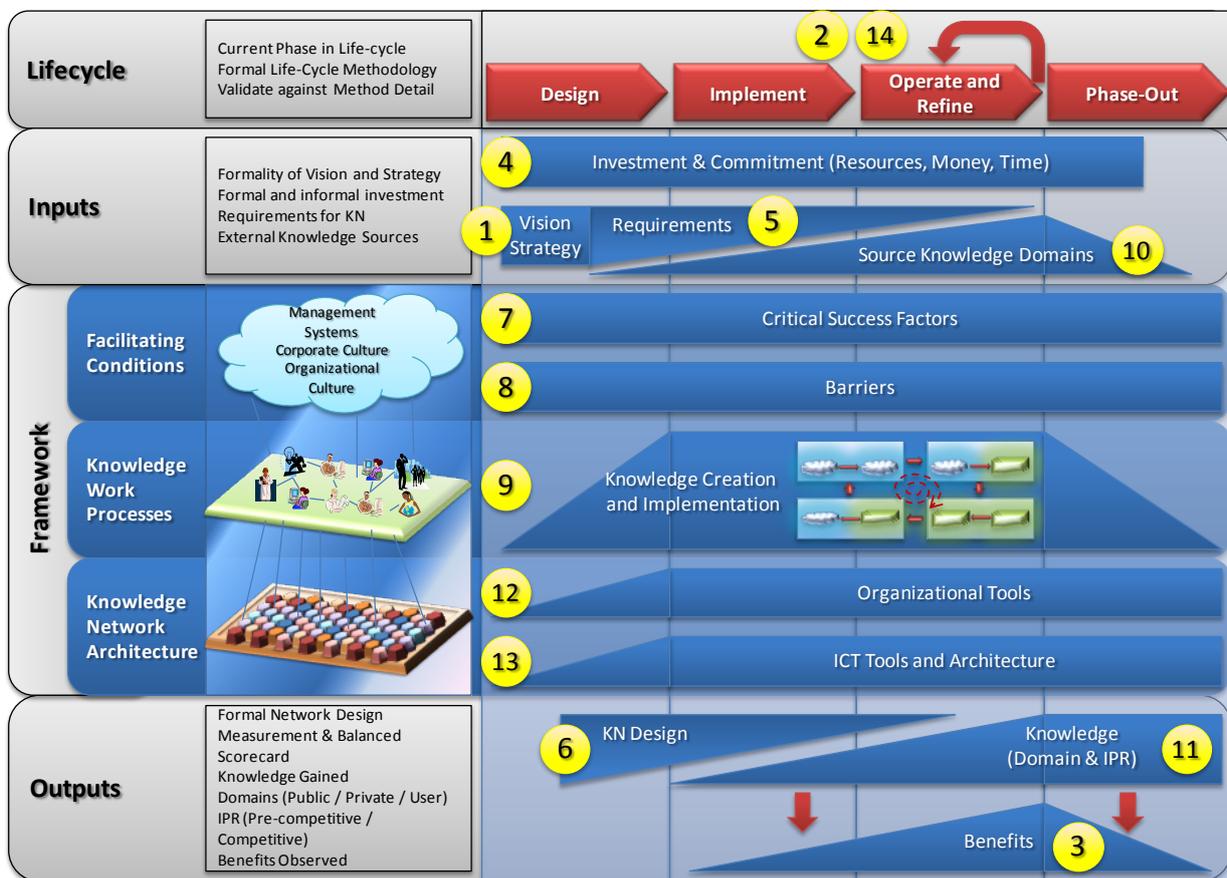
Figure 8-3: Questionnaire Structure

The survey assesses the presence of each of these aspects (in the following sequence – as indicated with the yellow numbered circles in Figure 8-3):

1. Presence of a Vision and Strategy
2. The network's current phase in the knowledge network lifecycle
3. Benefits observed in the network

4. Investment and commitment of participants
5. Formality of the KN Requirements
6. Presence of a KN Formal Design
7. The presence of Critical Success Factors
8. The presence of Barriers
9. Knowledge Work Activities
10. Source Knowledge Domains
11. Scope and Nature of the generated knowledge
12. Organizational Tools used
13. ICT Tools and Architecture Availability
14. Application of a Methodology

Questions were compiled, addressing each of these aspects. For the complete copy of the survey questionnaire, refer to Appendix D.

8.2.2 Networks Analyzed

A total of 6 knowledge networks were analysed in this case study. One or two key individuals in each network were approached, and the questionnaire was completed in one-to-one sessions (one interview was done using VOIP / Video-conferencing).

The networks used in the case study are:

- Stellenbosch University Innovation Workgroup and Partners - Stellenbosch
- Roland Jochem Personal Network – University of Kassel, Germany
- Infrastructure Delivery Improvement Programme – Treasury, Government of South Africa
- CIRP – Europe, headquartered in Paris, France
- Virtual Research Lab for a Knowledge Community in Production – Europe
- Knowledge Management Initiative at the Development Bank of Southern Africa

Each of the networks is described in more detail below.

8.2.2.1 Stellenbosch University Innovation Workgroup and Partners

In 1996 the Global Competitiveness Centre (GCC) in Engineering at the University of Stellenbosch was founded to:

- identify,
- acquire,
- master,
- multiply, and
- transfer

new technology that will support Competitiveness of enterprises.

Rapid Product Development and Enterprise Innovation became focus areas. By 2001 the GCC had about thirty Industrial partners and fifteen research partners, of which 40% are from European countries.

Research activities expanded and the challenge became how to capture and exploit the knowledge and experience in context with different research projects executed in the academic and industrial environments. It was decided to expand the then Intranet based client server network and collaboration platform to an Internet (web based) innovation support network.

Innovation Support Network / Enterprise Engineering Research Group

This network had to accommodate users, ranging from undergraduate students to graduate students, post-docs, researchers at a number of international institutes and also included several industrial partners. In addition, it had to cope with requirements from industrial projects. Deployment was done over a six year period with extensive enhancements to the collaboration platform, developed by a spin-out company of the GCC.

All information is captured in context of different projects guided by roadmaps. Each roadmap consists of a number of steps and each step is supported by appropriate templates, examples, best practice information and progress is guided by check lists. All knowledge is captured in documents and a document management system ensures access and version control. Navigation is supported by extensive search functionalities and inter roadmap navigation is possible.

Project life cycles cover a wide spectrum ranging from 2 months to as long as 5 years. Team sizes vary considerably, from two person teams to as large as 100 persons in commercial projects.

Collaborative Platform

Innovation management activities are supported by the web based collaborative platform, using roadmaps to guide teams through different innovation projects. A repository of generic roadmaps, populated in collaboration with a number of EU based research institutions covers a wide range of frameworks and topics, not within the scope of this research. In addition, own project roadmap templates were developed to support undergraduate and graduate students for the past five years in executing projects ranging from semester team projects in Enterprise Design 444, through graduate modules for enterprise engineering. Final year projects for industrial engineering students and Masters and PhD projects were also included. Functionality of the software platform was enhanced with feedback from students and industry collaborators.

Users of the network consisted out of voluntary users as well as captive users and the collaboration protocol was largely a free participative one.

Not all participants were equally enthusiastic about the initiative. However, some intense support also came to light and one of the success stories is the acceptance of the collaborative platform, in conjunction with a commercial collaborative platform, for a network of excellence in the EU framework.

8.2.2.2 Roland Jochem Personal Network

Prof. Dr.-Ing. Roland Jochem is the Director of the Institute for Industrial Science and Process Management, University of Kassel, in the Chair of Quality Management; Institute for Industrial Science and Process Management, at the University of Kassel.

Over the years Prof Jochem, a prominent figure in his research area, has developed a significant personal research network that he leverages in order to advance his own research activities. He has access to about 54 active individuals in his research network.

His research focus includes:

- Quality Management in the early phases of Product Creation Process

- Quality Methods for small and medium sized enterprises

- Quality in Innovation Processes

8.2.2.3 Infrastructure Delivery Improvement Programme

The Infrastructure Delivery Improvement Programme **(IDIP)** is a capacity-building programme of the South African government, designed to address problems relating to the planning and management of public sector infrastructure delivery. [11] The implementation approach has drawn partnership involving the National Treasury, the National Department of Public Works, Education, Health, the Development Bank of Southern Africa (DBSA) and the Construction Industry Development Board (CIDB).

The Goal of the programme is to contribute towards the Accelerated Shared Growth Initiative – South Africa (ASGISA) by improving the efficiency and effectiveness of the delivery of public sector infrastructure through developing and institutionalizing the best practice systems and tools, building capacity.

IDIP supports the provincial departments that deliver infrastructure to effectively render and sustain infrastructure and contribute towards Provincial Growth and Development Strategies (PGDS).

By linking **IDIP** to the PGDS, the improvement of infrastructure delivery is directed towards the South African Government's existing socio-economic development and growth objectives, ensuring that **IDIP** becomes relevant as an intervention, that will bring about sustained impact in the capacity of the provinces to deliver on their priorities, through better management of infrastructure.

The objectives of the programme are to:

- support improved efficiency and effectiveness of public sector infrastructure delivery by institutionalizing best practices tools and building capacity using the IDIP Toolkit and the Infrastructure Delivery and Budget Cycle Alignment Model as a benchmark;

- increase levels of infrastructure investment at provincial government level as a foundation for service delivery and social development;

- support the delivery of quality infrastructure in a manner that promotes socio-economic objectives of government;

- enhance and develop skills' and systems' capacity for infrastructure planning, management, budgeting, monitoring and reporting;

- contribute to the strengthening of co-operative governance by clarifying and formalizing roles and responsibilities, promoting communication between and among key role players, and by facilitating co-operation between and among the role players throughout the infrastructure delivery management process;

- explore innovative approaches to address system deficiencies and capacity constraints;

- improve monitoring and reporting on infrastructure delivery;

- contribute to the body of knowledge regarding best practice in capacity-building interventions in government; and

- promote the sustained increase and efficient spending of infrastructure budgets.

The principles of **IDIP** are to:

- support and enable provincial departments in the improvement of the efficiency and effectiveness of infrastructure delivery by institutionalizing best practices;

- ensure stakeholder buy-in and ownership of the intervention;

- create an enabling environment, which is conducive for professional government officials to operate effectively and efficiently and for skills to be transferred, to ensure the long term sustainability of IDIP initiatives;

- promote the sharing of knowledge and lesson learning;

- enhance other relevant government initiatives in improving efficiency; and

- promote the establishment of inter- and intra-departmental partnerships.

IDIP is implemented through provincial technical teams with multi-disciplinary expertise and skills that work closely with provincial officials, thereby enabling transfer of skills.

Management is based on a decentralized programme management system with a Programme Management Unit (PMU), which consists of representatives from all the national partners and a provincial management structure with the responsibility of managing **IDIP** in the provinces, on a daily basis.

IDIP has demonstrated good progress since its inception. It enjoys political leadership and support in both national and provincial spheres. With its focus on the improved capacity of government to plan and implement infrastructure delivery**, IDIP** is a well established vehicle for promoting sustainable socio-economic development and growth.

The benefits of **IDIP** are to:

- enable beneficiary departments to identify gaps and inconsistencies in their infrastructure delivery systems, also to design a solution and appreciate their role in resolving their problems;

- establish a programme management system that ensures effective allocation and utilization of resources;

- enhance partnerships and teamwork amongst all role players;

- promote co-operative governance between and among departments, as well as the national and provincial spheres of government;

- provide tools to guide planning and prioritization of infrastructure needs, procurement, programme and project management and reporting on infrastructure delivery; and

- provide a knowledge sharing and lesson learning facility, and a network that provides access to the following expertise:

  o infrastructure planning,

  o programme and project management,

  o construction procurement,

  o change management,

  o organizational development,

  o service delivery management systems and

  o monitoring and review. [11]

8.2.2.4 CIRP

CIRP, the International Academy for Production Engineering takes its abbreviated name from the French acronym of College International pour la Recherche en Productique (CIRP) and includes about 550 members from 41 countries. The number of members is intentionally kept limited, so as to facilitate informal scientific information exchange and personal contacts.

CIRP was founded in 1951 with the aim to address scientifically, through international co-operation, issues related to modern production science and technology.

CIRP now has about 170 Fellows and Honorary Fellows who are internationally recognized scientists elected to be CIRP members for life. CIRP also includes some 130 Associate members - well known scientists, with high potential, elected typically for a period of three years with the possibility of renewal. A number of Associate members eventually become Fellows. Some Associated members may also belong to fields related to Manufacturing.

CIRP, although an academic organization, encourages the participation of industry in its activities. There are about 140 Corporate members who follow the research work of the academic members of CIRP, and often contribute to the information exchange within CIRP by presenting their views on industrial needs and perspectives.

The Vision of CIRP:

To promote research and development among its members from academia and industry to contribute to the global economic growth and wellbeing of society.

The Mission of CIRP:

> *To develop the highest level International Network of eminent Researchers and Industrialists for the purpose of marshalling their Knowledge and Insights.*

CIRP aims in general at:

- Promoting scientific research, related to manufacturing processes, production equipment and automation, manufacturing systems, and product design and manufacturing

- Promoting cooperative research among the members of the Academy and creating opportunities for informal contacts among CIRP members at large

- Promoting the industrial application of the fundamental research work and simultaneously receiving feedback from industry, related to industrial needs and their evolution.

- Organizing an annual General Assembly with keynote and paper sessions, as well as meetings of the Scientific and Technical Committees, publishing papers, reports, annals and other technical information, organizing and sponsoring international conferences.

CIRP is organized into a number of Scientific Technical Committees (STCs) and Working Groups (WGs), covering many areas. CIRP organizes a General Assembly and the so-called January Meetings annually. In the General Assembly (GA), which lasts for a week, there is an intensive technical program with over 140 technical paper presentations from different fields of manufacturing, a number of keynote papers, at the opening of the conference, as well as technical work within the STCs. In parallel, there is a social program, aiming at making the culture of the General Assembly site known to the members and also at creating an informal environment for information exchange among the members. The January meetings are always organized in Paris, and last for three days.

Moreover, CIRP organizes, through its membership, a number of conferences, notably the Manufacturing Systems Seminar and a number of other conferences with relevant topics. CIRP members also organize a variety of conferences, under the sponsorship of CIRP.

The main publications of CIRP are the CIRP Annals (ISI accredited) in two volumes: Volume I, with refereed papers presented in the GA by Fellows, Associate, Corporate and Invited members, and Volume II with refereed keynote papers. There are also CIRP proceedings, including round table discussions, technical reports, special issues, reports and internal communications, proceedings of CIRP conferences, dictionaries of production engineering, etc. A Newsletter is also published twice a year.

The CIRP organization includes, besides the President, who is elected annually, the Council and a number of other committees, ensuring a continuous improvement of the CIRP organization and reflecting the changing needs of manufacturing science and technology.

CIRP has its headquarters in Paris, staffed by permanent personnel. (Information extracted from CIRP website [8])

8.2.2.5 Virtual Research Lab for a Knowledge Community in Production

The Virtual Research Lab for a Knowledge Community in Production (VRL-KCiP) was a FP6 European funded Network of Excellence, that originated from CIRP and related institutions.

The purpose of establishing the VRL-KCiP NoE was to reduce the fragmentation of research in the field of the production technologies and to bring a network-based approach to avoid duplication of effort in the modelling and the simulation of manufacturing processes, by joint partners. The objective was to support dynamic organizations, inter- enterprise interoperability, and necessary standardization.

One of the main objectives was to create a collaborative integrated design platform allowing the different members of the network to participate either in synchronous or asynchronous mode in collective design projects.

The VRL-KCiP network gathered two hundred and eighteen researchers, belonging to twenty research departments and representing fourteen countries. The group of associate members was made up of some colleagues from outside Europe (China, Japan, South Africa and USA) working on the same research themes and who could provide contributions. A group of industrial partners also supported the network.

At the completion of the FP6 program in 2008, VRL-KCiP transformed itself into a commercial entity, and is now known as EMIRAcle (European Manufacturing and Innovation Research Association).

EMIRAcle is now an association of 20 research laboratories in 14 different countries. [9] Their common mission is to act as a collaboration partner for European Product Development Enterprises in Manufacturing and Innovation research, with the goal of maintaining and improving their leading positions worldwide by increasing their productivity and innovation power.

Figure 8-4: VRL-KCiP / EMIRAcle Research Laboratories

VRL-KCiP is thus an important case study, since it was a formally set up knowledge network, with well formalized goals and designs, that achieved significant European Union funding, and progressed through the complete knowledge network life-cycle.

8.2.2.6 The Knowledge Management Integration Initiative: The Development Bank of Southern Africa

The Development Bank of Southern Africa (DBSA) is one of several development finance institutions in South and Southern Africa. Its purpose is to accelerate sustainable socio-economic development by funding physical, social and economic infrastructure.

In 2007, the bank initiated a Knowledge Management Integration Initiative, with the purpose of creating a Community of Interest, focusing on Culture and Management Roles in the bank.

While this network is focused on the activities of a single enterprise, about 100 individuals are registered, and about 70 individuals are active within the network. This network is still very young, and was selected to evaluate the importance of design activities on a new network.

8.2.3 Survey Analysis Summary

Based on the Generic Knowledge Network Framework and the questionnaire that was derived from the framework, each aspect of the 6 selected case study networks is discussed and analyzed in par D.2 in Appendix D.

The survey results for each of the 14 aspects are summarized in Table 8-3 below.

Table 8-3: Summarized Results from the Case Study Networks Survey

Survey Aspect Analyzed	Analysis Summary
1. **Presence of a Vision and Strategy**	The larger networks all have a well defined vision and strategy, while the smaller personal networks have mostly a knowledge domain interest area. When many participants are active in a network, it is important to have a common well-communicated Vision and Strategy. Smaller networks can get away with an informal vision and strategy.
2. **The network's current phase in the knowledge network lifecycle**	One network (DBSA) was still considered to be in a Design Phase, but given the network's activities, it was most probably more in an implementation phase, but lacking a formal design. Three networks were in an Operate and Refine phase, while one network was already Phased Out (VRL-KCiP), and it was thus possible to assess the measurement systems in place. Most networks that were perceived to be in an Operational and Refinement Phase had a measurement system in place. (The exception was the personal network.) Since networks were assessed that were in all phases of the life-cycle, a good representation of all life cycles was possible.
3. **Benefits observed in the network**	In established knowledge networks, most networks reported: • Increased Activities. • Increased Ability to deal with complexity. • Enhanced Learning. • Speed. Smaller new networks struggled to achieve the same benefits, and reported a variety of other benefits.
4. **Investment and commitment of participants**	Depending on the type of Knowledge Network, as well as the source of funding, the upfront investment and commitment can be significant: • VRL-KCiP received substantial EU FP6 funding, and participating organizations and resources received funding to make participation possible. • CIRP is an academic professional association, and is partly funded through membership fees (individuals and organizations). Participation therefore typically follows the traditional academic research allocation of 20% of time availability for network activities. • IDIP and DBSA are both knowledge networks functioning in an operational environment, and funding is therefore part of an operational budget, and key resources are required to be involved as part of their expected roles and responsibilities within their respected organizations. The analysis shows that investment and commitment from stakeholders and participants are important key success factors for a network.

Survey Aspect Analyzed	Analysis Summary
5. **Nature and Formality of the KN Requirements**	Depending on the vision and strategy of the network, the nature of the requirements can vary significantly. Formal requirements are often required by the contractual funding mechanism of the network, and formal requirements are not generally specified in order to design and plan the network.
6. **Presence of a KN Formal Design**	Similar to pt 5 above. Some networks evolved over time, and a formal design is often retrospectively captured in operating procedures.
7. **The Presence of Key Success Factors**	Most of the 14 Key Success Factors were present in the networks. Key success factors that were generally perceived to be problem areas, were incentives, ownership and trust.
8. **The Presence of Barriers**	A lack of skills, inability to identify network opportunities and reluctance of participants to commit time, were the most significant barriers present.
9. **Knowledge Work Activities**	All networks realised and confirmed that, in order to truly generate knowledge, all four SECI knowledge processes need to be present. The Learning aspect of knowledge work was often absent in the networks, but this was commonly recognized, and plans were in place to rectify the matter.
10. **Source Knowledge Domains**	Networks sourced knowledge from the public, private and user domains.
11. **Scope and Nature of the Generated Knowledge**	The VRL-KCiP network that was transformed into a commercial entity operated initially in a pre-competitive phase, but some work was considered a competitive advantage, that was protected. Jochem's network is purely an academic network, and knowledge generated is considered to be mostly pre-competitive. IDIP is a government network, and everything is therefore pre-competitive, and for transparency purposes, intended to be completely in the public domain.
12. **Organizational Tools used**	• Knowledge Discovery: Mostly individual research and meetings. Conferences and workshops not effectively used. • Knowledge Sharing: On a one-to-one basis and meetings – Conferences and workshops again less used. It thus seems as if the organizational tools were often not optimally used to leverage the network potential of these networks.
13. **ICT Tools and Architecture Availability**	• Knowledge Discovery: Mostly individual research on Internet. • Knowledge Capturing and Categorization: Document management and CMS tools. • Knowledge sharing: Mostly e-mail, telephone and VOIP. It thus seems as if the more advanced ICT tools were not often used, and that participants preferred to fall back on non-networked toolsets.

Survey Aspect Analyzed	Analysis Summary
14. Application of a Methodology	Networks often evolve over years, and an operational methodology becomes embedded in such a network's operating procedures.
	However, if a network has a requirement to quickly achieve benefits, the application of a formal methodology to design, implement and operate the network, will be an advantage.
	• The EE Group is a relatively old network that evolved over several years. Initial design was therefore absent, but the network was refined over the years, with the methodology embedded in the operating procedures.
	• IDIP is a new government funded network, and because of the political sensitivity of standardizing procedures across all provinces, a significant amount of time was spent designing and implementing the network.
	• The DBSA network is still a fairly new network, and is still being implemented.
	• VRL-KCiP was an FP6 funded network that went through the total life-cycle. Due to the procedures embedded in the FP6 program, as well as the organizations and personalities involved, this network scored well in all the phases of the methodology.

8.2.4 Case Study Conclusion

As shown in Table 8-3, the survey analyzed all 14 aspects of the Generic Knowledge Network Framework, thus allowing detailed conclusions to be documented for each aspect.

The version of the Integrated Knowledge Network Methodology used in the survey, was an early version (see Figure D-5 on page D-19), and the survey feedback was used to further refine the methodology to its current status as described in Chapter 7.

Table 8-4: Impact of the Survey Results on the Final Integrated Knowledge Networks Methodology

Survey Aspect Analyzed	Impact on the Integrated Knowledge Network Methodology
1. Presence of a Vision and Strategy	Reconfirmed the importance to have a Vision and Strategy.
2. The network's current phase in the knowledge network lifecycle	Confirmed the validity of the selected phases in the Integrated Knowledge Network Methodology.
3. Benefits observed in the network	Some networks struggled to quantify the benefits observed in an objective manner. This emphasized the importance of having a proper measurement system in place, that adheres to the life-cycle phases of the methodology, in that the measurement system is designed, implemented, operated and refined through-out the life of the network. This aspect was therefore enhanced in the final version of the methodology.
4. Investment and commitment of participants	The survey confirmed that investment and commitment from stakeholders and participants are important key success factors for a network. The project activity and financial planning aspects of the methodology were therefore further enhanced in the final version of the methodology.

Survey Aspect Analyzed	Impact on the Integrated Knowledge Network Methodology
5. **Nature and Formality of the KN Requirements** 6. **Presence of a KN Formal Design**	Because a network's design is derived from the network's requirements, which are in turn again derived from the network's vision and strategy, the design phase needs to address all three aspects formally. Survey Aspects 5 and 6 are therefore addressed together. The methodology was therefore enhanced to expand the design phase into 3 sub-phases: • Vision, Strategy, Domain and Stakeholders. • Requirements Analysis. • Detail Design and Planning.
7. **The Presence of Key Success Factors**	The key success factors that were generally perceived to be problem areas, were incentives, ownership and trust. The methodology was therefore enhanced to focus on these areas: • Incentives: The measurement system was expanded, and an incentive mechanism was made part of the formal design. • Ownership: Stakeholder facilitation was expanded through-out all the methodology's phases. • Trust: IPR protection mechanisms and contracting are key elements of providing a baseline for trustworthy relations, and these aspects were therefore expanded.
8. **The Presence of Barriers**	A lack of skills, an inability to identify network opportunities and a reluctance of participants to commit time, were the most significant barriers present. The methodology was therefore enhanced to focus on these areas: • Lack of skills: The Implementation Phase was expanded with a training plan and training workshops. • Inability to identify network opportunities: Marketing and Stakeholder selection were expanded. More focus on evolving the network to identify new opportunities during the "Operate and Refine" phase. • Reluctance to commit time: Planning and contracting expanded.
9. **Knowledge Work Activities**	All networks realized and confirmed that, in order to truly generate knowledge, all four SECI knowledge processes need to be present. The design phase of the network already contained sufficient focus on all four SECI processes.
10. **Source Knowledge Domains** 11. **Scope and Nature of the Generated Knowledge**	(The source and generated knowledge aspects are addressed together.) Due to the fact that the networks operated in public, private and user domains, and thus both in pre-competitive and competitive phases, the methodology had to be expanded to address the IPR aspects.
12. **Organizational Tools used** 13. **ICT Tools and Architecture Availability**	Organizational and ICT tools were often not optimally used to leverage the network potential of the surveyed networks. The initial version of the methodology already sufficiently addressed this. However, the methodology was expanded to focus on the continued maintenance and refinement of this architecture during the "Operate and Refine" phase.

Survey Aspect Analyzed	Impact on the Integrated Knowledge Network Methodology
14. Application of a Methodology	Networks often evolve over years, and a methodology thus needs to ensure that there is sufficient scope for the refinement requirements through-out the life of the network. The methodology's refinement phase was therefore expanded.
	In addition, the application of a formal methodology enabled the networks to achieve benefits earlier, thus highlighting the requirement that the methodology needs to plan and encourage early successes.

The survey case studies were not only drivers for the continued refinement of the Integrated Knowledge Network Methodology but also showed that:

- Participating in a knowledge network helped stakeholders to benefit and realize the original network requirements. Most of the case study networks identified Innovation as a reason for existence and these networks all confirmed that participating in a network helped the stakeholders to achieve innovation results more productively.

- A knowledge network's maturity plays an important role – the more mature a network, the more successful it becomes, allowing participants and stakeholders to derive benefits from the network.

- The case studies also substantiated the fact that knowledge networks will generally evolve. However, when a methodology is used to provide a better starting point for a knowledge network, it results in a more successful knowledge network that provides more benefits over a longer period of time.

How these conclusions contribute towards the research method and argument is discussed in the following chapter.

Chapter 9: Conclusions

As illustrated in Figure 9-1, the final chapter addresses the following:

- **Research Method**: An analysis of the Research Method used, with a cross reference between the elements of the research method, and the chapters in this document.

- **Conclusions**: Research conclusions based on the outcome of the research method and the analysis done in the Case Studies in chapter 8.

- **Research Contribution**: A summary of the contribution of this research, as embedded in the two main deliverables.

- **Topics for Future Work**: A discussion of the future research potential of this research topic.
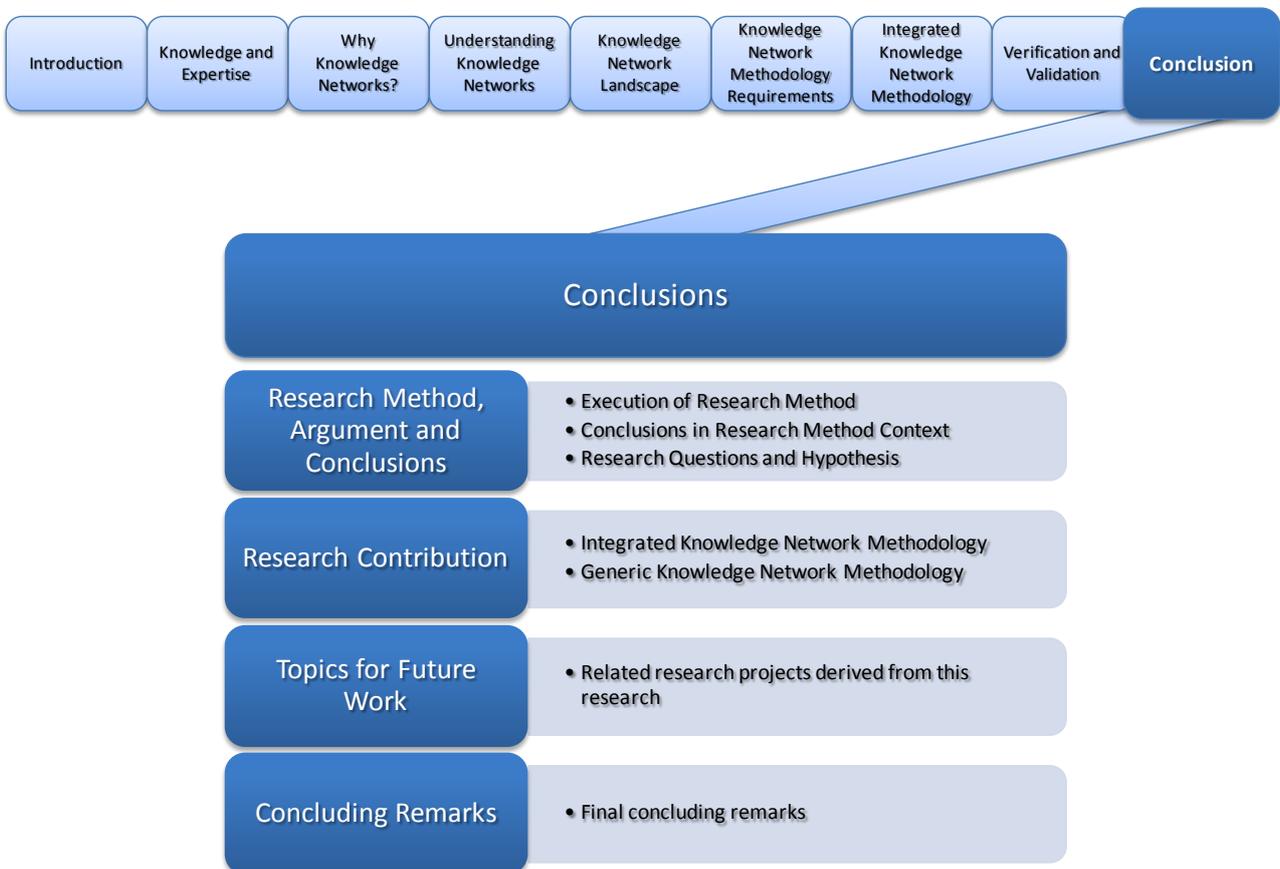
Figure 9-1: The Structure of Chapter 9 within the Context of the Overall Navigation Structure

9.1 Research Method, Argument and Conclusions

As discussed in par 1.2, the Research Hypothesis for the study is:

> *Integrated Knowledge Networks (IKN) have a positive (significant) impact on the rate at which innovation is deployed.*
>
> *Utilizing an IKN requires an understanding of designing, deploying, operating and refining, and eventually phasing-out of an IKN.*

This section shows how the above hypothesis has been addressed in this research, by first discussing the execution of the research method, the conclusions in the context of the research method, and then explaining in the conclusions how the research hypothesis has been addressed.

9.1.1 Execution of the Research Method

In order to satisfactorily address the hypothesis, the following two Research Questions should be attended to first:

> *Question 1: Are Integrated Knowledge Networks significantly beneficial to the Innovation Process?*
>
> *Question 2: If a formalized IKN methodology is used, are participants and stakeholders in a better position to utilize and benefit from the Integrated Knowledge Network?*

The research approach for this project was described in paragraph 1.2. For reference, Figure 9-2 provides a document chapter cross reference to indicate how chapters in this document had contributed to the research method and argument presented here.

- **Establishing the Current State of the Art**: It was important to identify the current state of the art thinking in the research community. The literature study documented in this report covers just a small portion of the extensive research being performed in this arena, and it focused on understanding the research domains, why knowledge networks are important, the theory behind knowledge networks, and identifying and reviewing existing methodologies and frameworks. Chapter 2 reviewed knowledge, and why knowledge networks are important in the organizational context. Chapter 3 focused on the purpose of knowledge networks, with a specific focus on innovation. Chapter 4 again focused on the theory behind knowledge networks, and reviewed some of the frameworks associated with knowledge networks. Chapter 5 reviewed different variations of knowledge networks, with the purpose of understanding different types of networks, how these networks differ, as well as the commonality between and among the networks.

- **Identifying opportunities**: Once the current state of the art was fully understood, one could then identify the gaps and thereby identify opportunities to improve the knowledge network management processes. In this research, two existing methodologies were reviewed, and the gaps were identified. Based on the challenges experienced in a local network, combined with the identified gaps and opportunities, it was then possible to derive and document requirements for a more complete knowledge network methodology (see chapter 5 and appendix A).

Introduction	Knowledge and Expertise	Why Knowledge Networks?	Understanding Knowledge Networks	Knowledge Network Landscape	Knowledge Network Methodology Requirements	Integrated Knowledge Network Methodology	Verification and Validation	**Conclusion**

- **Developing a Framework and Methodology**: Once existing methodologies were understood and the challenges within these methodologies were identified, and embodied into a set of requirements, a new adapted methodology (the Integrated Knowledge Network Methodology) and framework (the Generic Knowledge Network Framework) could then be developed and constructed. The objective and functional requirements were identified in chapters 3, 4 and 5, while the methodology requirements were documented in Chapter 6. Chapter 6 also described the transformation process that was used to derive the Integrated Knowledge Network Methodology. The methodology and the Generic Knowledge Network Framework were then discussed in Chapter 7.
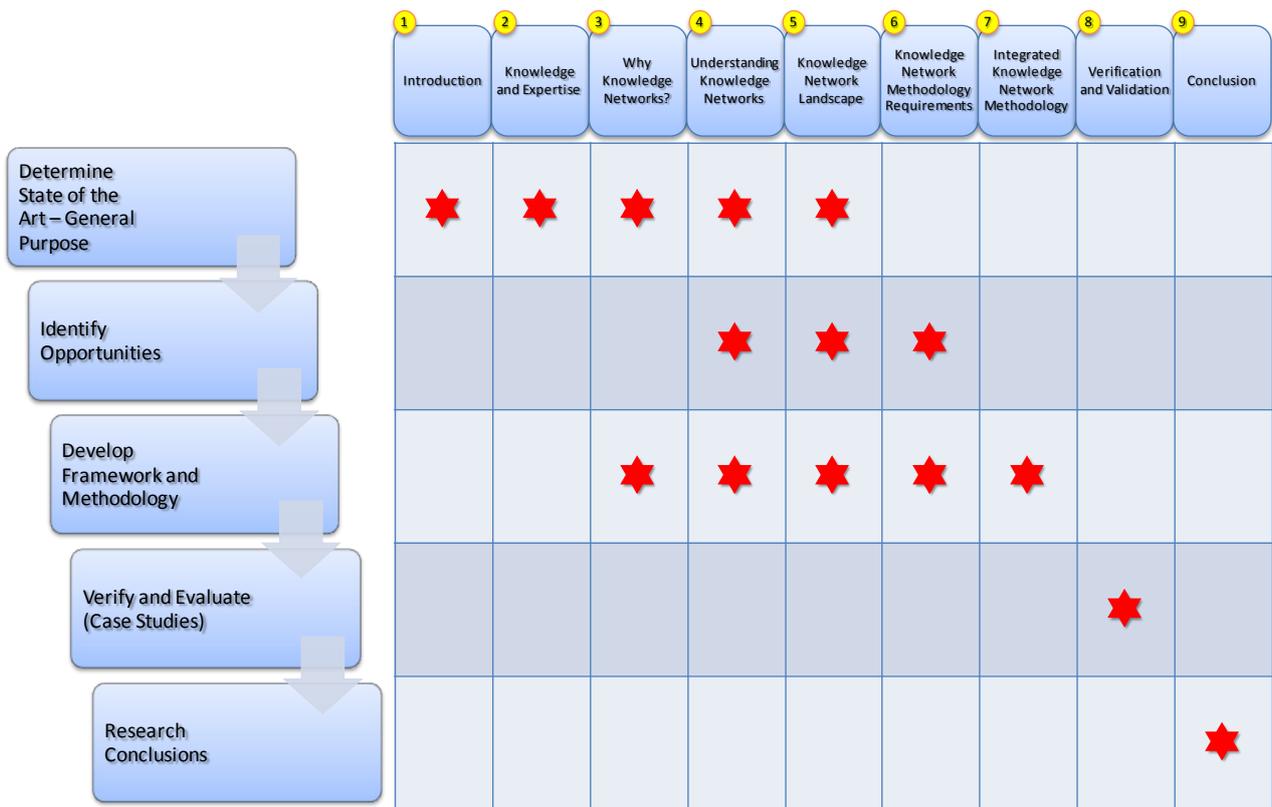
Figure 9-2: The Research Method Chapter Cross-Reference

- **Verifying and Evaluating**: In order to evaluate the validity of the Integrated Knowledge Network Methodology and Generic Knowledge Network Framework, they were firstly verified against the documented requirements, secondly tested for encouraging facilitating conditions (chapter 8), and lastly, the Generic Knowledge Network Framework was tested in practice with 6 selected case studies. These case studies substantiated the completeness of the Generic Knowledge Network Framework, and also served as a benchmark for evaluating the Integrated Knowledge Network Methodology.

- **Research Conclusions:** Based on the outcomes of the above method, it was then possible to successfully address the research questions, thereby addressing the research hypothesis. The following section details the conclusions derived from this research.

9.1.2   Research Conclusions in the Context of the Research Method

Figure 9-3 depicts the research method and main outcomes with conclusions derived from the research argument.

The conclusions, within the context of the Research Method and Argument, are:

- **Current State of the Art**: The literature review discussed in chapters 1 to 5 confirmed that:

  o The Knowledge Creation Process is fundamental for successful innovation.

  o To create knowledge sustainably over a period of time, all four SECI processes (socialization, externalization, combination and internalization) must be consistently present.

  o A formalized knowledge network is a suitable mechanism for creating and sharing knowledge.

  o The definition used for an Integrated Knowledge Network indicates that an IKN resembles a generic version of all the network variants reviewed and analyzed in this research.

- **Identifying opportunities**: With the current state of the art documented and the landscape categorized, it became clear that:

  o While various versions and variants of knowledge networks are used in the innovation process, no formalized and structured methodology for designing, implementing and creating knowledge networks could be located in existing research literature.

  o In addition, the inter-organizational aspects of knowledge networking were not well addressed in the methodologies observed.

- **Developing a Framework and Methodology**: Once the existing methodologies were reviewed and the gaps within these methodologies were identified, a set of requirements could be defined. These requirements consist of:

  o Purpose Requirements (chapter 3),

  o Network Functional Requirements (chapter 4), as well as

  o Methodology Requirements (chapter 6).

Based on these requirements,

  o An adapted and extended Integrated Knowledge Network Methodology for designing, implementing, operating and phasing-out a network was then defined (chapter 7), and

  o A Generic Knowledge Network Framework was developed (chapter 7). This framework can be used as a guide and checklist for developing and implementing a new knowledge network. It also facilitates an understanding of the life cycle of any knowledge network, as well as the typical inputs and outputs of a knowledge network.

Determine State of the Art – General Purpose

- Knowledge Creation is fundamental for successful innovation
- Sustainable Knowledge Creation requires all four SECI processes
- Organizational Knowledge Creation requires a Knowledge Network
- IKN is a Generic Version of a KN

Identify Opportunities

- Inter-organizational aspects of Knowledge Networks are lacking in existing methodologies
- There is no formalized and comprehensive structural way of coming up with a new Integrated Knowledge Network

Develop Framework and Methodology

- Requirements Defined:
  - KN Reasons for existence / Purpose
  - KN Functional Requirements
  - KN Methodology Requirements
- Methodology and Design Framework
  - IKN Methodology
  - Generic Design Framework

Verify and Evaluate (Case Studies)

- Verification of Methodology
  - Methodology Satisfies the Requirements
  - Methodology Encourages Facilitating Conditions
- Evaluation (Case Study Outcomes)
  - Innovation as a Requirement was realized as a benefit
  - KN Maturity plays an important role
  - Knowledge Networks always evolve
  - A formalized design helps to achieve benefits earlier

Figure 9-3: The Conclusions within the Context of the Research Method

- **Verifying and Evaluating**: The verification process included:

  o A requirements verification process whereby the methodology has been analyzed to ensure that all requirements have been addressed in the methodology, and

  o Whether the methodology contained and promoted facilitating conditions.

In order to evaluate both the validity and the applicability of the Generic Knowledge Network framework and methodology, six existing knowledge networks were compared with the components of the Generic Knowledge Network Framework and methodology (Chapter 8 and Appendix D). The case studies showed that:

o Participating in a knowledge network helped stakeholders to benefit and realize the original network requirements. Most of the case study networks identified Innovation as a reason for existence and these networks all confirmed that participating in a network helped the stakeholders to achieve innovation results more productively.

o A knowledge network's maturity plays an important role – the more mature a network, the more successful it becomes, allowing participants and stakeholders to derive benefits from the network.

o The case studies also substantiated the fact that knowledge networks will generally evolve. However, when a methodology is used to provide a better starting point for a knowledge network, it results in a more successful knowledge network that provides more benefits over a longer period of time.

9.1.3 Research Conclusions within the Context of the Hypothesis and Research Questions

In order to reach a conclusion on whether the hypothesis set in this research has been satisfactorily addressed, one first need to review the conclusions within the context of the research questions:

Question 1: Are Integrated Knowledge Networks significantly beneficial to the Innovation Process?

Response: Yes. The literature review confirmed that the knowledge creation process is a fundamental requirement for successful and sustained innovation. The literature also suggested that knowledge networks are an ideal mechanism for creating knowledge in an organizational context. An integrated knowledge network establishes the knowledge network aspect between and among organizations. The latest trends in the Innovation landscape (i.e. Innovation Networks and Open Innovation) require the presence of this inter-organizational aspect. One can therefore conclude that Integrated Knowledge Networks are beneficial to the Innovation Process.

The case studies also reconfirmed that stakeholders who participated in knowledge networks realised the required benefits, i.e. to **increase innovation**, optimize risk and improve efficiency.

Question 2: If a formalized IKN methodology is used, are participants and stakeholders in a better position to utilize and benefit from the Integrated Knowledge Network?

Response: Yes. The case studies substantiated the fact that knowledge networks will generally evolve, but when a methodology is used to provide a better starting point for a knowledge network, it results in a more successful knowledge network that provides more benefits faster and over a longer period of time.

Since both research questions have been positively responded to, one can therefore conclude that the hypothesis can be confirmed as true in that:

> *Integrated Knowledge Networks (IKN) have a positive (significant) impact on the rate at which innovation is deployed.*
>
> *Utilizing an IKN requires an understanding of designing, deploying, operating and refining, and eventually phasing-out of an IKN.*

However, simply recognizing that an understanding of designing, deploying, operating and refining an IKN is required, will not ensure the successful operation of a Knowledge Network. The following section (par 9.2) discusses the contribution of this research, to explain how this is enabled.

9.2   Research Contribution

This paragraph describes the main research deliverables, and the evolution process of the methodology developed.

9.2.1   Main Research Deliverables

The main contribution from this research is embodied in two deliverables:

- **An Integrated Knowledge Network Methodology**: This methodology (see par 7.1) enables one to design, implement, operate, refine and phase out an Integrated Knowledge Network. This methodology is a significant enhancement compared to other methodologies currently available, in that it enhances the inter-organizational aspects of existing methodologies, and addresses other weaknesses highlighted by literature and the survey case studies.

- **A Generic Knowledge Network Framework:** This framework (see par 7.2) can be used as a guide and checklist for developing and implementing a new knowledge network. It also facilitates an understanding of the life cycle of any knowledge network, as well as the typical inputs and outputs of such a knowledge network.

This contribution is significant because it will empower future network designers, facilitators and stakeholders, using the methodology and framework, to design and deploy new networks that will provide benefits much faster to all the stakeholders, and continue to do so sustainably.

The following paragraph describes how this research added value and evolved into the current version of this methodology.

9.2.2   Evolution of the Integrated Knowledge Network Methodology

During the execution of this research, the St Gallen methodology (Back, et al. [14]) was used as a starting baseline, and initial enhancements were made to this methodology. Two subsequent refinements of the Integrated Knowledge Network Methodology were developed:

- **The initial version of the methodology (IKNM Version 1):** This methodology refined and expanded the St Gallen method, to focus on the Inter-Organizational Aspects of Integrated Knowledge Networks. The original version of the methodology is described in a PICMET '08 proceedings paper - see Schutte and Du Preez [87].

- **The current version of the methodology (IKNM Version 2):** As reported in chapter 8 (par 8.2.4), the feedback from the case studies indicated that additional updates were required, and this resulted in an updated version of the methodology, that is described in Chapter 7 of this document.

This evolution process is summarized in Table 9-1 below, within the context of the Generic Knowledge Network Framework (Figure 7-7) aspects, how value was added as the methodology evolved.

Table 9-1: The Evolution of the Integrated Knowledge Network Methodology

Framework Aspect	Methodology Baseline		
	St Gallen (Back, et al. [14])	IKNM Ver. 1 (Schutte and Du Preez [87])	IKNM Ver. 2
1. Vision and Strategy	Yes	Inter-organizational Aspect: Vision needs to address the direction and objectives of all stakeholders.	Measurement system linked to Vision and Strategy.
2. Lifecycle Phases		Restructured into a Systems Engineering approach life-cycle.	
3. Benefits			Benefits linked to measurement system. Planning focus on early benefits.
4. Investment and commitment		Contractual Framework Requirements recognized	Strong focus on contractual and formalization of financial commitment and control.
5. KN Requirements	High level in Vision and Strategy	Recognized as important in the Generic KN Framework.	Formalized Requirements phase added.
6. KN Formal Design		Recognized as important in the Generic KN Framework.	Formalized Detail Design Phase added.
7. Presence of Key Success Factors		Methodology validated for presence of Key Success Factors. (Schutte and Du Preez [87])	Further enhanced for Incentives, Ownership and Trust.
8. Presence of Barriers		Methodology Validated for discouragement of Barriers. (Schutte and Du Preez [87])	Further enhanced to enhance skills development, network opportunities and time commitment.
9. Knowledge Work Activities	Yes	Recognition that all four reference types must be present in a sustainable KN.	
10. Source Knowledge Domains		Public, Private and User Domains identified. IPR aspects recognized.	IPR aspects embedded in the contractual framework.
11. Scope and Nature of the Generated Knowledge		Pre-competitive and Competitive phases recognized.	IPR aspects embedded in the contractual framework.

Framework Aspect	Methodology Baseline		
	St Gallen (Back, et al. [14])	IKNM Ver. 1 (Schutte and Du Preez [87])	IKNM Ver. 2
12. Organizational Tools	Yes		Recognized that Organizational Tools need continued refinement.
13. ICT Architecture	Yes		Recognized that ICT Tools need continued refinement.
14. Application of a Methodology	Yes	Enhanced	Enhanced and formalized.

9.3 Candidate Topics for Future and Related Work

While conducting this research, a number of topics were identified for future work. This work is addressing the following focus areas:

- **Formalizing Knowledge Network Facilitating Conditions**: In this research, a number of key success factors and barriers were identified and used in the verification process of the methodology. Identifying, expanding and analyzing these facilitating key success factors and barriers, determine the collaborative success of any knowledge network. By understanding and formalizing these aspects, the methodology can be further enhanced. This has been initiated as the focus of a master's research project.

- **Innovation Information System Framework**: This involves the design of appropriate information systems' support for the innovation process, with the main aim of improving organizational innovation capability. The research project will aim to develop a framework that guides the design of an innovation supporting information system architecture, given organization-specific innovation capability maturity levels. This has been initiated as the focus of a new PhD study.

- **Integrated Knowledge Network Maturity Model**: In reviewing various knowledge networks during the survey, a wide range of knowledge network maturity was observed. It was also realized that during the evolution of the networks, they often started off as very immature, and slowly evolved into more mature networks. Developing an Integrated Knowledge Network Maturity Model may thus help to understand this evolution process and also provide knowledge network stakeholders with a better understanding and more focused growth-path to get to a more mature stage earlier. (Similar to the work done by Essmann [34])

- **Knowledge Profiling**: A key element towards the success of a knowledge network is the stakeholder selection process. What potential participants know, and are able to contribute, is not always very obvious, often leading to the incorporation of participants who are not able to contribute sufficiently to the network's activities. In an inter-organizational context, this is even more difficult. This research focuses on identifying the elements that will describe an individual's or organization's knowledge profile, therefore providing better access to selection criteria that can be used when stakeholders are selected. This is currently the focus of a master's research project.

9.4 Concluding Remarks

The levels of maturity of Knowledge Management and Knowledge Networking tools have increased significantly in the past decade. The contribution of knowledge networking to facilitate the efficient management of innovation is also widely accepted.

Innovation feeds on the abundant availability of reliable knowledge in context. The ability to access, analyze, synthesize, and share this knowledge, is the key to innovation. In turn, the outputs of innovation projects contribute to the pool of knowledge, thereby incubating significant opportunities for future innovation. The way knowledge is used, spread and stored by an organization's employees, determines whether this organization has a culture of stimulating or restraining innovation. In order to innovate effectively and sustainably, existing knowledge should therefore not only be captured, but also shared and integrated.

Understanding the components of an integrated knowledge network, as well as their interdependencies, is the start to facilitating enhanced efficient utilization of such a network. This may invariably lead to improvement of the operations of innovation networks.

Expanding on these principles will increase the success rate of innovation projects, and open new opportunities for executing innovation projects.

"Knowledge is power,
and the right knowledge lets man perform miraculous,
almost godlike tasks"

- Prof Robert Langdon
(The main character in Dan Brown's novel "The Lost Symbol")

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Appendix A: Related Background Literature Research

This appendix contains related background literature information. While the information contained in this appendix contributes towards the general knowledge network area, this information did not fit within the overall research argument in the main body of this document, and it was thus moved to the appendix for reference.

A.1 Virtual Teams - a Challenge in Collaboration

> *"I think it is in collaboration that the nature of art is revealed."*
> *- Steve Lacy (Jazz artist)*

Virtual Teams have captured the imagination of academics and practitioners for their potential to enable work across time zones, over long distances and across geographical and organizational boundaries. Technological advances have made this working mode a reality. A number of business models (call centres, offshore software development, support centres) are based on this concept. Zigurs and Qureshi [105] suggested that:

> *"Virtual Teams are not really teams, but individuals brought together through technology. Virtual work does not have the traditional characteristics of work in an organization, surrounded by people and the hustle and bustle of work activity; instead it takes place in a workspace that is of one's own configuration and time. Virtuality is now associated with activities that can take place anytime, anywhere, and anyway one desires, with no physical, geographical, or structural constraints."*

Some would label "virtual teams" an oxymoron, claiming that teams lose their identity and existence as they leave the close confines of face-to-face interaction. A growing challenge of networked and virtual enterprises is managing knowledge dispersed across space and time to collectively achieve joint goals. Interaction of virtual teams is obviously communication intensive. This implies that knowledge creation in virtual teams requires reflection and discussion among a diverse group.

In their review of electronic communication and changing organizational forms, Fulk and DeSanctis [36] suggest that new technology brings about changes in relations between organizations and in the organizational form itself.

Within the organizational form itself, they describe the formation of leaner forms of organizations associated with the flattening of hierarchies and the decline in administrative support staff. This includes greater horizontal coordination related to electronic workflow, concurrent engineering, stockless production and the rise of computer supported and even virtual organizations.

In addition, distributed technologies such as e-mail have been active in facilitating the informal diffusion and dissemination of information throughout organizations. While these technologies have been instrumental in refining formal group processes, they may at times also reproduce hierarchical relationships by strengthening existing superior- subordinate relationships.

Further to such studies, Fulk and DeSanctis [36] identify an overall reduction in the size of organizations and the emergence of new types of coupling. In this environment, the core

organization either spins off a leaner, more flexible, organization or creates federated organizations by decentralizing some operations and centralizing others.

As described in the previous section, the establishment and use of virtual teams in enterprises and/or projects is the result of the above trends. The challenge is to ensure that these virtual teams can collaborate successfully.

A.1.1 Characteristics of Virtual Teams

Three major characteristics of virtual teams have emerged (Ratcheva and Vyakarnam [81]):

Virtual teams are boundary-less, capable of crossing geographic, temporal, organizational, and functional boundaries*:* This clearly distinguishes between a **team** and a **virtual team**, suggesting that a team becomes virtual when any one of the three components is added:

- different geography or locations,
- different organizations or parts of the organization, or
- different duration or length of time they work together as a team.

The greater the extent of each characteristic, the more virtual the team becomes.

Dynamic, fluid and temporary membership*:* Dynamic membership means that team composition can adapt quickly in response to changing project needs. Individuals join, exit and change roles within these teams depending on the project demands at any given time. A virtual team is seen as a pool of experts that temporarily band together to tackle some customer or organizational need.

Communication through information technology: Virtual teams are connected and communicate through various electronic means such as telephones, fax machines, e-mail, video-conferencing or groupware. Lipnack and Stamps [54] suggest that what makes virtual teams '*historically new is the awesome array of interactive technologies at their disposal*'.

A.1.2 Challenges in Virtual Teams

While technology has enabled virtual teams to work together, there are a number of challenges that have hampered the successes of these teams (Qureshi and Vogel [78]):

- **Organization Structure**: Virtual Teams enable the organization or project to split itself into smaller, decentralized, and numerous more entities. This deviates from the traditional structure that normally has an implied management structure.

- **Coordination**: Due to the dispersed nature of Virtual Teams, coordination needs to deviate from the traditional processes. How should work be organized, tasked and coordinated? How is communication facilitated?

- **Skill Specialization**: Smaller focused teams also create the possibility to group specialized skills together in virtual teams. The challenge remains how to best integrate the different skills into a coherent team.

- **Training and Knowledge Retention**: Teams require abilities to learn, to acquire information, and to develop and remember how to use it for problem solving and decision making in future.

- **Trustworthy Relationships**: Networking activities required trustworthy relationships in order for teams to function efficiently. The nature of Virtual Teams makes the establishment of relationships difficult. A significant amount of research has been done in this area alone.

- **Cultural Considerations**: Virtual Teams, by definition, implies a collection of members from different cultural backgrounds.

A.1.2.1 Organization and Virtual Team Structures

The move towards smaller, more numerous, more decentralized units is seen by many to suit the complex nature of modern enterprise. This pressure towards numerous, smaller, decentralised units, results from the increasingly recognized importance of heterogeneous teams that consist of individuals representing different functions and skills.

These teams are often dispersed across different parts of the enterprise. This becomes more relevant as the structure of organizations is recast to include higher degrees of collaborative team-work.

Another restructuring currently taking place within enterprises is a move towards **networks.** Some networks appear within and others in between organizations. This is seen to complement a move towards greater flexibility and competitiveness (Charan [21]; Sproull and Kiesler [92]).

Networks appear to be more readily supported by electronic communications technology for the management of its dispersed parts. Specifically, this form of organization

- enables geographically dispersed members to work together,

- provides a virtual space or forum for communication, and

- may enable the creation and maintenance of an identity and structure for organizations that cannot be identified through a building or physical boundary.

In addition to these points, there are numerous areas in which effective team support is enabled by network structures in organizations.

Trust is an important issue particularly when virtual teams are globally dispersed. The development of trustworthy relationships has been considered as an important socio-psychological dimension of all network activities.

Meyerson, et al. [57] developed the concept of 'swift' trust for temporary teams whose existence, like those of virtual teams, is formed around a common task with a finite lifespan. Jarvenpaa and Ives [45] found that virtual teams do not really need "high trust" in a traditional sense. "Swift trust" takes place, which is very much task- oriented and yet empathic enough in order to achieve good performance. Teams with "swift trust" comment seriously and in a constructive way on their work with other participants.

Such teams consist of members with diverse skills, limited history of working together, and with little prospect of working together again in the future. The tight deadlines under which these teams work leave little time for relationship building.

Trust in such teams is maintained by a 'highly active, proactive, enthusiastic, generative style of action' (Meyerson, et al. [57]). Interpersonal relationships in virtual teams, therefore, are likely to

be built as a result of similar personal and professional characteristics, such as similar professional background and qualifications, as well as respect for each other's professional qualities and expertise. The greater the team members' diversity is, the more time will be required for team members to form strong bonds.

A.1.2.2   *Virtual Team Coordination*

As distributed teamwork expands, more information is required for the purpose of coordinating and controlling various parts of an enterprise.

According to Simon [90], in order to be successful, the behaviour of a group of people should not only involve the adoption of correct decisions, but also that all members of the group carry out the same decisions. Coordination, he claims, may be either procedural or substantive in nature. Procedural coordination establishes the lines of authority and outlines the sphere of activity of every member, while substantive coordination specifies the content of an individual's work.

An organizational chart, specifying reporting relations, is a form of procedural coordination whereas, substantive coordination may range from guidelines for the design of a product to blueprints in factory production processes.

- **Technology:** Differentiation and diversity raise the level of information required for coordination and integration. In this, the ***technology alone cannot provide coordination and integration***. Galbraith [38] suggests that as an organization faces new and different situations, operating rules and procedures have to be supplemented by coordination devices. Coordination issues relevant to collaborative technology support include formal mechanisms such as structuring of communication, and preparation in advance of meetings and informal mechanisms such as the "grapevine" interaction. Informal coordination through "Chat boxes" may be used as a means of sustaining coordination without unduly adulterating content. Other systems encourage the use of audio or videoconferencing as a coordinating mechanism for same-time sessions. This may be useful for increased reliance on heavier content structuring and instructions or to overcome coordination difficulties in different-time sessions. Another approach to addressing coordination is through protocols. This suggests that the use of group technologies must be complemented with facilitation, moderation mechanisms and appropriate guidelines for chairing. In addition, rules and procedures are required for structuring electronically supported teamwork.

- **Facilitation:** Virtual teamwork also requires careful attention to *facilitation* mechanisms for enhancing group performance. The research of authors, such as, Dean, et al. [24], Eden and Ackermann [32], Niederman, et al. [63], Nunamaker Jr, et al. [67], and Vreede [101] have investigated both structured and unstructured mechanisms for facilitating group meetings. Their work has shown us that facilitation is one of the most important factors affecting the success of computer supported meetings. However, for electronic group meetings, which are distributed across space and time, careful investigation of facilitator presence and mechanisms for facilitation are required. This is particularly important if facilitation and an interactive structuring of group processes are seen to affect the success of virtual teamwork.

- **Organizing Work:** Organizing work and coordination in virtual teams has been the subject of research by authors such as Hiltz and Turoff [42], Qureshi and Vogel [78], and Sproull and Kiesler [92], who consider informal communication and coordination mechanisms in virtual teams. Researchers such as Malone and Lai [56], Schmidt and Simonee [85], and Vreede [101] consider more formal coordination mechanisms.

The coordination challenge for virtual teams is in allocating tasks based on knowledge and skill in an environment that is often dispersed across space, time and organizations. Coordinating access to people and resources, that are dispersed in this way, is an area that requires research and practical application.

A.1.2.3   Virtual Team Specialization

A commonly accepted view that has been put forward by authors such as Galbraith [38] and Lawrence and Lorsch [50], is that organizations respond to uncertainty by specializing.

Information has the effect of an informal, undefined integrating mechanism. In this, collaborative technology support may be seen as a means of facilitating the exchange of information and thus, the integration of parts of the organization.

A.1.2.4   Virtual Team Task

The function of labour is being transformed within the current restructuring of organizations. Labour is no longer just a unit of production or a resource available for production, but it is taking on a more refined role. The value of an individual is no longer entirely determined by their skill and the amount that they produce. It is becoming increasingly apparent that a mixture of skills, the ability to acquire new skills and the ability to access, possess, and use appropriate knowledge and information, are required to achieve changing targets for performance. (Qureshi and Vogel [78])

Drucker [25] refers to the workforce of this type as **knowledge specialists** because every individual possesses a specific type of knowledge and skill that is necessary to perform the tasks that are allocated. These workers are referred to as information workers (Zuboff [106]) as they produce and have access to the basic information that is specific to their responsibilities; an essential element to the efficient functioning of an organization.

It is not only possible for individuals at lower levels of the organization to make important decisions, but it is increasingly becoming a necessity. Decisions based on skill and expert knowledge are required on every level in order to ensure productivity or quality gains and appropriate responsiveness.

A.1.2.5   Virtual Team Learning

Enterprises need to develop an ability to learn, an ability to acquire information, and to develop and remember how to use it for problem solving and decision making. The importance of this cannot be underestimated, especially given the need for organizations to increase their collective reservoir of knowledge and skill. (Qureshi and Vogel [78])

Technology alone cannot sustain these changes unless coupled by consistent learning processes that provide the enterprise with the flexibility and adaptability to changing circumstances and competitive position.

In this, an issue considered paramount by Morrison, et al. [60] is how to develop an organizational memory that serves the organization and encourages learning without stifling emergent ideas. Being able to find information as well as creating an organizational climate that encourages information sharing with consistent rewards becomes necessary.

A.1.3 Creating Teams

In his book "Leading Teams", J. Richard Hackman (See interview Coutu and Beschloss [23]) sets out five basic conditions that leaders of companies and other organizations must fulfil in order to create and maintain effective teams:

- Teams must be real. People have to know who is on the team and who is not. It's the leader's job to make that clear.

- Teams need a compelling direction. Members need to know, and agree on, what they're supposed to be doing together. Unless a leader articulates a clear direction, there is a real risk that different members will pursue different agendas.

- Teams need enabling structures. Teams that have poorly designed tasks, the wrong number or mix of members, or fuzzy and unenforced norms of conduct, invariably get into trouble.

- Teams need a supportive organization. The organizational context – including the reward system, the human resource system, and the information system – must facilitate teamwork.

- Teams need expert coaching. Most executive coaches focus on individual performance, which does not significantly improve teamwork. Teams need coaching as a group in team processes – especially at the beginning, midpoint, and end of a team project.

A.1.4 Conclusion: Why are Virtual Teams Relevant?

Alavi, et al. [12], Qureshi, et al. [77], and Yap and Børn-Andersen [104] researched knowledge creation in virtual teams. They concluded that the challenge lies in understanding the creation of virtual communities within which the creation of knowledge takes place and the creation and maintenance of knowledge networks. Lack of trust and selective sharing is a further complicating factor in ensuring efficient integration of and access to information.

A.2 Knowledge Network Variants

The process of creating knowledge in networks to foster innovation has been labelled, using different names. These terms are associated with slightly different meanings and characteristics. Since this research focuses on how integrated knowledge networks can improve the innovation process, the author therefore selected those knowledge network variants that are used in the Innovation Landscape. Each network variant is briefly described below.

A.2.1 Social Networks

A **Social Network** is an informal network of individuals collaborating through a common social interest, usually using internet technology. [7]:

> "A social network is a social structure made of nodes (which are generally individuals or organizations) that are tied by one or more specific types of interdependency, such as values, visions, idea, financial exchange, friends, kinship, dislike, conflict, trade, web links, sexual relations, disease transmission (epidemiology), or airline routes."

Another definition, as follows (Valente [97]):

> "A social network is the pattern of friendship, advice, communication or support which exists among the members of a social system."

And, according to Mitchell [58] and Lincoln [53]:

> "a specific set of linkages among a defined set of actors, with the additional property that the characteristics of these linkages as a whole may be used to interpret the social behaviour of the actors involved"

A.2.2 Communities of Practice

Community-of-Practice (CoP) is a related concept to that of knowledge networks. Wenger and Snyder [103] defines a CoP as follows:

> ". . .a group of people informally bound together by shared expertise and passion for a joint enterprise."

IBM Global Services has worked with communities of practice as a form of knowledge networks since 1995 (Gongla and Rizzuto [40]). Communities are part of their knowledge management strategy and within IBM, communities of practice are recognized to have a positive influence on the organization's ability to stay productive and innovative.

Some high-tech companies have successfully adopted the concept of community of practice. Examples of communities of practice are found in many organizations and have been called by different names at various times, names such as "learning communities" at Hewlett-Packard Company, "family groups" at Xerox Corporation, "thematic groups" at the World Bank, "peer groups" at British Petroleum, p.l.c., and "knowledge networks" at IBM Global Services, but they remain similar in general intent.

A.2.3 Knowledge Networks

Seufert, et al. [89] defines **Knowledge Networking** as follows:

> *"A number of people, resources and relationships among them, who are assembled in order to accumulate and use knowledge primarily by means of knowledge creation and transfer processes, for the purpose of creating value."*

Knowledge networks, can be emergent or intentional. Intentional knowledge networks are seen as networks that are built up from scratch, whereas emergent knowledge networks already exist but have to be cultivated in order to perform.

In this way, a network may evolve whose participants share a common language, and a common set of values and objectives. This social network is backed up and transformed by information and communication technology. As this network of knowledge-resources is continuously being augmented by knowledge gained from learning situations, a knowledge network should be regarded as a dynamic structure rather than as a static institution.

A.2.4 Networks of Excellence

Networks of Excellence is a term used in European FP6 and FP7 Research projects, and refers to transnational multi-partner projects grouping together the main players on a given research topic. The following definition by Kenway, et al. [48]:

> *"Networks of Excellence are designed to strengthen scientific and technological excellence on a particular research topic by integrating at European level the critical mass of resources and expertise needed to provide European leadership and to be a world force in that topic. This expertise will be networked around a joint program of activities aimed principally at creating a progressive and durable integration of the research capacities of the network partners while, of course at the same time advancing knowledge on the topic."*

A.2.5 Community-based participatory research

Community-based participatory research (CBPR) is research that is conducted as an equal partnership between traditionally trained "experts" and members of a community. In CBPR projects, the community participates fully in all aspects of the research process. CBPR projects start with the community. Community is often self-defined, but general categories of community include geographic community, community of individuals with a common problem or issue, or a community of individuals with a common interest or goal.

CBPR encourages collaboration of "formally trained research" partners from any area of expertise, provided that the researcher provide expertise that is seen as useful to the investigation by the community, and be fully committed to a partnership of equals and producing outcomes useful to the community. Equitable partnerships require sharing power, resources, credit, results, and knowledge, as well as, a reciprocal appreciation of each partner's knowledge and skills at each stage of the project, including problem definition/issue selection, research design, conducting research, interpreting the results, and determining how the results should be used for action.

CBPR differs from traditional research in many ways. One of the principal ways in which it is different is that instead of creating knowledge for the advancement of a field or for the sake of knowledge, CBPR is an iterative process, incorporating research, reflection, and action in a cyclical process.

A.2.6 Joint Ventures

A **Joint Venture (JV)** is a temporary partnership or conglomerate, often formed to share risk or expertise in a specific project, for the duration of the project only.

Joint ventures are normally more focused on a contractual framework, and that some form of knowledge networking needs to exist within the Joint Venture, in order for it to be a successful innovation mechanism.

A.2.7 Innovation Networks

Innovation Networks refer to the networks that may exist between an inventor, transformer, financier and broker in order to identify, finance and commercialize new innovations.

See Figure A-1 for a typical Innovation Network Organizational Model.

Business Model	Description
●	**Inventor** Intellectual powerhouses that conduct basic science research and/or design products and services that result in patentable inventions.
⬡	**Transformer** Multifunction production and marketing services that convert inputs from Inventors and other Transformers into valuable business innovations for either internal or external customers.
■	**Financier** Funding source for Innovation Network service providers – especially Inventors and startup Transformers. Financiers will seek to own intellectual property rights for inventions.
▲	**Broker** Marker makers that find and connect Innovation Network service providers – buying and selling or enabling service delivery both within and among companies.

Figure A-1: Innovation Network Organizational Model

- Adapted from Radjou [79]

As illustrated in Figure A-2, potential innovation partners can be (Ritter and Gemünden [82]):

- suppliers,
- co-suppliers,
- consultants,
- buyers,
- distributors,

- competitors, and

- research and training institutes.

In Figure A-2, different potential stakeholders are categorized with their typical contributions in an Innovation Network.
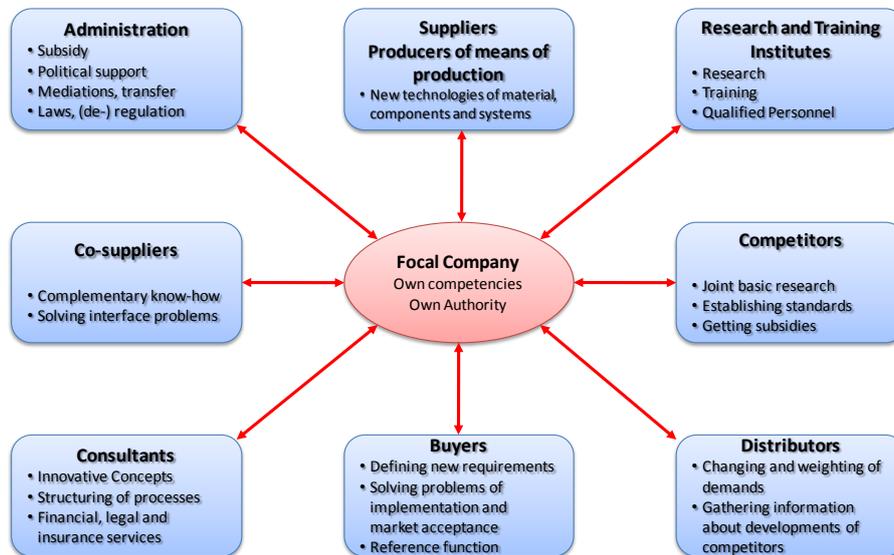
Figure A-2: Potential Innovation Partners and their Contributions.

- Adapted from Ritter and Gemünden [82]

A.2.8 Competence Networks "Kompetenznetze"

Competence Networks refer to networks of competent entities, focusing on a certain research topic or domain. This term is especially used in:

- Germany - "Kompetenznetze"

- Medicine and Health research

One such a network is "***kompetenznetze.de***" of the Federal Ministry of Economy and Technology in Germany. This network currently represents about 130 networks of competence in 18 fields of innovation and more than 30 German regions. The German innovation clusters combined in networks of competence have a regional focus, act on an international scale, concentrate on a specific thematic area, are capable of generating innovations with a particularly high value-added potential, cover many links in the value chain and incorporate multiple sectors of industry and scientific disciplines. They stand out by virtue of the close interaction and communication among their members, work within the context of an infrastructure that favours innovation and help to give regions a distinct profile and an advantageous position with respect to their international competitors. As a result of that, Germany has an excellent standing in most areas of research with strategic importance to the future.

The fields of innovation include Aerospace Technology, Agrobusiness, Traffic and Transportation, Bionics, Biotechnology, Education & Training, Environmental Technology, Genomics, Industrial Manufacturing, Information and Communication Technology, Maritime Technologies, Materials

Science, Mechatronics / Microsystems Engineering, Medical Engineering, Medicine, Nanotechnology, Optical Technologies/Laser Technology and Power Engineering.

A.2.9 Integrated Knowledge Networks

The Enterprise Engineering Research Group at the Department of Industrial Engineering, University of Stellenbosch, defines an **Integrated Knowledge Network** as:

> "A formal network of organizations that position their systems, processes and people in such a way as to allow for the integrated transfer of information and knowledge between the organizations to support sustainable innovation."

An alternative definition has been discussed in par 3.6:

> "A Knowledge Network signifies a number of people and resources, and the relationships between them, that are able to capture, transfer and create knowledge for the purpose of creating value. An Integrated Knowledge Network spans all domains, communities, and trust relationships with the goal of fostering sustainable innovation that will continue to promote the competitiveness of its users."

Du Preez and Louw [30] defines the main role-players in an Integrated Knowledge Network as universities, S&T Institutions, government bodies, single enterprises, competitors, suppliers and the market as is depicted in Figure A-3. These are organized in different communities, so that when integrated, constitute a knowledge network.
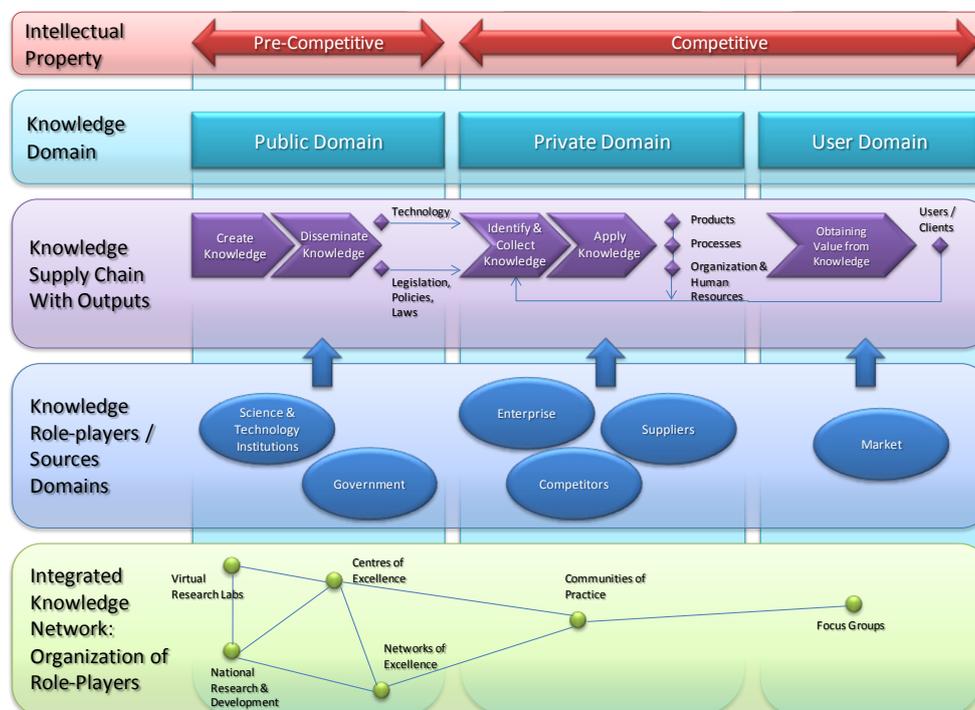
Figure A-3: Components of an Integrated Knowledge Network

- Du Preez and Louw [30]

An Integrated Knowledge Network is thus an inter-organizational version of a Knowledge Network.

Appendix B: Knowledge Network Methodology Requirements Details

This appendix lists all the Knowledge Networks' requirements discussed in the document, that were used for the development of the Integrated Knowledge Network Methodology:

- Purpose Requirements (Knowledge Network Objectives)

- Functional Requirements

- Methodology (Control and Measure Objective) Requirements
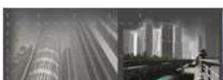
B.1   Purpose Requirements

Table B-1: Purpose Objective Requirements (To 3ʳᵈ level)

Requirement Id	Description
R1.1: Personal Growth and Support Networks	Personal networks have many dimensions—families, school friends, co-workers, neighbours, people we know through religious, civic, or wellness activities—all of which tend to be informal. We leverage these networks when we need assistance, looking for a job, a new car, or a good book to read. These networks grow organically and randomly as we meet people in our daily comings, goings, and stayings. The sum of the people we know through our networks constitute our personal network, those we are most likely to turn to when we have an idea, need advice, or desire fellowship. (Anklam [9])
R1.2: Idea Networks	Idea networks are based on a creative exchange that lets ideas build on each other. The results or outcomes of idea networks are emergent: When you enter an idea network's virtual space or enter a room where it is meeting, you do so knowing that you will not know where the conversation will lead. (Anklam [9])
R1.2.1: Innovation Increase	This purpose correlates with one of the main purposes identified by Von Krogh, et al. [86]. This is also the most important focus of this research – refer to Chapter 3: Why Knowledge Networks? – The Innovation Focus
R1.2.2: Advocacy	An advocacy network takes the power of an idea and gives it legs; political and spiritual networks attract people of specific attitudes, opinions, and values, who are passionate about a viewpoint and want to educate and persuade others to that viewpoint. Grassroot political campaigns and social movements have always used a network model to diffuse ideas, enroll membership, and lobby for change or reform. Today, bloggers of all stripes connect and interconnect using the power of the World Wide Web to meet, exchange, and build on each other's ideas. (Anklam [9])
R1.3: Learning Networks	Learning networks focus on augmenting the personal capacity of an individual or a group in a particular area of skill, expertise, vocation, avocation, or knowledge. (Anklam [9])
R1.3.1: Interest and Information	Interest networks, often called "communities of interest," went mainstream with the availability of free services from Yahoo! and Google Groups. We pursue those most important to us through participation in learning networks. For business and civic topics, we rely on either formal structures (corporate communications, phone trees, newsletters), or word of mouth. If you need to know something, you need to trust that it will be made known to you by virtue of your membership of these groups. (Anklam [9])

Requirement Id	Description
R1.3.2: Communities and Networks of Practice	The most formally studied of the various types of learning network is the community of practice. Formal communities of practice are distinguished by three intentional characteristics: • A shared domain of interest and a desire to develop competency in that domain; • Community activities through which one shares one's own learning experiences with others; • The development of a shared repertoire of practice that includes resources, stories, techniques and methods. (Anklam [9])
R1.3.3: Professional Associations	Professional associations exist to enhance the integrity of the practices on which they are based and to provide educational and reputation-building opportunities for members. Many associations are formal, incorporated organizations that provide learning and networking opportunities through newsletters, publications, and annual meetings. Within an association, special interest groups provide focus on individual topics. (Anklam [9])
R1.3.4: Research Networks	Research laboratories, both those dedicated to pure research and those doing applied research for product development, are looking for more and better ways to not only collaborate across internal boundaries, but also to be more active in bringing ideas from academic and professional networks into their companies. (Anklam [9])
R1.4: Mission Networks	Mission networks are directed to the social good. Arts and culture, education, environment, health, human services, religion, and social justice are the primary categories of service to which non-profit organizations (NPOs) devote themselves. The networking strategy for these organizations is often dual: • Creating a network of organizations to develop and maintain the program; • Creating networks in the target population. (Anklam [9])
R1.4.1: Local Service-Oriented Non-Profit Organizations	A local service organization begins with a person or small group who sees injustice in the distribution of wealth, the wrongful use of environmental resources, or an opportunity to enrich the personal lives of others through education, music, or the arts. These local networks produce value for their neighbourhood's present and future. (Anklam [9])
R1.4.2: Global Networks	Global Networks, typically founded and funded by organizations such as the United Nations, are focused on human services, including disaster relief and healthcare, education, economic development, human rights, and the development and application of international law. Another set of prominent global networks are those devoted to environmental causes. Groups like Greenpeace and the

Requirement Id	Description
	World Wildlife Fund have embraced the network form of organization to enable local action in the face of threats to species and habitats (including human ones). (Anklam [9])
R1.4.3: Regional Economic Networks	Regional Economic Networks are focused on regional ecosystems to sustain healthy economies in their respective geographic areas. The flow of ideas, start-up creation, and partnering activities produce value for the companies and individuals involved, and also for the regions as a whole. (Anklam [9])
R1.5: Business Networks	The goal of a for-profit business network is production and growth—growth of revenue, profit, and returns to shareholders through growth of market reach, product breadth, expertise and knowledge. In this category of business networks are non-profit organizations (including public and educational institutions) whose stakeholders demand accountability for financial and operational functions. All these types of business-based institutions are seeing the benefits of the network approach to growth—to partner rather than to acquire, to work through alliances, to bring customers into the planning and assessment processes, and to reach out and reach within to leverage networks for strategic change. (Anklam [9])
R1.5.1: Supplier Networks	The traditional view of the supply chain as a linear flow of transformation, movement, and storage of goods has shifted with the growth in understanding of the important role of relationships in managing risk. When competitive advantage comes from delivering a quality product to a customer at the time it's needed, companies must focus not just on the ties to their suppliers but also on the strength of those ties. The company–supplier relationships are taking on a network approach to linking suppliers with one another through knowledge sharing, both online and face-to-face, involving employees and senior executives in their supplier companies, through everything from planning and forecasting to improved quality and work methods. (Anklam [9])
R1.5.2: Alliances, Partnerships and Trade Associations	An **alliance** is an agreement between two or more parties, made in order to advance common goals and to secure common interests. A **partnership** is a type of business entity in which partners (owners) share with each other the profits or losses of the business undertaking in which all have invested. A **trade association**, is an organization founded and funded by businesses that operate in a specific industry. An industry trade association participates in public relations activities, such as advertising, education, political donations, lobbying and publishing, but its main focus is collaboration between companies, or standardization.

Requirement Id	Description
	A **joint venture** (often abbreviated JV) is an entity formed between two or more parties to undertake economic activity together. The parties agree to create a new entity by both contributing equity, and they then share in the revenues, expenses, and control of the enterprise. The venture can be for one specific project only, or a continuing business relationship. The creation and maintenance of such alliances is a delicate task of managing relationships between and among individuals at all levels of an organization.
R1.5.3: Independent Business and Consulting Networks and Alliances	The economic and demographic shift created a large pool of professionals joining the ranks of independent consultants. These consultants quickly understood the importance of networking, joining networks and being attached to connections within their geographical or topical areas of interest. These networks begin with a goal of tangible outcome: generating business. To survive and be successful, however, these networks must also offer opportunities for practice development and shared learning. (Anklam [9])
R1.5.4: Customer User Groups	A user group is a type of club focused on the use of a particular technology, usually (but not always) computer-related. User groups started in the early days of mainframe computers, as a way to share sometimes hard-won knowledge and useful software, usually written by end users, independently of the factory-supplied programming efforts. SHARE, a user group originated by aerospace industry corporate users of IBM mainframe computers, was founded in 1955 and is the oldest computer user group still active. User groups have been a mainstay of technology companies to create educational programs, provide an opportunity for professional networking, and influence the direction of the industry, which was at that time IBM. IBM now interacts with its users in a variety of communities, including Share. The model has worked well, and not just for IBM: Software companies of all sizes either host annual user group meetings or support member-led user groups. Purposes: To • sustain a practice community among users; • provide a platform for the company to divulge future product plans or shifts in corporate strategy; • create social capital by having users come into direct contact with the employees and executives of the companies whose products they use; and • create a channel for obtaining valuable customer feedback on current products and future plans. (Anklam [9])

Requirement Id	Description
R1.5.5: Leadership Networks	The value of developing personal networks has been on the leadership agenda since the early 1990's, when network building became a top priority for senior managers. The common characteristics of these networks: • Unlike task forces, these are not temporary, but are longstanding networks that sustain change in the organization; • Members identify with the network and with each other; the frequency and honesty of their dialogues reshape personal relationships; • Continuous interaction over time builds a shared understanding of the business; • Managers' performance and potential for promotion is evaluated against their contributions to the network and sometimes by the network itself; • Networks are dynamic and take initiative, becoming the vehicle for redirecting the flows of information and decisions, the uses of power, and the sources of feedback within the hierarchy. (Anklam [9])
R1.5.6: Strategic Change	Social capital represents the bonds, norms, and trust that exist among people in an organization. A corporation that is high in social capital is a fertile breeding ground for networks: the more people know others and are comfortable connecting to them, the easier it is to form and work in networks. Informal networks have always operated in the spaces between business processes, in small teams or at the water cooler, baseball leagues, training courses, and cafeterias. Ties between and among people strengthen as people work together on projects and are drawn together by a common purpose. Networks emerge, self-organize around a purpose, and develop a unique structure and style that enable them to create value, often beyond their members' wildest dreams. (Anklam [9])

B.2   Functional Requirements

Table B-2: Functional Requirements (To 3rd level)

Requirement Id	Description
R2: Knowledge Network Functions	The top level functional requirement placeholder
R2.1: Connect People and Organizations	Inherent in the definition of network, to connect entities. Per the definitions of Back, et al. [14], Seufert, et al. [89], Du Preez, et al. [29], one of the main purposes of Knowledge Networks is to connect people and organizations.
R2.1.1: Identify and Select Collaborators	A knowledge network is comprised of collaborators sharing explicit and tacit knowledge and interacting with one another. Only the appropriate composition of collaborators ensures an effective and efficient knowledge sharing and collaboration within the knowledge network. The identification and selection of the appropriate knowledge network participants is thus crucial for its future performance.
R2.1.2: Gain Commitment of Top Management	Since a knowledge network is a formally set-up structure, it implicates management acceptance and support. The commitment of management is crucial for the knowledge network's survival, as the management has to provide the required financial, personal as well as organizational resources.
R2.1.3: Mechanisms to gain Management Commitment	There must be a requirement and a business purpose for a knowledge network before Management will commit. It is important to sell the benefits to management.
R2.1.4: Connect Collaborators	Mechanisms to introduce and connect the identified collaborators are required.
R2.1.5: Communication Mechanisms	In order for people and organizations to connect and communicate, Communication Mechanisms need to be present. These can be ICT mechanisms such as Websites, Forums, VOIP, etc, or also the more traditional mechanisms such as face-to-face meetings, telephone, etc.
R2.1.6: Encourage Trust and Openness	Especially in a Virtual Team environment, where geographically dispersed people and organizations are required to work together, Trust and Openness is a challenge. Trust and Openness must thus be encouraged, and also given time to develop.
R2.1.7: Face-to-Face Meetings and Forums	In order to create the necessary opportunities for the socialization aspects of knowledge transfer, a knowledge network needs to make use of face-to-face meetings and Forums.

Requirement Id	Description
R2.1.8: Gain Commitment of Members	Barriers to the establishment of a knowledge network can be encountered on the level of the managerial hierarchy, but also on that of potential knowledge network participants, the latter covering a wide field. In addition, there might be organizational barriers, such as the geographical dispersion of the participants, but also personal barriers. These barriers must be kept in mind during the initial contact and this contact should be aimed at creating mutual understanding and a mutual knowledge base.
R2.1.9: Recognition of Members	In order to create the necessary motivation for network members, the network needs to recognize the contributions of members.
R2.1.10: Protect Intellectual Property	Mechanisms (organizational, procedurally and ICT) should exist to protect the intellectual property of individuals and organizations.
R2.2: Create and Share Knowledge	Per the definitions of Back, et al. [14], Seufert, et al. [89], Du Preez, et al. [29] one of the main purposes of Knowledge Networks is to create and share knowledge.
R2.2.1: Transfer Existing Knowledge	The processes of socialization, externalization, combination and internalization, whereby knowledge is transferred.
R2.2.2: Share Knowledge	Through communication mechanisms, knowledge is shared.
R2.2.3: Share Experience	Sharing Tacit Knowledge through Socialization and Externalization.
R2.2.4: Share Literature	Share explicit knowledge through Combination and Internalization.
R2.2.5: Share Research Outputs	Share explicit knowledge through Combination and Internalization.
R2.2.6: Exploit Knowledge	An aspect of the Knowledge Creation process is to seek new application for existing knowledge, and to use this knowledge in new innovations.
R2.2.7: Support Network Purpose	The Knowledge that is created by the network must support the overall goal and purpose of the Knowledge Network.
R2.2.8: Identify Knowledge Gaps	Depending on the purpose of the knowledge network, there will be a knowledge domain that needs to be explored. Depending on the tacit and explicit knowledge available to the network, Knowledge Gaps can be identified that can help to focus the activities of the network.
R2.2.9: Create New Knowledge	New knowledge is created by ensuring that all four aspects of BA is present in the network. (Nonaka, et al. [65])
R2.2.10: Execute Research	Research networks will create knowledge through research activities.
R2.2.11: Document Research Outputs	The process of externalization.

Requirement Id	Description
R2.2.12: Explore Explicit Knowledge	In order to conduct research activities, or to identify knowledge gaps, the explicit knowledge domains need to be explored (i.e. find all related knowledge in documents). This can be done through searches (Google, Intranet, Library searches), Text mining, Taxonomy searches, etc.
R2.2.13: Explore Tacit Knowledge	In order to ensure that there is an understanding of the tacit knowledge present in the network, it is important that the existence of tacit knowledge is captured in a manner that makes it searchable. The concept of Knowledge Profiles can be used to make this possible.

B.3 Methodology (Control and Measure Objective) Requirements

Table B-3: Control and Measure Objective Requirements (To 3rd level)

Requirement Id	Description
R3.1: Facilitating Conditions	
R3.1.1: Define Network Vision and Strategy	Determining the knowledge vision and strategy sets the direction and purpose for the knowledge network, and provides the basis for motivating all activities within the knowledge network.
R3.1.2: Supportive Environmental Factors	Ensure that a supportive environment exists that will foster the development of the knowledge network.
R3.1.3: Define Network Expectations	As a derivative of the vision and strategy, expectations need to be defined, so that all stakeholders' expectations can be aligned.
R3.2: Knowledge Processes	
R3.2.1: Identify Network Mode(s)	Identify the modes applicable to the network: • Experiencing Network • Materializing Network • Resystemizing Network • Learning Network Note that a network may operate in more than one mode at a time.
R3.2.2: Organize the Processes	Depending on the Network Mode, it is possible to identify the required processes, and then to organize the processes.
R3.2.3: Assign Roles to Processes	Once the processes have been identified, the processes need to be allocated to different roles in the network.
R3.2.4: Identify Barriers	Barriers may prevent a knowledge network from being successful (see 4.7). Identifying Barriers upfront will help to create a supportive environment for the network.
R3.2.5: Identify Success Factors	Key success factors are one of the components of a network's facilitating conditions (see par 4.6). To identify these success factors upfront will enable the stakeholders to grow the factors, and identify missing factors.
R3.2.6: Facilitate Building Relationships	A knowledge network consists mostly of a number of relationships between individuals and organizations. Building these relationships therefore expands the network.
R3.2.7: Integrate and Coordinate other networks / organizations	An Integrated knowledge Network specifically focuses on networking between organizations and other networks. (See par 3.6 and par A.2.9)
R3.3: Knowledge Network Architecture	
R3.3.1: Organizational Tools	Organizational tools are tools such as meetings, forums, workshops etc that are used to enable networking.
R3.3.2: Information and Communication Tools	ICT tools are normally computerized tools such as knowledge management systems, websites, internet access, etc, that enable network participants to perform research.
R3.4: Control Targets and Measurements	

Requirement Id	Description
R3.4.1: Setup Performance Targets	Performance targets need to be defined, agreed and set up. See par 4.8.
R3.4.2: Integrate Performance Measures	Performance measures must be integrated in the normal operating processes of the network.
R3.4.3: Measure Performance	Once performance measures are set up, they needs to be measured regularly or on a continuous basis.
R3.4.5: Network Goal Achievement	Measure whether the network's goals are achieved,
R3.4.6: Measure Individual Performance	As described in par 4.8, individuals need to be measured.
R3.4.7: Measure Organizational Performance	As described in par 4.8, participating organizations need to be measured.
R3.4.8: Measure Networking Performance	As described in par 4.8, the network needs to be measured.
R3.4.9: Incentives / Reward System	As described in par 4.8, there needs to be an incentives and reward system.
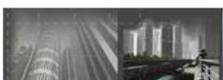
Appendix C: Integrated Knowledge Network Methodology Supporting Information

This appendix contains additional detail on the Integrated Knowledge Network Methodology:

- The Integrated Knowledge Network Methodology Process Hierarchy, listing all the activities in the methodology.

- Additional details on the Network Design activities.

- Methodology Verification against Requirements Cross-reference.
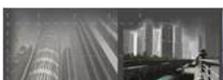
C.1   Methodology Process Hierarchy

Table C-1: Methodology Process Hierarchy

Process Identifier	Description
M1	Design
M1.1	Vision, Strategy, Domain and Stakeholders
M1.1.1	Define Need, Purpose and Strategy
M1.1.1.1	Knowledge Need and Purpose
M1.1.1.2	Knowledge Vision
M1.1.1.3	Knowledge Strategy
M1.1.1.4	Identify Target Domain
M1.1.2	Identify and Select Stakeholders
M1.1.2.1	Stakeholder Identification
M1.1.2.2	Stakeholder Analysis
M1.1.2.3	Preliminary Selection of Stakeholders
M1.1.3	Financial Feasibility
M1.1.3.1	Expected Outputs and Benefits
M1.1.3.2	Required Inputs
M1.1.4	IPR Strategy
M1.1.4.1	Public, Private or User Domain
M1.1.4.2	Pre-competitive vs Competitive Stage
M1.1.5	Network Variant
M1.2	Requirements Analysis
M1.2.1	Knowledge Requirement Analysis
M1.2.1.1	Identify Required Knowledge
M1.2.1.2	Knowledge Work Processes
M1.2.1.3	Knowledge Deliverables
M1.2.2	Knowledge Network Reference Types
M1.2.2.1	Select Reference Types
M1.2.2.2	Facilitating Conditions
M1.2.2.3	Network Functions
M1.2.3	Define Control Targets
M1.2.3.1	Measures
M1.2.3.2	Targets
M1.2.4	Financial Support Requirements
M1.2.4.1	Funding Model Requirements
M1.2.4.2	High Level Budget
M1.2.4.3	High Level Benefit Analysis
M1.2.5	Contractual Requirements
M1.2.5.1	Stakeholder Types
M1.2.5.2	IPR Stages
M1.2.5.3	Benefit Expectations
M1.2.5.4	Participation Expectations
M1.3	Detail Design and Planning
M1.3.1	Network Design

Process Identifier	Description
M1.3.1.1	Network Structure
M1.3.1.2	Knowledge Processes
M1.3.1.3	OrganiZational Tools
M1.3.1.4	ICT Architecture
M1.3.2	Planning
M1.3.2.1	Deliverable Plan
M1.3.2.2	Milestone Plan
M1.3.2.3	Communication Plan
M1.3.2.4	Change Management Plan
M1.3.3	Performance Measures
M1.3.3.1	Measures
M1.3.3.2	Targets
M1.3.3.3	Corrective Actions
M1.3.3.4	Incentives
M1.3.4	Financial Model(s)
M1.3.4.1	Funding Model
M1.3.4.2	Detailed Budget
M1.3.4.3	Cash Flow
M1.3.4.4	Benefits Analysis
M1.3.5	Contractual Model(s)
M1.3.5.1	Stakeholder Responsibilities
M1.3.5.2	IPR Protection
M1.3.5.3	Access to Benefits
M2	Implement
M2.1	Plan and Prepare to Implement
M2.1.1	Approach Stakeholders
M2.1.1.1	Market the Network
M2.1.1.2	Facilitate Top Level Commitment
M2.1.1.3	Contracting
M2.1.2	Plan Implementation Activities
M2.1.2.1	Architecture Plan
M2.1.2.2	Roll-out Plan
M2.1.2.3	Training Plan
M2.1.3	Organizational Procedures
M2.1.3.1	Map Goals, Tasks and Activities
M2.1.3.2	Organize the Processes
M2.1.3.3	Determine Roles and Responsibilities
M2.1.4	Build or Procure Architecture
M2.1.4.1	ICT Architecture
M2.1.4.2	Organizational Architecture
M2.1.5	Funding
M2.1.5.1	Obtain Initial Funding
M2.1.5.2	Establish Financial Control
M2.2	Roll-out and Implement

Process Identifier	Description
M2.2.1	Facilitate Stakeholder Participation
M2.2.1.1	Facilitate Internal Participation
M2.2.1.2	Facilitate External Participation
M2.2.2	Kick-off Workshops and Meetings
M2.2.2.1	Training Workshops
M2.2.2.2	Detail Planning Workshops
M2.2.3	Organize
M2.2.3.1	Assign Roles based on Skills
M2.2.3.2	Organize People and Meetings
M2.2.4	Roll-out Architecture
M2.2.4.1	Knowledge Base
M2.2.4.2	Tools
M2.2.4.3	Communication
M2.2.5	Implement Performance Measures
M2.2.5.1	Communicate Measures
M2.2.5.2	Set and Agree Targets
M2.2.5.3	Start to Collect Data
M3	Operate and Refine
M3.1	Operate
M3.1.1	Manage Stakeholders and Facilitate Funding
M3.1.1.1	Market to Existing Stakeholders
M3.1.1.2	Facilitate Top Level Commitment
M3.1.1.3	Contracting
M3.1.1.4	Ensure Funding Continuity
M3.1.2	Evolve, Sustain and Facilitate
M3.1.2.1	Evolve Network Goals, Tasks and Activities
M3.1.2.2	Sustain Established Activities
M3.1.2.3	Facilitate Internal and External Participation
M3.1.3	Maintain Architecture
M3.1.3.1	Maintain Knowledge Base
M3.1.3.2	Maintain Tools
M3.1.3.3	Maintain Communication
M3.2	Refine
M3.2.1	Expand Stakeholders and Funding
M3.2.1.1	Market to New Stakeholders
M3.2.1.2	Expand Stakeholders Commitment
M3.2.1.3	New / Renew Contracting
M3.2.1.4	Expand Funding Commitments
M3.2.2	Measure Performance
M3.2.2.1	Perform Health Check
M3.2.2.2	Identify Ailing Network Symptoms
M3.2.2.3	Corrective Action
M3.2.3	Enhance Architecture
M3.2.3.1	Enhance Knowledge Base

Process Identifier	Description
M3.2.3.2	Enhance Tools
M3.2.3.3	Enhance Communication
M4	Phase-Out
M4.1	Plan Phase-Out
M4.1.1	Plan Phase-Out Communication
M4.1.1.1	Plan Stakeholder Communication
M4.1.1.2	Plan Results and Benefits Documentation
M4.1.2	Plan Architecture Close-Out
M4.1.2.1	Plan ICT Migration / Closure
M4.1.2.2	Plan Other Infrastructure Closure
M4.1.3	Plan Contractual Close-out
M4.1.3.1	Identify Outstanding Contractual Commitments
M4.1.3.2	Identify Financial Commitments
M4.2	Execute Phase-Out
M4.2.1	Document Results and Performance
M4.2.1.1	Benefits Analysis
M4.2.1.2	Close-out Reports
M4.2.1.3	Financial Close-Out
M4.2.2	Close or Migrate Architecture
M4.2.2.1	Transfer or Archive Knowledge Base
M4.2.2.2	Archive Communication Base
M4.2.3	Contractual Close-out
M4.2.3.1	Resolve Outstanding Contractual Issues
M4.2.3.2	Close Contracts
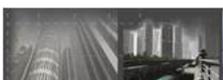
C.2   Network Design Details

This section contains some of the details of the **Network Design** activity (Process Id M1.3.1 on page 100) of the Integrated Knowledge Network Methodology.

C.2.1 Knowledge Work Processes

The **Knowledge Work Processes** (Process Id M1.3.1.2) is a derivative of the Knowledge Reference Types identified in the Requirements Analysis phase. For each knowledge reference type, different knowledge work processes are applicable.

The following four operational knowledge tasks with the resulting network reference types need to be considered: (Back, et al. [14])

- **Experiencing knowledge network**: The main operational task of this knowledge network is to have the members exchanging their tacit knowledge, best practices, and solutions through interaction and common experience. The following facilitating conditions characterize the experiencing network:
    o Direct interaction between individuals within personal relationships.
    o Shared experiences and activities.
    o Values associated with a "high-care culture" (e.g. shared trust basis, empathy and openness).
    o A high degree of face-to-face contact, intensive communication between the members, including both short- and long-term interaction (e.g., meetings versus one-week workshops).
    o A low degree of lingual and cultural differences.
    o Geographical and social proximity.
- **Materializing knowledge network**: The main operational task of this knowledge network is to have knowledge "owners" or experts communicating their tacit knowledge in an explicit form through language, and thus capture their knowledge in documents or other forms. The following facilitating conditions characterize the materializing network:
    o An appropriate mix of special knowledge and skills, and interdisciplinary combinations of groups.
    o Trust within the network.
    o A high degree of communication.
    o Shared values and interests between and among network members.
    o Sufficient time to structure the knowledge and capture it in a knowledge base.
    o Appropriate organizational tools with which to support the materializing of tacit knowledge, i.e. clear-cut roles, and communication rules.
- **Resystemizing knowledge network**: The main operational task of this knowledge network is to systematize and refine existing knowledge. The following facilitating conditions characterize the resystemizing network:

- o The knowledge culture has to ensure that no information hiding of knowledge occurs, or that the hiding of explicit knowledge is at least minimized.
- o Within the organization, knowledge can easily be accessed, and there are not too many restrictions.
- o ICT tools are widely used.
- o A high degree of awareness of the possibilities and limitations of ICT tools is necessary. This must consider the resystemizing and structuring of knowledge, including measures to design the related knowledge work processes and to adequately integrate them.
- o There should be clear-cut and special roles.
- o There should be a high degree of formalization.
- o It could be rather large in size.

- **Learning knowledge network**: The main operational task of this knowledge network is to learn, embody, and apply existing explicit knowledge. The following facilitating conditions characterize the learning network:
  - o Central to this type of network is experiencing and experimenting with new knowledge while simultaneously applying and maintaining knowledge already obtained. Therefore, learning by doing, experimentation, trial-and-error processes, on-the-job learning, informal communications, and the simulation of existing problems are typical courses of action.
  - o Structural and cultural conditions should enable practice-oriented and continuous learning, the application of new knowledge, learning from experience, etc.
  - o Values such as tolerance of failures or experiments and openness should be fostered.
  - o Sufficient time for individual learning and reflection, as well as for working together, is of great importance.
  - o There should be action-oriented processes to apply knowledge.
  - o There should be learning within a learning environment.

C.2.2 Organizational Tools

The design of the **Organizational Tools** (Process Id M1.3.1.3)needs to support the activities of each Knowledge Network Reference Type (Back, et al. [14]):

- **Experiencing Network.** The appropriate organizational tools have to be used in order to support specific characteristics of experiencing networks, and to foster a knowledge-enriching environment. The basis for choosing an appropriate tool is, again, the main operational knowledge task of transforming tacit knowledge into tacit knowledge that is pursued by these networks. Since intensive communication between and among network members is crucial, communication tools are the most important tools to support experiencing networks. The following list gives an overview of relevant organizational tools that support an experiencing network:

Communication and coordination tools:

- o knowledge forums
- o think-tanks
- o knowledge workshops
- o coffee corners/talk rooms
- o meeting and moderation tools
- o conversation and negotiation techniques
- o active listening
- o language tools (dialogue, storytelling, common language, metaphors, controlled vocabulary, organizational thesaurus and dictionary)

Organization and management tools:

- o management tools
  - ▪ conflict management tools
  - ▪ presentation techniques
  - ▪ HRM tools (e.g., job rotation, job enrichment, mentoring/coaching, training and development, and education)
  - ▪ knowledge vision/goals
  - ▪ contact/networking management
- o organizational structure tools
  - ▪ group work
  - ▪ roles and responsibilities (e.g., knowledge activists, community/network roles)
- o organizational culture tools
  - ▪ corporate culture change programmes
  - ▪ organizational development tools
  - ▪ change agent

- **Materializing Network.** Organizational tools in materializing networks must primarily support the **process** of transforming tacit knowledge into explicit knowledge. This process can be divided into two parts. Firstly, tacit knowledge has to be identified and then articulated. Organizational tools to support this process are tools for visualization or language tools such as metaphors, analogies, etc. Furthermore, it should be emphasized that the process of articulating the knowledge is rather communication-intensive. Secondly, the articulated knowledge has to be translated into an understandable format. Organizational tools may also support this task. Examples are organization and management tools such as presentation techniques, knowledge maps, defined roles and responsibilities in order to manage the process of bringing the knowledge into a well-structured and understandable format, etc. The following list gives an overview of relevant organizational tools to support the knowledge reference mode materializing network:

Communication and coordination tools:

- o knowledge forums
- o think-tanks
- o knowledge workshops
- o coffee corners/talk rooms
- o meeting and moderation tools
- o conversation and negotiation techniques
- o active listening
- o language tools (dialogue, storytelling, common language, metaphors, controlled vocabulary, organizational thesaurus and dictionary)

Organization and management tools:

- o management tools
  - presentation techniques
  - knowledge maps
  - visualization tools
  - knowledge vision/goals
- o organizational structure tools
  - roles and responsibilities (e.g., knowledge authors, reviewers, and content manager)
  - group work
  - project management
  - knowledge units
- o organizational culture tools
  - corporate culture change programs
  - organizational development tools
  - change agent

- **Resystemizing Network.** A wide range of organizational tools exists to support the resystemizing network mode and influence the relevant knowledge work processes, the cultural and structural facilitating conditions, as well as network characteristics. A number of organizational communication and coordination tools might be used for the particular exchange of explicit knowledge. In addition, organization and management tools help to manage knowledge work processes, to establish the network structure by providing roles, to influence the knowledge culture by using organizational culture tools, etc. The following list gives an overview of relevant organizational tools for resystemizing networks:

Communication and coordination tools:

- o knowledge forums
- o think-tanks
- o knowledge workshops
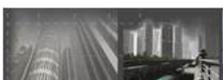
- o meeting and moderation tools
- o language tools (common language, metaphors, controlled vocabulary, organizational thesaurus and dictionary)

Organization and management tools:

- o management tools
    - performance management tools
    - visualization tools (e.g., knowledge maps)
    - self-management tools
    - rewards and incentives
    - knowledge vision/goals
- o organizational structure tools
    - roles and responsibilities (e.g., knowledge gatherer, knowledge analyst, knowledge author, knowledge reviewer, and content manager)
    - knowledge units
- o organizational culture tools
    - corporate culture change programmes
    - organizational development tools
    - change agent

- **Learning Network.** Tools **in** learning networks primarily support the transformation of explicit knowledge into tacit knowledge. In this process at least two sub-processes have to be taken into account: firstly, explicit knowledge has to be made available in a suitable form (e.g., well structured, easily readable, and understandable). Secondly, the explicit knowledge has to materialize through action and practice. Thus, close attention should be paid when selecting the particular organizational tools to support the special circumstances of explicit knowledge. The following list offers a more comprehensive overview of organizational tools to support learning networks:

Communication and coordination tools:

- o knowledge forums
- o think-tanks
- o knowledge workshops
- o meeting and moderation tools
- o language tools (common language, metaphors, controlled vocabulary, organizational thesaurus and dictionary)

Organization and management tools:

- o management tools
    - performance management tools
    - visualization tools (e.g., presentation techniques, and knowledge maps)
    - scenario learning
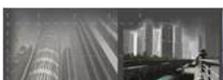
- simulation
- planning tools (e.g., scenario techniques)
- self-management tools (e.g., time management)
- HRM tools (e.g., mentoring, coaching, training and education)
- learning tools (e.g., learning lessons, and learning journeys)
- feedback
- rewards and incentives
- knowledge vision/goals
  - organizational structure tools
    - roles and responsibilities (e.g., network moderator, media expert, trainer and coach)
    - group work
    - project management
    - organizational culture tools
    - corporate culture change programs
    - organizational development tools
    - change agent

C.2.3 ICT Architecture

ICT Architecture (Process Id M1.3.1.3): Information and communication technology tools support processes that help to fulfil the operational knowledge task and also influence, directly and/or indirectly, the network's facilitating conditions. (Back, et al. [14]):

- **Experiencing Network ICT Tools:** There are various ICT tools that are helpful in supporting knowledge networks of this type, particularly to overcome the geographical dispersal of an experiencing network's members. Examples of virtual communities demonstrate that establishing personal relationships, trust, and sharing experiences and tacit knowledge can, to some degree, be done "virtually" as well. Therefore, ICT communication tools (especially synchronous technologies and tools with a high degree of media richness) are mostly relevant for this network reference type, whereas intelligent tools, organization and management tools, as well as a knowledge base, are less important. The following list gives an overview of relevant ICT tools to support the knowledge reference mode experiencing network:

Communication and coordination tools:

  - messaging/e-mail
  - real-time conferencing systems
  - non-real-time conferencing systems (e.g. discussion databases)
  - learning platforms
  - community tools

Integration and database tools:

- o internet-technologies (some of them)
- o knowledge management suites

- **Materializing Network ICT Tools**: Diverse database tools help provide a knowledge base in which explicit knowledge can be made accessible in a materializing network. Since this process can be structured quite well, the utilization of workflow management tools is also possible. Furthermore, some intelligence tools might be put in place, for example, skill mining tools to identify experts for certain content areas or problem-solving tools such as reasoning technologies. The following list gives an overview of relevant organizational and ICT tools to support the reference mode materializing network:

  Communication and coordination tools:

  - o messaging/e-mail
  - o workflow management
  - o group decision support systems
  - o real-time conferencing systems
  - o non-real-time conferencing systems (e.g., discussion databases)
  - o learning platforms
  - o community tools

  Organization and management tools:

  - o visualization tools
  - o creativity tools

  Intelligence tools:

  - o skill mining
  - o categorization/clustering
  - o problem solving tools

  Integration and database tools:

  - o internet-technologies (some of them)
  - o knowledge management suites
  - o databases
  - o data dictionaries
  - o repositories

- **Resystemizing Network ICT Tools:** In resystemizing networks, nearly all the potential provided by ICT can be utilized. In other words, not only the communication in knowledge networks and closely related knowledge tasks, such as locating/capturing, sharing/transferring, or storing knowledge can be supported electronically, but also tasks to manage and control the network, such as measurement and performance management. The use of intelligence tools, specifically "intelligence agents" which are to a certain degree able to act autonomously, might lead to an understanding of knowledge networks, in which software systems not only play a role as tools, but, similar to the human

representatives, become autonomous actors. The following list gives an overview of relevant organizational and ICT tools for resystemizing networks:

Communication and coordination tools:

- o document management/archiving
- o workflow management
- o messaging/e-mail
- o calendaring/scheduling
- o real-time conferencing systems (video conferencing, audio conferencing, and data conferencing (chat, whiteboard, and application sharing))
- o non-real-time conferencing systems (e.g., discussion databases)
- o learning platforms
- o group editing/group document handling
- o community tools
- o collaborative filtering

Organizational and management tools:

- o personal information management (PIM)
- o decision support systems
- o management support systems/executive support systems
- o visualization tools
- o creativity tools
- o measuring tools

Intelligence tools:

- o intelligence agents
- o data mining
- o text mining
- o business intelligence
- o categorization/clustering tools
- o problem solving tools (neural networks, reasoning, and rule-based systems)

Integration and database tools:

- o internet-technologies
- o CSCW/groupware-suites
- o knowledge management suites
- o enterprise portals
- o databases
- o data dictionaries
- o repositories
- o data warehousing

representatives, become autonomous actors. The following list gives an overview of relevant organizational and ICT tools for resystemizing networks:

Communication and coordination tools:

- o document management/archiving
- o workflow management
- o messaging/e-mail
- o calendaring/scheduling
- o real-time conferencing systems (video conferencing, audio conferencing, and data conferencing (chat, whiteboard, and application sharing))
- o non-real-time conferencing systems (e.g., discussion databases)
- o learning platforms
- o group editing/group document handling
- o community tools
- o collaborative filtering

Organizational and management tools:

- o personal information management (PIM)
- o decision support systems
- o management support systems/executive support systems
- o visualization tools
- o creativity tools
- o measuring tools

Intelligence tools:

- o intelligence agents
- o data mining
- o text mining
- o business intelligence
- o categorization/clustering tools
- o problem solving tools (neural networks, reasoning, and rule-based systems)

Integration and database tools:

- o internet-technologies
- o CSCW/groupware-suites
- o knowledge management suites
- o enterprise portals
- o databases
- o data dictionaries
- o repositories
- o data warehousing

     o search and retrieval

- **Learning Network ICT Tools**: There is a wide range of ICT tools to support the facilitating conditions of a learning network in order to provide access to explicit knowledge for learning purposes. Learning platforms, visualization tools, learning portals, audio and video streaming, and community tools are just a few of them. After obtaining access to explicit knowledge, the second process of embodying the explicit knowledge – in which communication plays an important role – might be supported with organizational and ICT tools as well. Examples of organizational tools are various communication tools and also organization and management tools such as coaching, mentoring, simulation, scenario learning, group work, and project management. ICT tools with which to support this process entail the entire tool class of synchronous and asynchronous communication tools, as well as tools for personal information management (PIM), simulation and modelling tools. As with the other network reference type, organizational tools also exist to influence cultural aspects within learning networks. The goal, therefore, should be to establish a knowledge culture that encourages the desired learning processes. The following list gives a more comprehensive overview of ICT tools with which to support learning networks:

  Communication and coordination tools:

  - messaging/e-mail
  - real-time conferencing systems (video conferencing, audio conferencing, and data conferencing (chat, whiteboard, and application sharing)
  - non-real-time conferencing systems (e.g., discussion databases)
  - learning platforms
  - community tools

  Organizational and management tools:

  - personal information management (PIM)
  - scheduling/calendaring
  - simulation and modelling tools
  - visualization tools

  Integration and database tools:

  - internet technologies
  - knowledge management suites
  - enterprise portals
  - databases
  - repositories
  - search and retrieval
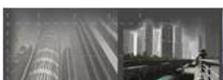
C.3   Methodology Verification against Requirements

Table C-2: Requirement / Methodology Cross Reference

Requirement	Methodology Cross-Reference
R1: Purpose Requirements	
R1.1: Personal Growth and Support Networks	M1.1: Vision, Strategy, Domain and Stakeholders
R1.2: Idea Networks	M1.1: Vision, Strategy, Domain and Stakeholders
R1.2.1: Innovation Increase	M1.1.5: Network Variant
R1.2.2: Advocacy	M1.1.5: Network Variant
R1.3: Learning Networks	M1.1: Vision, Strategy, Domain and Stakeholders
R1.3.1: Interest and Information	M1.1.5: Network Variant
R1.3.2: Communities and Networks of Practice	M1.1.5: Network Variant
R1.3.3: Professional Associations	M1.1.5: Network Variant
R1.3.4: Research Networks	M1.1.5: Network Variant
R1.4: Mission Networks	M1.1: Vision, Strategy, Domain and Stakeholders
R1.4.1: Local Service-Oriented Non-Profit Organizations	M1.1.5: Network Variant
R1.4.2: Global Networks	M1.1.5: Network Variant
R1.4.3: Regional Economic Networks	M1.1.5: Network Variant
R1.5: Business Networks	M1.1: Vision, Strategy, Domain and Stakeholders
R1.5.1: Supplier Networks	M1.1.5: Network Variant
R1.5.2: Alliances, Partnerships and Trade Associations	M1.1.5: Network Variant
R1.5.3: Independent Business and Consulting Networks and Alliances	M1.1.5: Network Variant
R1.5.4: Customer User Groups	M1.1.5: Network Variant
R1.5.5: Leadership Networks	M1.1.5: Network Variant
R1.5.6: Strategic Change	M1.1.5: Network Variant
R2: Knowledge Network Functions	
R2.1: Connect People and Organizations	M1.1.2: Identify and Select Stakeholders
R2.1.1: Identify and Select Collaborators	M1.1.2.1: Stakeholder Identification
	M1.1.2.2: Stakeholder Analysis
R2.1.2: Gain Commitment of Top Management	M2.1.1.2: Facilitate Top Level Commitment
R2.1.3: Mechanisms to gain Management Commitment	M2.1.1.2: Facilitate Top Level Commitment
	M2.1.1.1: Market the Network
R2.1.4: Connect Collaborators	M2.2.1: Facilitate Stakeholder Participation
	M3.1.2.3: Facilitate Internal and External Participation
R2.1.5: Communication Mechanisms	M1.3.1.3: Organizational Tools
	M1.3.1.4: ICT Architecture

Requirement	Methodology Cross-Reference
R2.1.6: Encourage Trust and Openness	M1.3.2.3: Communication Plan
	M2.2.1: Facilitate Stakeholder Participation
	M3.1.2.3: Facilitate Internal and External Participation
R2.1.7: Face-to-Face Meetings and Forums	M1.3.1.3: Organizational Tools
	M2.2.3.2: Organize People and Meetings
R2.1.8: Gain Commitment of Members	M2.1.1.2: Facilitate Top Level Commitment
	M3.1.2.3: Facilitate Internal and External Participation
R2.1.9: Recognition of Members	M1.3.3.4: Incentives
	M3.2.2: Measure Performance
R2.1.10: Protect Intellectual Property	M1.1.4: IPR Strategy
	M1.2.5: Contractual Requirements
	M1.3.5.2: IPR Protection
R2.2: Create and Share Knowledge	
R2.2.1: Transfer Existing Knowledge	M3.1.2: Evolve, Sustain and Facilitate
R2.2.2: Share Knowledge	M3.1.2: Evolve, Sustain and Facilitate
R2.2.3: Share Experience	M3.1.2: Evolve, Sustain and Facilitate
R2.2.4: Share Literature	M3.1.2: Evolve, Sustain and Facilitate
R2.2.5: Share Research Outputs	M3.1.2: Evolve, Sustain and Facilitate
R2.2.6: Exploit Knowledge	M3.1.2: Evolve, Sustain and Facilitate
R2.2.7: Support Network Purpose	M3.1.2: Evolve, Sustain and Facilitate
R2.2.8: Identify Knowledge Gaps	M3.1.2: Evolve, Sustain and Facilitate
R2.2.9: Create New Knowledge	M3.1.2: Evolve, Sustain and Facilitate
R2.2.10: Execute Research	M3.1.2: Evolve, Sustain and Facilitate
R2.2.11: Document Research Outputs	M3.1.2: Evolve, Sustain and Facilitate
R2.2.12: Explore Explicit Knowledge	M3.1.2: Evolve, Sustain and Facilitate
R2.2.13: Explore Tacit Knowledge	M3.1.2: Evolve, Sustain and Facilitate
R3: Control and Measure Objective Requirements	
R3.1: Facilitating Conditions	
R3.1.1: Define Network Vision and Strategy	M1.1.1: Define Need, Purpose and Strategy
R3.1.2: Supportive Environmental Factors	M2.1.1.2: Facilitate Top Level Commitment
R3.1.2: Supportive Environmental Factors	M2.2.4: Roll-out Architecture
	M2.2.1: Facilitate Stakeholder Participation
R3.1.3: Define Network Expectations	M1.1.1.1: Knowledge Need and Purpose
R3.2: Knowledge Processes	
R3.2.1: Identify Network Mode(s)	M1.1.5: Network Variant
R3.2.2: Organize the Processes	M2.2.3: Organize
R3.2.3: Assign Roles to Processes	M2.2.3.1: Assign Roles based on Skills
R3.2.4: Identify Barriers	M2.2.1: Facilitate Stakeholder Participation
R3.2.5: Identify Success Factors	M2.2.1: Facilitate Stakeholder Participation

Requirement	Methodology Cross-Reference
R3.2.6: Facilitate Building Relationships	M2.2.1: Facilitate Stakeholder Participation
R3.2.7: Integrate and Coordinate other networks / organizations	M2.2.1.2: Facilitate External Participation
R3.3: Knowledge Network Architecture	
R3.3.1: Organizational Tools	M2.1.4.2: Organizational Architecture
	M2.2.4: Roll-out Architecture
R3.3.2: Information and Communication Tools	M2.1.4.1: ICT Architecture
	M2.2.4: Roll-out Architecture
R3.4: Control Targets and Measurements	
R3.4.1: Setup Performance Targets	M2.2.5.2: Set and Agree Targets
R3.4.2: Integrate Performance Measures	M2.2.5: Implement Performance Measures
R3.4.3: Measure Performance	M2.2.5.3: Start to Collect Data
	M3.2.2: Measure Performance
R3.4.5: Network Goal Achievement	M3.2.2.1: Perform Health Check
R3.4.6: Measure Individual Performance	M3.2.2: Measure Performance
R3.4.7: Measure Organizational Performance	M3.2.2: Measure Performance
R3.4.8: Measure Networking Performance	M3.2.2: Measure Performance
R3.4.9: Incentives / Reward System	M1.3.3.4: Incentives

C.4   IKN Methodology Comparison to the St Gallen "Putting Knowledge Networks into Action"

The table below contains a cross-reference between the Integrated Knowledge Network Methodology, and the St Gallen "Putting Knowledge Networks into Action" methodology (Back, et al. [14]) discussed in par 6.2.1 on page 87. The comparison was only performed up to the 3rd level in the IKN Methodology.

Table C-3: IKN Methodology / St Gallen "Putting Knowledge Networks into Action" Cross Reference

Process Identifier	Description	Amendment	Notes
M	Methodology Top Level	Structural	The Overall Structure of the methodology was amended to accommodate 4 main phases.
M1	Design	Scope / Structural	Structured into 3 sub-phases.
M1.1	Vision, Strategy, Domain and Stakeholders	Scope	Inter-organizational aspects added
M1.1.1	Define Need, Purpose and Strategy	Scope	Inter-organizational aspects expended.
M1.1.2	Identify and Select Stakeholders	Scope	Inter-organizational aspects, as well as preliminary selection phase added.
M1.1.3	Financial Feasibility	New	Financial feasibility analysis not covered in existing KN methodologies reviewed.
M1.1.4	IPR Strategy	New	IPR protection strategies is a derived requirement from the inter-organizational aspect of IKNs – therefore not addressed in existing KN methodologies.
M1.1.5	Network Variant	Scope	
M1.2	Requirements Analysis	Scope	
M1.2.1	Knowledge Requirement Analysis	Scope	Detail expanded.
M1.2.2	Knowledge Network Reference Types	Existing	From the St Gallen methodology "Putting Knowledge Networks into Action".
M1.2.3	Define Control Targets	New	While existing methodologies mention the importance of

Process Identifier	Description	Amendment	Notes
			performance measurement, it is not addressed in the design phases.
M1.2.4	Financial Support Requirements	New	Financial requirements not covered in existing KN methodologies reviewed.
M1.2.5	Contractual Requirements	New	Derived from the inter-organizational requirement.
M1.3	Detail Design and Planning	Scope	
M1.3.1	Network Design	Existing	From the St Gallen methodology "Putting Knowledge Networks into Action".
M1.3.2	Planning	New	Project Management Planning aspects added.
M1.3.3	Performance Measures	New	Design of Performance Measures added – existing KN methodologies do not address the detail design of measures.
M1.3.4	Financial Model(s)	New	Financial models not covered in existing KN methodologies reviewed.
M1.3.5	Contractual Model(s)	New	Derived from the inter-organizational requirement.
M2	Implement	Scope / Structural	Similar to the "Start-up" tasks of "Putting Knowledge Networks into Action", but with more focus on planning to implement.
M2.1	Plan and Prepare to Implement	New	
M2.1.1	Approach Stakeholders	Scope	Stronger focus on the inter-organizational marketing and contracting aspects.
M2.1.2	Plan Implementation Activities	New	Project Management Planning aspects added.
M2.1.3	Organizational Procedures	Existing	Similar to "Putting Knowledge Networks into Action"
M2.1.4	Build or Procure Architecture	Scope	Recognition that the organizational and ICT architecture may be procured externally.
M2.1.5	Funding	New	Funding aspects not directly addressed in existing KN methodologies.
M2.2	Roll-out and Implement	Scope	
M2.2.1	Facilitate Stakeholder Participation	Scope	External participation added.
M2.2.2	Kick-off Workshops and Meetings	New	

Process Identifier	Description	Amendment	Notes
M2.2.3	Organize	Existing	Similar to "Putting Knowledge Networks into Action"
M2.2.4	Roll-out Architecture	Scope / Structural	Restructured in that Architecture is defined as Organizational and ICT, and are rolled out together.
M2.2.5	Implement Performance Measures	Scope	Inter-organizational aspects added.
M3	Operate and Refine	Scope / Structural	
M3.1	Operate	Structural	
M3.1.1	Manage Stakeholders and Facilitate Funding	Scope	Maintenance of contracts and the assurance of continued funding added.
M3.1.2	Evolve, Sustain and Facilitate	New	
M3.1.3	Maintain Architecture	New	
M3.2	Refine		"Putting Knowledge Networks into Action" adapts the KN based on measures, while the IKN method recognizes that Network Evolution is a continuous process.
M3.2.1	Expand Stakeholders and Funding	New	Recognition that, as the KN evolves, new stakeholders may be added, and funding requirements will change.
M3.2.2	Measure Performance	Existing	Similar to "Putting Knowledge Networks into Action"
M3.2.3	Enhance Architecture	New	As the network evolves, the architecture will need to be enhanced.
M4	Phase-Out	Scope / Structural	
M4.1	Plan Phase-Out	New	Recognition that the phase-out of the KN must be planned.
M4.1.1	Plan Phase-Out Communication	New	
M4.1.2	Plan Architecture Close-Out	New	
M4.1.3	Plan Contractual Close-out	New	
M4.2	Execute Phase-Out	Scope	"Putting Knowledge Networks into Action" allows a network to "die gracefully" i.e. a more passive approach, while the IKN methodology has a more active approach, where the phase-

Process Identifier	Description	Amendment	Notes
			out is executed, based on a plan.
M4.2.1	Document Results and Performance	New	Existing methodologies do not cater for the archiving and protection of value (i.e. knowledge generated)
M4.2.2	Close or Migrate Architecture	New	The architecture will often be the archiving mechanism for the value within the KN.
M4.2.3	Contractual Close-out	New	Inter-organizational contractual requirements need to be finalized.

Appendix D: Integrated Knowledge Network Methodology Validation Details

This appendix contains additional information on the Methodology Validation:

- The Survey Questionnaire used in the validation.

- An analysis of the survey results.
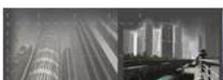
D.1 Assessment Survey Questionnaire

The following questionnaire was used in interviews with representatives from the selected target knowledge networks. The design of this survey is discussed in Chapter 8.

D.1.1 General, Vision and Strategy

Ref	Question	Response		
1.1	Does the knowledge network have a name?	Yes		
		No		
1.1.1	If .1 was yes, what is the name of the network?			
1.2	What is the main knowledge domain?			
1.3	How would you categorize this network?	Social Network		
		Community of Practice		
		Joint Venture		
		Network of Excellence		
		Network of Practice		
		Innovation Network		
		Knowledge Network		
		Other		
1.4	Is there a common vision and strategy?	Yes		
		No		
1.4.1	If "yes", provide a short description of the **vision and strategy**.			
1.5	Who are the Knowledge Network Stakeholders?			
1.6	How were the stakeholders selected?			
1.7	Is there a knowledge network champion? (Somebody who is driving network activities, and if this person was not present, would have caused the network to fail)	Yes		
		No		
1.7.1	If "yes", who is it?			
1.7.2	Is there a successor?			
1.8	Geographical Dispersion:	Within a single enterprise at a single location		
		Within a single enterprise at multiple locations.		
		Multiple enterprises, multiple locations, same urban location		
		Multiple enterprises, multiple locations, same country		
		Multiple enterprises, multiple locations, internationally dispersed		
1.9	List the locations:			

D.1.2 Life Cycle

Figure D-1: Knowledge Network Life Cycle

Ref	Question	Response
2.1	In what year was the knowledge network established?	
2.2	The network is currently in the following life cycle phase:	Design ☐ Implementation ☐ Operation ☐ Operation and Refinement ☐ Phase-out ☐
2.2.1	If Phase = "Operation and Refinement": Is there a measurement system in place?	Yes ☐ No ☐
2.2.2	Briefly describe the measurement system	
2.3	How many active organizations participate in this network?	
2.4	How many individuals are **registered** in this network?	
2.5	How many individuals are **active** in this network?	

D.1.3 Benefits

Networks are increasingly recognized as a valuable facilitator to foster economic development. The review of the literature [1] attributes a number of benefits to networks:

Ref	Benefit	Observed	Notes
3.1	**What benefits have been realized by this network?**		
3.1.1	**What are the main Benefits Realised?**		

Ref	Benefit	Observed	Notes
3.1.2	**Increased Scale and Scope of Activities:** the outcomes of collaboration may be applicable to all partners' market, and thus may expand individual firm's customer base. If a firm is part of a customary network, its performance capacity can be considerably extended through synergies between firm's different technological competencies;	Yes ☐ No ☐ Some ☐	
3.1.3	**Shared Costs and Risks:** costs for major innovations, such as a new generation of semiconductors or aircraft, have risen rapidly and are now beyond the means of any single firm. Collaboration can share the high costs and therefore risks of innovation;	Yes ☐ No ☐ Some ☐	
3.1.4	**Improved Ability to Deal with Complexity**: many key technological developments are complex and draw on a wide range of scientific and commercial knowledge. This reinforces the need for co-operation from participants in different fields of expertise and a closer strategic and technological integration between firms is a means for dealing with the complexity of multiple sources and forms of technology;	Yes ☐ No ☐ Some ☐	
3.1.5	**Enhanced Learning Effects:** with continuous and rapid market and technology change there are pressures on firms to improve their learning capacities. Collaboration and networks can provide possibilities, not only of learning about new technologies, but learning about methods of creating future technologies and of the ways those technologies might affect the existing business. It can teach companies new ways of doing things not only technologically, but also organizationally;	Yes ☐ No ☐ Some ☐	
3.1.6	**Positive Welfare Effect:** internalizing positive externalities through R&D collaboration results in increased R&D efficiency and an increase of overall R&D expenditure. A set of benefits underlying the collaboration is one that considers flexibility and efficiencies;	Yes ☐ No ☐ Some ☐	

Ref	Benefit	Observed	Notes
3.1.7	**Flexibility:** networks offer flexibility, not in contrast to markets, but to hierarchies. Vertically integrated firms establish overheads and production capacities, and in doing so, forsake the flexibility of immediate resource reallocation that networks provide. Hence, large firm/small firm interaction might be facilitated such that the resource advantages of the former are linked with the behavioural or creative advantage of the latter;	Yes ☐ No ☐ Some ☐	
3.1.8	**Efficiency:** The efficiency enhancing effect of networks is related to the specific nature of technological knowledge. Much of the knowledge is tacit—that is difficult to codify in the form of blueprints—and firm specific. It is, therefore, difficult to transfer easily and quickly through market mechanisms. Collaboration provides a mechanism to transfer whereby this kind of transfer is based on trust between the partners;	Yes ☐ No ☐ Some ☐	
3.1.9	**Speed:** Speed may be needed to take advantage of opportunities that might not exist for long, and might require a fast response. An existing network can put together a package of resources and capacities to meet such challenges in a customized response which, in its flexibility and scope, lies beyond the capacity of an un-networked integrated firm. Moreover, rapid product development depends on the reliance on outside suppliers. Mansfield (1988)6 found that time to market was sped up through a policy of outsourcing to suppliers. The capability to commercialize products can in this case be seen to rest on the successful exploitation of the knowledge of other firms.	Yes ☐ No ☐ Some ☐	

D.1.4 Investment and Commitment

Ref	Investment and Commitment	Present	Notes
4.1	Was there an upfront financial investment to establish the network?	Yes ☐ No ☐	
4.2	Are participating enterprises currently supporting network activities financially?	Yes ☐ No ☐	
4.3	Was time made available for the network initiator to establish the network?	Yes ☐ No ☐	
4.3.1	How much time was made available? (hours per week)		
4.4	Is time made available for the Network facilitator to work on network activities?	Yes ☐ No ☐	

Ref	Investment and Commitment	Present		Notes
4.4.1	How much time per week is spent by the network champion / facilitator?			
4.5	Is there an agreement with all participating enterprises on how much time participants may spend on network activities? • **Expected**: Participants are expected to spend time on activities. • **Allowed**: Participants are allowed to spend time on activities. • **No Agreement**: There is no formal agreement, but participants do spend time, • **Non Allowed**: Participants may not spend time on network activities in working hours.	Expected		
		Allowed		
		No agreement		
		Non allowed		
4.5.1	How many hours per week does a typical participant spend on network activities?			
4.6	What other resources are invested in this network?			

D.1.5 Requirements

Ref	Requirements	Present		Notes
5.1	Was there a formal requirement statement for the network?	Yes		
		No		
5.2	Were the following requirements recognized, when the network was established? (formally or informally)			
5.2.1	Connect people and/or enterprises.	Yes		
		No		
5.2.2	Protect Intellectual Property.	Yes		
		No		
5.2.3	Create and Share Knowledge	Yes		
		No		
5.2.4	Recognition that special processes and activities are required to share Tacit knowledge.	Yes		
		No		
5.2.5	Increase Innovation	Yes		
		No		
5.2.6	Risk Optimization	Yes		
		No		
5.2.7	Improve Efficiency	Yes		
		No		

D.1.6 Design

Ref	Requirements	Present		Notes
6.1	Was there a formal design document for the network?	Yes		
		No		
6.2	Was the design approved by the stakeholders before the network was commissioned?	Yes		
		No		
6.3	Has the design been updated?	Yes		
		No		

D.1.7 Presence of Critical Success Factors

Ref	Critical Success Factor	Present		Notes
7.1	**What were the main Critical Success Factors:**			
7.2	**Were the following Critical Success Factors present?**			
7.2.1	**Clear Need:** An important condition for the development of a network is that the members perceive that there is a clear need to belong i.e. the network can achieve something that the individual members cannot achieve on their own.	Yes		
		No		
		Partial		
7.2.2	**Objectives:** Related to the requirement that a network should have clear needs, there is also the requirement that it should have objectives that primarily reflect the needs of the member organizations.	Yes		
		No		
		Partial		
7.2.3	**Leadership and Vision:** Networks that have a leader, who is able to articulate clear and concise goals, are more likely to be successful then those networks whose members are unclear as to its future direction. The leader should not only be able to communicate the network's long term goals but must also be able to translate those goals into a realistic programme of action.	Yes		
		No		
		Partial		
7.2.4	**Early Successes:** The research has indicated the importance of achieving early successes in order to get member organizations to continue their involvement in the network. It is vital, therefore, that networks structure their objectives and work programme to ensure that members can see a return for their investment in the short term.	Yes		
		No		
		Partial		

Ref	Critical Success Factor	Present	Notes
7.2.5	**Trust:** On paper, a grouping of companies in a sector might make the ideal candidates for a network. However, the successful development of networks has been found to be very dependent on the level of trust between member organizations. Since the network involves members who normally act on their own, the implementation of network activities requires a certain level of trust by the members. The gaining of trust is particularly important in those networks whose membership includes companies that compete against each other.	Yes ☐ No ☐ Partial ☐	
7.2.6	**Ownership**: If the network is to succeed then it will be necessary for them to take ownership of the development process and drive the network forward. If the companies do not have ownership of the network they will not be committed to it. They will perceive that it will have an agenda that may not approximate to their own	Yes ☐ No ☐ Partial ☐	
7.2.7	**Time:** The formation of a durable network can take time. A considerable period can elapse before the members have developed trust and confidence in the network to undertake joint activities. Member organizations need to interact socially before they can commit themselves to working with other members.	Yes ☐ No ☐ Partial ☐	
7.2.8	**Critical Mass:** The lack of critical mass can delay the outputs from a network.	Yes ☐ No ☐ Partial ☐	
7.2.9	**Key Player:** Related to the issue of critical mass, the presence of a major player with the vision and resources can be influential in driving the network forward.	Yes ☐ No ☐ Partial ☐	
7.2.10	**Communication/Branding:** The development of a clear identity for a network can be critical for its longevity.	Yes ☐ No ☐ Partial ☐	
7.2.11	**Facilitation**: To be successful networks need on-going facilitation. The inputs of a network manager in terms of supporting the network, brokering the needs of individual members, coordinating what is a complex process and implementing the network's work programme, can have a significant bearing on its long term viability.	Yes ☐ No ☐ Partial ☐	
7.2.12	**Social Factors:** An aspect, often over-looked in the development of networks, is the importance of social interaction.	Yes ☐ No ☐ Partial ☐	

Ref	Critical Success Factor	Present		Notes
7.2.13	**Top-Down Incentives or Pump Priming:** The provision of State funding where submissions, involving two or more applicants, can obtain higher scoring points, has been found to be very helpful in the development of networks.	Yes		
		No		
		Partial		
7.2.14	**Process:** While the concept of networks is easy to grasp, operationally a network is both complex and challenging to operate. The key success factor is the process or the "how" factor i.e. how companies are attracted to participate in a network, how their commitment is gained, how the process of developing the network is managed, how it is structured, how decisions are made, how communication is handled, how action programmes are delivered, etc.	Yes		
		No		
		Partial		

D.1.8 Barriers that Inhibited Success

Ref	Barriers	Present		Notes
8.1	What were the main Barriers?			
8.2	Were the following barriers present?			
8.2.1	There is a general lack of awareness as to the benefits of networks (as distinct from networking) among the business community;	Yes		
		No		
		Some		
8.2.2	There is a reluctance to commit time and resources to a process that is not well understood, or the results of which are not clear;	Yes		
		No		
		Some		
8.2.3	Networks are too closely aligned with 'networking' in the mind of business managers and seen as a quasi-social activity rather than an important business function;	Yes		
		No		
		Some		
8.2.4	There is a reluctance to share information and knowledge with other firms, especially competitors;	Yes		
		No		
		Some		
8.2.5	Firms are not always well placed to identify the opportunities for network relationships with other companies since their knowledge and information base may be limited to their own contacts;	Yes		
		No		
		Some		
8.2.6	Membership of a network may expose companies to the danger of "lock-in" where excessive focus is placed on the affairs of the network to the detriment of events in the outside environment;	Yes		
		No		
		Some		

Ref	Barriers	Present		Notes
8.2.7	Even where managers foresee a benefit in establishing a network relationship they may not have the skills or resources to facilitate or co-ordinate the actual implementation of the network. This has been referred to (Dixit and Nalebuff, 1991) as the 'collective action problem', where a group of individuals or firms may frequently fail to achieve co-operation, even where it would be beneficial to every individual in the group.	Yes		
		No		
		Some		

D.1.9 Knowledge Work

Figure D-2: Knowledge Work Processes and Network Reference Types

This section determines the presence of the following types of network activities:

- Experiencing Network
- Materializing Network
- Resystemizing Network
- Learning Network

Ref	Knowledge Work	Present	Notes
9.1	**Experiencing Network**: The exchange of Tacit Knowledge between individuals in order to convey personal knowledge and experience.		
9.1.1	Individuals are **encouraged** to participate in joint activities (Nonaka: socialization) with the purpose of sharing tacit knowledge. The term "socialization" is used to emphasize the importance of joint activities in the process of converting new tacit knowledge through shared experiences. Since tacit knowledge is context specific and difficult to formalize, transferring tacit knowledge requires sharing the same experience through joint activities.	Yes ☐ No ☐ Some ☐	
9.1.2	Joint Socialization activities are **formally organized** in the network. (as opposed to encouraged)	Yes ☐ No ☐ Some ☐	
9.1.3	What organizational mechanisms or tools are used for exchanging Tacit Knowledge?		
9.1.4	The network members are aware of the importance of sharing tacit knowledge, and the complexities involved in successfully transfer tacit knowledge.	Yes ☐ Most ☐ Some ☐ Few ☐ No ☐	
9.2	**Materializing Network**: Converting Tacit Knowledge into Explicit Knowledge. This means the conversion of implicit into explicit knowledge, and the exchange of knowledge between individuals and a group.		
9.2.1	Tacit knowledge is externalized by expressing and translating it into forms such as metaphors, concepts, hypotheses, diagrams, models, or prototypes so that it can be understood by others in the network.	Yes ☐ No ☐ Some ☐	
9.2.2	There is a formal plan and direction to materialize the tacit knowledge in the network.	Yes ☐ No ☐ Some ☐	
9.2.3	What organizational mechanisms or tools are used for externalizing Tacit Knowledge?		
9.2.4	The network members are aware of the importance of externalizing tacit knowledge.	Yes ☐ Most ☐ Some ☐ Few ☐ No ☐	
9.3	**Resystemizing Network**: The transformation of explicit knowledge into more complex and more systematized explicit knowledge through Combination or Systemization.		

Ref	Knowledge Work	Present	Notes
9.3.1	Explicit knowledge converges into more complex and systematic explicit knowledge in the network.	Yes No Some	
9.3.2	Knowledge is exchanged and combined through such media as documents, meetings, telephone conversations, or computerized communication networks.	Yes No Some	
9.3.3	What organizational mechanisms or tools are used for systematizing Tacit Knowledge? (eg meetings, telephone conversations, documents, computerized communication networks)		
9.3.4	The network members are aware of the importance of systemizing explicit knowledge.	Yes Most Some Few No	
9.4	**Learning Network**: the conversion of organization-wide, explicit knowledge into the implicit knowledge of the individual through internalization.		
9.4.1	Members are given the opportunity and encouraged to recognize personally relevant knowledge within the network.	Yes No Some	
9.4.2	What mechanisms or tools are used for internalizing Tacit Knowledge? (eg workshops, meetings, hands-on experience, animations, etc)		
9.4.3	Network members realize that when knowledge is internalized into individuals' tacit knowledge bases in the form of shared mental models or technical knowhow, it becomes valuable assets.	Yes Most Some Few No	

D.1.10 Source Knowledge Domains

Figure D-3: Source Knowledge Domains

Ref	Knowledge Sources	Present		Notes
10.1	Knowledge is sourced from the following domains (May select more than one)	Public Domains		
		Private Domains		
		User Domains		
10.2	Types of Public Knowledge Domains accessed as sources: (Add others if applicable)	Internet		
		Science and Technology Institutions		
		Government		
10.3	Types of Private Knowledge Domains accessed as sources: (Add others if applicable)	Internal Organisation		
		Other participating organizations		
		Competitors		
		Suppliers		
10.4	Types of User Knowledge Domains accessed as sources: (Add others if applicable)	Users		
		Clients		
		Market		
10.5	How is Source Intellectual Property procured?			
10.6	How is source Intellectual Property protected?			

D.1.11 Generated Knowledge
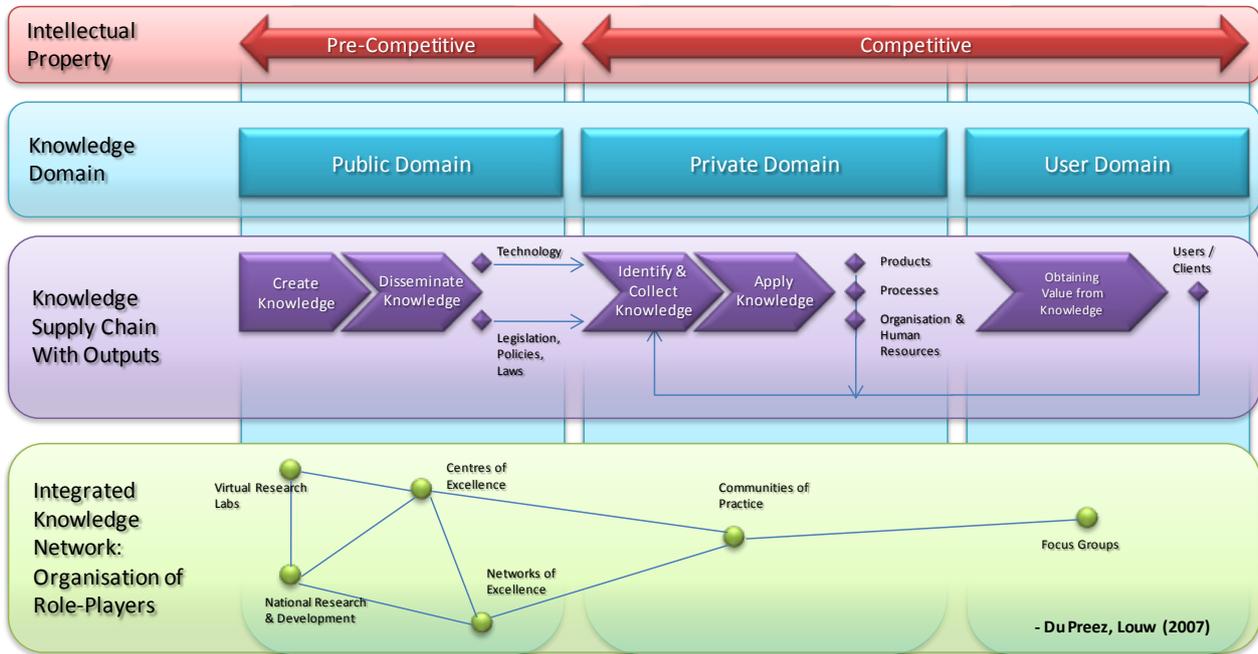
Figure D-4: Created Knowledge Domains and IPR

Ref	Knowledge Outputs	Present		Notes
11.1	The knowledge created within the network are within the following domains: (May select more than one)	Public Domains		
		Private Domains		
		User Domains		
11.2	The network is currently operating in a: (May select more than one)	Pre-competitive phase		
		Competitive phase		
11.3	How is created Intellectual Property protected?			

D.1.12 Organizational Tools

Ref	Organizational Tools	Used		Notes
12.1	The Following Organizational Tools are used for Knowledge Discovery			
12.1.1	• Meetings	Frequently[1]		
		Sometimes		
		Seldom		
		Never		
		Not Avail		

---

[1] Frequently: Daily, Sometimes: once per week, Seldom: Once per month

Ref	Organizational Tools	Used		Notes
12.1.2	• Conferences	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.1.3	• Seminars and Workshops	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.1.4	• Time allocated for research activities	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.1.5	• Other			
12.2	Knowledge Capturing and Categorization			
12.2.1	• Seminars and Workshops	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.2.2	• Time allocated for research activities	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.2.3	• Other			
12.3	Communication and Knowledge Sharing			
12.3.1	• Meetings	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.3.2	• Conferences	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		

Ref	Organizational Tools	Used		Notes
12.3.3	• Seminars and Workshops	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.3.4	• One-to-one	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
12.3.5	• Other			

D.1.13 ICT Tools and Architecture

Ref	ICT Tools	Used		Notes
13.1	Knowledge Discovery Technologies			
13.1.1	• Open Internet Search Facilities (Google, Scholar Google etc)	Frequently[1]		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.1.2	• Subscription Internet Search Facilities (eg Subscription based journal databases)	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.1.3	• Local / Intranet Search Facilities (eg Wiki, Content Management system, Knowledge Management system, Document Management System)	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.1.4	• Text Mining Utilities	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		

---

[1] Frequently: Daily, Sometimes: once per week, Seldom: Once per month

Ref	ICT Tools	Used		Notes
13.1.5	• Combined collaborative technologies such as Eden™	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.1.6	• Other			
13.2	Knowledge Capturing and Categorization Facilities			
13.2.1	• Document Management	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.2.2	• Knowledge Management	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.2.3	• Content Management System	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.2.4	• Wiki	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.2.5	• Combined collaborative technologies such as Eden™	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.2.6	• Other			
13.3	Communication and Knowledge Sharing			
13.3.1	• E-mail	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.2	• Instant Messaging	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		

| Ref	ICT Tools	Used		Notes
13.3.3	• VOIP	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.4	• PSTN	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.5	• Tele-conferencing	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.6	• Video-conferencing	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.7	• Internal Forums	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.8	• Open Internet Forum	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.9	• Social Networks (eg Facebook)	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.10	• Combined Collaborative Technologies such as Eden™	Frequently		
		Sometimes		
		Seldom		
		Never		
		Not Avail		
13.3.11	• Other			

D.1.14   *Verify against Methodology*

Figure D-5: The Knowledge Network Methodology

Amended Methodology for Integrated Knowledge Networks	Applied		Notes
1) Designing an Integrated Knowledge Network			
a) The Knowledge Vision	Yes		
	No		
	Partial		
	NA		
b) Decide on the Network Option			
i) Identify the Knowledge Strategy	Yes		
	No		
	Partial		
	NA		
ii) Select and Understand a Process or Task	Yes		
	No		
	Partial		
	NA		
iii) Perform Stakeholder Analysis (organizational and individual level, synergies and opportunities)	Yes		
	No		
	Partial		

D.1.14 Verify against Methodology

Figure D-5: The Knowledge Network Methodology

Amended Methodology for Integrated Knowledge Networks	Applied		Notes
1) Designing an Integrated Knowledge Network			
a) The Knowledge Vision	Yes		
	No		
	Partial		
	NA		
b) Decide on the Network Option			
i) Identify the Knowledge Strategy	Yes		
	No		
	Partial		
	NA		
ii) Select and Understand a Process or Task	Yes		
	No		
	Partial		
	NA		
iii) Perform Stakeholder Analysis (organizational and individual level, synergies and opportunities)	Yes		
	No		
	Partial		

Amended Methodology for Integrated Knowledge Networks	Applied		Notes
	NA		
iv) Understand the Different Type of Knowledge Needed	Yes		
	No		
	Partial		
	NA		
v) Decide on the Network Option	Yes		
	No		
	Partial		
	NA		
c) Select the Appropriate Network Reference Type			
i) Types of Operational Knowledge Tasks and Types of Knowledge Created	Yes		
	No		
	Partial		
	NA		
ii) Facilitating Conditions Determine the Knowledge Reference Type	Yes		
	No		
	Partial		
	NA		
iii) Identified Deliverables Determine the Appropriate Knowledge Network	Yes		
	No		
	Partial		
	NA		
2) Implementing an Integrated Knowledge Network			
a) Start-up			
i) Justification and Communication Plan	Yes		
	No		
	Partial		
	NA		
ii) Facilitate Top Management Commitment and Find Sponsors	Yes		
	No		
	Partial		
	NA		
iii) Establish a Contractual Framework	Yes		-
	No		
	Partial		
	NA		
iv) Map Specific Goals, Tasks and Activities	Yes		
	No		
	Partial		
	NA		
v) Organize the Specific Processes	Yes		
	No		
	Partial		
	NA		

Amended Methodology for Integrated Knowledge Networks	Applied		Notes
b) Mapping Processes and Roles			
i) Facilitate the Relationships within the Network	Yes No Partial NA		
ii) Determine the Roles and Responsibilities	Yes No Partial NA		
iii) Roles and Skills	Yes No Partial NA		
iv) Organize the People and Meetings	Yes No Partial NA		
v) Facilitate Commitment of Members	Yes No Partial NA		
vi) Provide Organizational Tools to Create a Knowledge-enriching Environment and to Support People and Processes	Yes No Partial NA		
vii) Organize the Appropriate ICT Architecture	Yes No Partial NA		
viii) Set up a Knowledge Base for all Network Types	Yes No Partial NA		
c) Facilitate Relationships to the Outside World			
i) Develop the Knowledge Management Board	Yes No Partial NA		
ii) Provide or Broker Support to Internal Network Initiatives	Yes No Partial NA		
iii) Integrate and Coordinate with Other Functions	Yes No Partial NA		

Amended Methodology for Integrated Knowledge Networks	Applied		Notes
d) Establish Internal Measurement			
i) Choose and Organize the Appropriate Rewards / Incentives	Yes		
	No		
	Partial		
	NA		
ii) Establish Measures for the Individual / Role / Organization /Network	Yes		
	No		
	Partial		
	NA		
iii) Success Factors	Yes		
	No		
	Partial		
	NA		
3) Operating and Refining an Integrated Knowledge Network			
a) Internal and Inter-Organizational Knowledge Network Measurement System			
i) A Health Check for the Knowledge Network	Yes		
	No		
	Partial		
	NA		
ii) Symptoms of an Ailing Network	Yes		
	No		
	Partial		
	NA		
iii) Actions for Handling and Avoiding Failures	Yes		
	No		
	Partial		
	NA		
4) Phasing Out an Integrated Knowledge Network			
a) Fading and Dying with Grace	Yes		
	No		
	Partial		
	NA		
b) Contractual Close-out	Yes		
	No		
	Partial		
	NA		

D.2   Case Study Validation Analysis

Based on the Generic Knowledge Network Framework and the survey questionnaire that was derived from the framework, each aspect of the selected case study networks is discussed and analyzed in this appendix.

Note: To guide the reader through the survey questionnaire framework and to provide the context, a miniature version of the Generic Knowledge Network Framework is displayed at the beginning of the analysis of each of the 14 aspects, with the current aspect highlighted in yellow. It is not the intention to be able to read the details – refer to Figure 7-7 on page 122 for the full-size and complete version. (Since these navigation context diagrams are repetitive copies of earlier illustrations, these diagrams are not captioned or numbered.)

D.2.1 Vision and Strategy

Determining the knowledge vision and strategy sets the direction and purpose for the knowledge network, and provides the basis for motivating all activities within the knowledge network. The knowledge vision requires strong commitment from top management of all participating organizations.

A knowledge vision should spur on new thinking, idea generation, and action. It should also spark new organizational imagination and creativity. Therefore it could be seen as an enabler for the generation of new ideas and knowledge.

Defining a knowledge vision and strategy in advance is important because it helps to create the specific roadmap with which to support all knowledge activities. Having a clear picture of the present situation, as well as foresight into future events, reduces the risk of moving in the wrong direction, thereby developing knowledge that may not be important in future.

The questionnaire assesses:

- Does the network have an identity (a name, brand etc)?

- What are the main knowledge domains the network operates in?

- Is there a vision and strategy for the network?

- The presence of a network champion / facilitator.

The results are summarized in Table D-1 on page D-24. As can be expected, the larger networks all have a well defined vision and strategy, while the smaller personal networks have mostly a knowledge domain interest area.
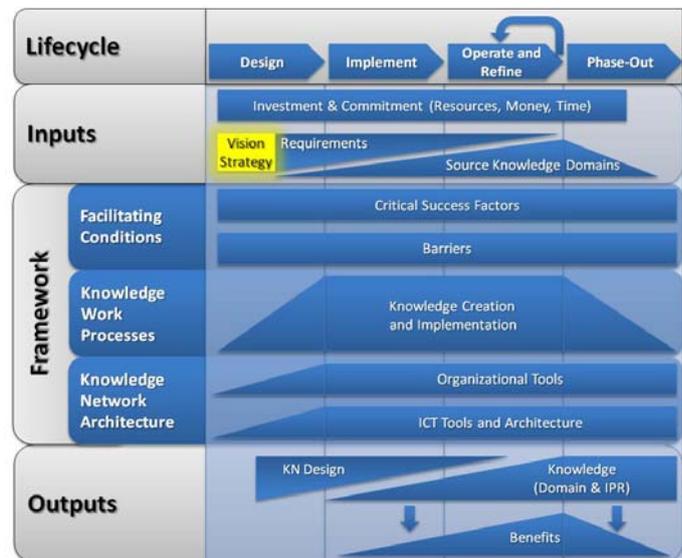
Table D-1: Questionnaire Responses Summary: Vision and Strategy

| Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
1.1	Does the knowledge network have a name?	No	Yes	Yes	Yes	Yes	Yes
1.1.1	If .1 was yes, What is the name of the network?		Enterprise Engineering Group GCC	IDIP	Knowledge Management Integration	CIRP	VRL-KCiP (EMIRAcle)
1.2	What is the main knowledge domain?	Quality and interoperability	Enterprise Engineering	Management Systems - Strategic Planning and Budgeting	Research knowledge & Project Management	Manufacturing Design and Production	New Manufacturing Processes
1.3	How would you categorize this network?	JV, NoE, KN	KN	COP, NOP, Capacity building Change Management Programme	Community of Interest	Professional Research Society	NOE
1.4	Is there a common vision and strategy?	Yes	Partly	Yes	Yes	Yes	Yes
1.4.1	If "yes", provide a short description of the **vision and strategy**.	What is new in domains Identify experts	Built out of need - adapted as developed.	Logframes	Knowledge Management Strategy - focus on Culture and Management Role	Received Strategy from Prof Kals	Share information. Task force
1.5	Who are the Knowledge Network Stakeholders?	Prof Jochem, IPK, Stb	Researchers, Students (Local and international)	4 State Depts, CIDB, Provincial Governments		Industry and Academics	VRL Participants – Research organizations, Universities.
1.7	Is there a knowledge network champion?	Yes	Yes	Yes	Yes	Yes	Yes
1.7.2	Is there a successor?	No	Yes	Yes	Yes	Yes	NA
1.8	Geographical Dispersion:	5. Multiple enterprises, Multiple locations, international	5. Multiple enterprises, Multiple locations, international	4. Multiple enterprises, Multiple locations, same country	3. Single enterprise, Multiple locations, same country	5. Multiple enterprises, Multiple locations, international	5. Multiple enterprises, Multiple locations, international

D.2.2 Current Life Cycle Phase, and Size of the Network

Depending on the current phase within the life cycle of the network, different aspects will be more prominent. In order to assess each network correctly, it is thus important to understand the current phase within the life cycle the network currently finds itself.

It is also important to understand the impact that the size of the network will have on its operations.

The questionnaire therefore addresses:

- The age of the network.

- The perceived phase within the network's life cycle.

- If the network is busy refining itself, the measurement criteria are determined.

- The size and extent of the network in terms of number of organizations, and number of participants.
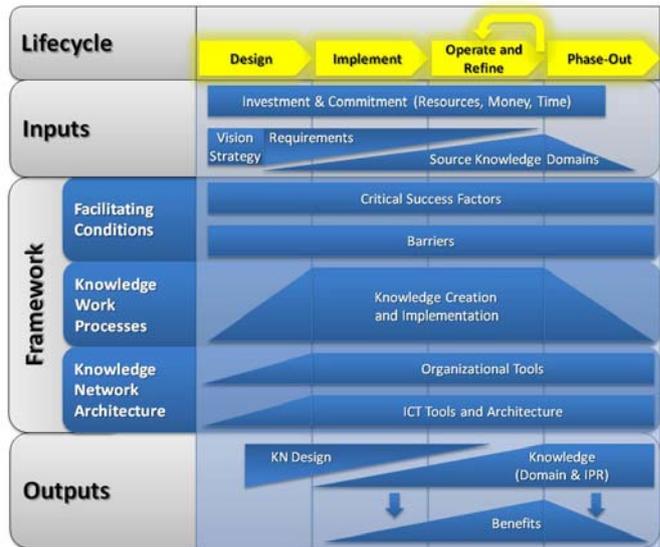
The results are summarized in Table D-2 on page D-26.

Life Cycle Phases:

One network (DBSA) was still considered to be in a Design Phase, but given the network's activities, it was most probably more in an implementation phase, but lacking a formal design.

Three networks were in an Operate and Refine phase, while one network was already Phased Out (VRL-KCiP), and it was thus possible to assess the measurement systems in place.

Measurement System:

Most networks that were perceived to be in an Operational and Refinement Phase had a measurement system in place. (The exception was the personal network.)

VRL-KCiP had a very formal measurement system that consisted of 9 measures and 20 KPI's – it was clear that this network was from this perspective the most mature. Interestingly, this maturity was reached within a very short time-span (5 years), indicating that a formal and effective design and management process were in place. Given the expectation in FP6 and FP7 European Union programmes for formal progress reports, this can be expected.

Other networks had measurement systems in place that supported the main goals of the network.

Table D-2: Questionnaire Responses Summary: Current Life Cycle Phase

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
2.1	In what year was the knowledge network established?	1992	1995	2005	2007	1950	2004
2.1.1	Calculated age (years)	17	14	4	2	59	5
2.2	The network is currently in the following life cycle phase:	4- Operation and Refinement	4- Operation and Refinement	2- Implementation	1- Design	4- Operation and Refinement	5- Phase-out
2.2.1	If Phase = "Operation and Refinement": Is there a measurement system in place?	No	Yes	Yes	No	Yes	Yes
2.2.2	Briefly describe the measurement system		Outputs: Publications Students Research Projects Research Proposals (eg FP7) Number of collaboration partners and projects	Part of the network's design - measure the positive impact.		Representation of Countries, Citation Index Ranking	9 Measures and 20 KPI's - refer doc sent by Serge
2.3	How many active organizations participate in this network?	64	30	36	1	140	86
2.4	How many individuals are **registered** in this network?	54	150	81	100	420	218
2.5	How many individuals are **active** in this network?	54	50	81	70	200	60

Size of the Networks assessed:

All networks had a significant number of participants – on average:

- 60 participating organizations

- 170 **registered** individuals

- 86 **active** participants

This related to approximately 50% of all registered participants active within their networks, with the smaller more personal or single organization networks having a higher percentage of active participants. As can be expected, the larger more prestigious networks such as CIRP and VRL-KCiP will have a larger proportion of participants who are registered, but not active.

D.2.3 Benefits Observed

As shown in Figure 7-7: Generic Knowledge Network Framework, the raison d'être (reason for existence) for any Knowledge Network is to realize benefits for its participants.

The literature [1] attributes a number of generic benefits to knowledge networks, and the Case Study Knowledge Networks has each been assessed against the list of benefits shown below, so as to determine whether the list of benefits has been realized in these networks.

The list of benefits:
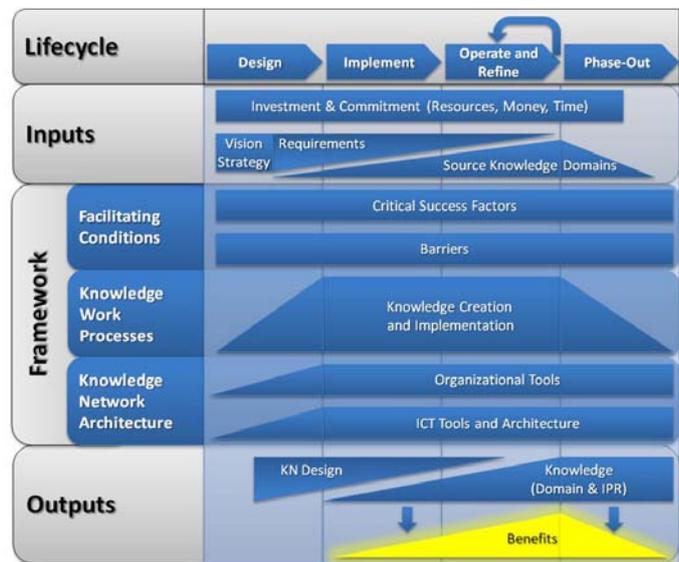
3.1.2 **Increased Scale and Scope of Activities:** the outcomes of collaboration may be applicable to all partners' market, and thus may expand individual enterprise's customer base. If an enterprise is part of a customary network, its performance capacity can be considerably extended through synergy between and among the enterprise's different technological competencies;

3.1.3 **Shared Costs and Risks:** the costs for major innovations, such as a new generation of semiconductors or aircrafts, have risen rapidly and are now beyond the means of any single enterprise. Collaboration can share the high costs and therefore risks of innovation;

3.1.4 **Improved Ability to Deal with Complexity**: many key technological developments are complex and draw on a wide range of scientific and commercial knowledge. This reinforces the need for co-operation from participants in different fields of expertise and a closer strategic and technological integration between enterprises is a means of dealing with the complexity of multiple sources and forms of technology;

3.1.5 **Enhanced Learning Effects:** with continuous and rapid market and technology change there is pressure on enterprises to improve their learning capacities. Collaboration and networks can provide possibilities not only of learning about new technologies, but

learning about methods of creating future technologies and of the ways those technologies might affect the existing business. It can teach companies new ways of doing things, not only technologically, but also organizationally;

3.1.6   **Positive Welfare Effect:** internalizing positive externalities through R&D collaboration results in increased R&D efficiency and an increase of overall R&D expenditure. A set of benefits underlying the collaboration is one that considers flexibility and efficiencies;

3.1.7   **Flexibility:** networks offer flexibility, not in contrast to markets but to hierarchies. Vertically integrated enterprises establish overheads and production capacities, and in doing so forsake the flexibility of immediate resource reallocation that networks provide. Hence, the interaction between large and small enterprises might be facilitated in such a way that the resource advantages of the former are linked with the behavioural or creative advantage of the latter;

3.1.8   **Efficiency:** The efficiency enhancing effect of networks is related to the specific nature of technological knowledge. Much of the knowledge is tacit—that is difficult to codify in the form of blueprints—and enterprise specific. It is, therefore, difficult to transfer easily and quickly through market mechanisms. Collaboration provides a mechanism to transfer whereby this kind of transfer is based on trust between the partners;

3.1.9   **Speed:** Speed may be needed to take advantage of opportunities that might not exist for long, and might require a fast response. An existing network can put together a package of resources and capacities to meet such challenges in a customized response which, in its flexibility and scope, lies beyond the capacity of an un-networked integrated enterprise. Moreover, rapid product development depends on the reliance on outside suppliers.

The Questionnaire allowed respondents to rate the presence of each generic benefit, and this was translated into a percentage for comparison purposes. Each respondent also had an opportunity to list specific benefits observed in the network. The results are summarized in Table D-3.

Table D-3: Questionnaire Responses Summary: Benefits Observed

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
3.1.1	What are the main Benefits Realized:	New Ideas New Approaches Publications Common Projects New Contacts	Extending Research scope, sixe and activities. Improving the quality of the outputs. Expediting implementation	Refer "Logframe"	Use knowledge more effectively, Continued involvement, Silos broken Development Dialogue	Education of students, young researchers and researchers. Production of Research outputs	Reseach and Validation Network activities - New contacts
3.1.2	Increased Activities	100%	100%	100%	50%	100%	100%
3.1.3	Shared Cost and Risk	0%	100%	100%	100%	25%	50%
3.1.4	Ability to Deal with Complexity	100%	100%	100%	50%	100%	50%
3.1.5	Enhanced Learning	100%	100%	100%	50%	100%	100%
3.1.6	Positive Welfare	100%	100%	100%	50%	100%	75%
3.1.7	Flexibility	0%	50%	100%	100%	75%	25%

| Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
3.1.8	Efficiency	50%	100%	100%	50%	100%	100%
3.1.9	Speed	100%	100%	100%	0%	100%	100%

As can be expected, in established knowledge networks, most respondents reported:

- Increased Activities.

- Increased Ability to deal with complexity.

- Enhanced Learning.

- Speed.

Smaller new networks struggled to achieve the same benefits, and reported a variety of other benefits.

Overall, as illustrated in Figure D-6, Knowledge Networks reported benefits (in the sequence of the most to the least realized benefit):

1. Increased Activities

2. Enhanced Learning

3. Positive Welfare

4. Ability to deal with complexity

5. Efficiency

6. Speed

7. Shared Cost and Risk, and

8. Flexibility
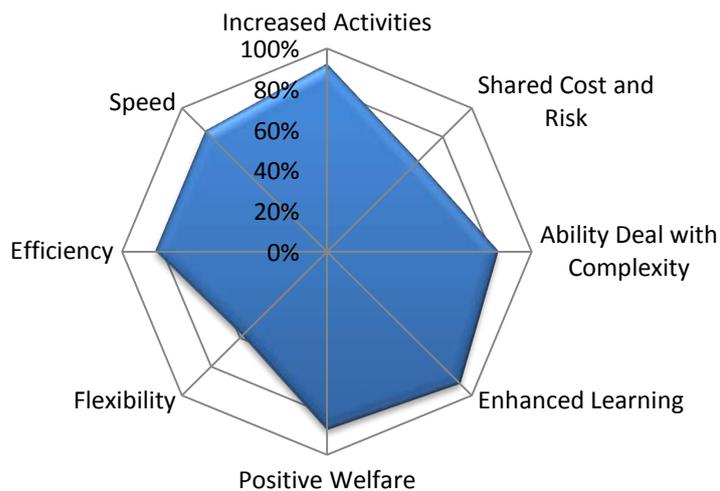
**Figure D-6: Relative Presence of Benefits Observed**

It is thus satisfying that most networks observed these benefits, but it seems that a lack of flexibility and lack of speed are problem areas in some of the evaluated networks.

D.2.4 Commitment and Upfront Investment

Successful Knowledge Networks require commitment, time and funding to optimize the benefits that can be realized from such a network. The Knowledge Network framework (see Figure 7-7) therefore recognizes the Commitment and Upfront Investment as an important input in making a Knowledge Network operational.

The questionnaire assesses the investment and commitment for each case study, by focusing on the following aspects:

- Presence of an upfront financial investment

- Current financial support

- Time expectation and availability of the Network Initiator, Network Facilitator, and Network Participants.
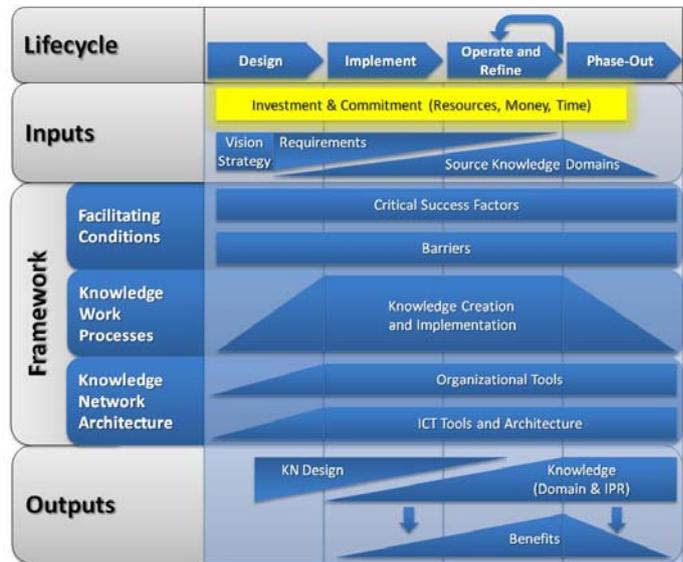
The results are summarized in Table D-4.

Table D-4: Questionnaire Responses Summary: Commitment and Upfront Investment

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
4.1	Was there an upfront financial investment to establish the network?	Yes	Yes	Yes	Yes	No	Yes
4.2	Are participating enterprises currently supporting network activities financially?	Yes	Yes	Yes	No	Yes	NA
4.3	Was time made available for the network initiator to establish the network?	Yes	Yes	Yes	Yes	No	Partly
4.3.1	How much time was made available? (% of time)	20%	20%	100%	100%	20%	50%
4.4	Is time made available for the Network facilitator to work on network activities?	No	Yes	Yes	Yes	Yes	Yes
4.4.1	How much time per week is spent by the network champion / facilitator? (% of time)	10%	20%	100%	100%	20%	100%
4.5	Is there an agreement with all participating enterprises on how much time participants may spend on network activities? 4- **Expected:** Participants are expected to spend time on activities. 3- **Allowed:** Participants are allowed to spend time on activities. 2- **No Agreement**: There is no formal agreement, 1- **Non Allowed**: Participants may not spend time on network activities in working hours.	2. No Agreement	3. Allowed	4. Expected	4. Expected	2. No Agreement	4. Expected
4.5.1	How many hours per week does a typical participant spend on network activities? (% of time)	20%	40%	50%	0%	20%	45%

As indicated by the results, depending on the type of Knowledge Network, as well as the source of funding, the upfront investment and commitment can be significant:

- VRL-KCiP received substantial EU FP6 funding, and participating organizations and resources received funding to make participation possible. Participants therefore spent a high proportion of their time on network activities.

- CIRP is an academic professional association, and is partly funded through membership fees (individuals and organizations). Participation therefore typically follows the traditional academic research allocation of 20% of time availability for network activities. Due to the long history of CIRP (nearly 60 years), the financial investment happened over a very long period, during which CIRP migrated from a "circle of friends" to a high profile academic research association.

- IDIP and DBSA are both knowledge networks functioning in an operational environment, and funding is therefore part of an operational budget, and key resources are required to be involved as part of their expected roles and responsibilities within their respected organizations.

D.2.5 Requirements

If a Knowledge Network has a formal documented list of requirements that is derived from the Vision and Mission of the network, this serves as an input for the design of the Knowledge Network.

As discussed in Chapters 3 and 4, Knowledge Network requirements consist of Purpose (Chapter 3) and Functions (Chapter 4).

The questionnaire assessed a subset of the purposes and functional requirements discussed in Chapters 3 & 4:

- Knowledge Network Purposes: The focus in the questionnaire is based on the definition of Von Krogh, et al. [99] and not on the more complete categorization of Anklam [13]. Since the focus of this document is on Innovation, the Von Krogh categorization was found to be more appropriate for the questionnaire:

  o To increase Innovation

  o To optimize Risk

  o To improve Efficiency

- High Level Functional Requirements
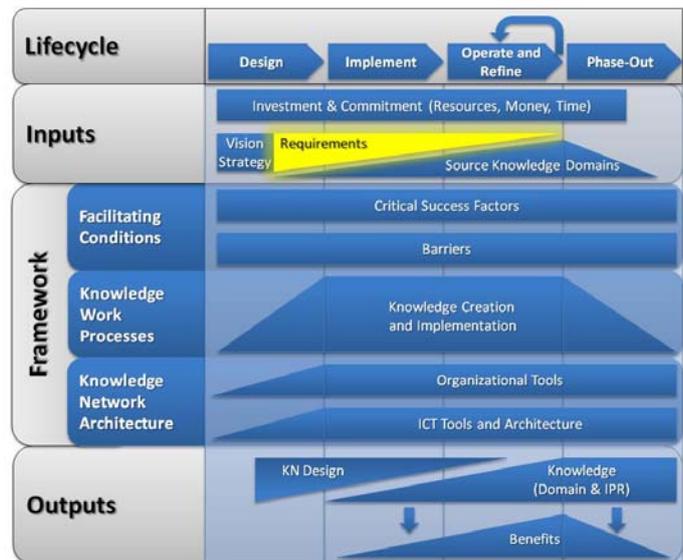
In addition, the questionnaire also assessed the formality of the Requirement Statement.

The questionnaire responses are summarized in Table D-5.

Table D-5: Questionnaire Responses Summary: Requirements

| Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
5.1	Was there a formal requirement statement for the network?	No	No	Yes	Yes	No	Yes
5.2	Were the following requirements recognized, when the network was established?						
5.2.1	Connect people and/or enterprises.	Yes	Yes	Yes	Yes	Yes	Yes
5.2.2	Protect Intellectual Property.	No	Yes	No	No	No	Yes
5.2.3	Create and Share Knowledge	Yes	Yes	Yes	Yes	Yes	Yes
5.2.4	Recognition that special processes and activities are required to share Tacit knowledge.	Partly	Yes	Yes	Yes	Partly	Yes
5.2.5	Increase Innovation	Yes	Yes	No	No	Yes	Yes
5.2.6	Risk Optimization	No	No	Yes	Yes	No	Partly
5.2.7	Improve Efficiency	Yes	Yes	Yes	Yes	Yes	Yes

Based on the feedback, the average requirement profiles for all the knowledge network case studies were plotted. As can be expected, depending on the overall vision and strategy of each case study network, the profile can be quite variable.

Figure D-7 compares the Requirement Profile of the VRL-KCiP network with the average profile of all networks. The common requirements are Connect, Share and Improve Efficiency, while VRL-KCiP has a much more significant emphasis on Innovation, IP Protection, and Knowledge Processes.
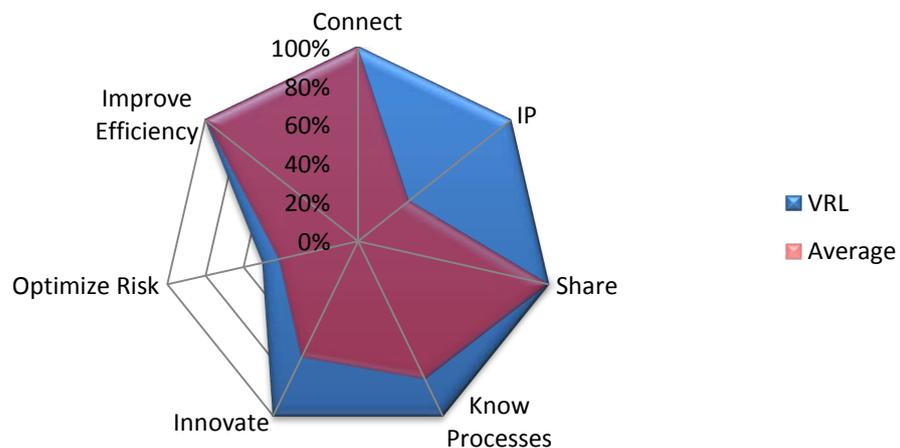
Figure D-7: Relative Presence of Requirements Specified: All Networks vs VRL

Similarly, Figure D-8 compares the Requirement Profile of IDIP with the average profile of all networks, and here, due to the nature of IDIP, there is no primary requirement to Innovate, and to protect IP. (Since this is a Government Initiative that is promoting transparency, one may argue that all the information is in the public domain.)
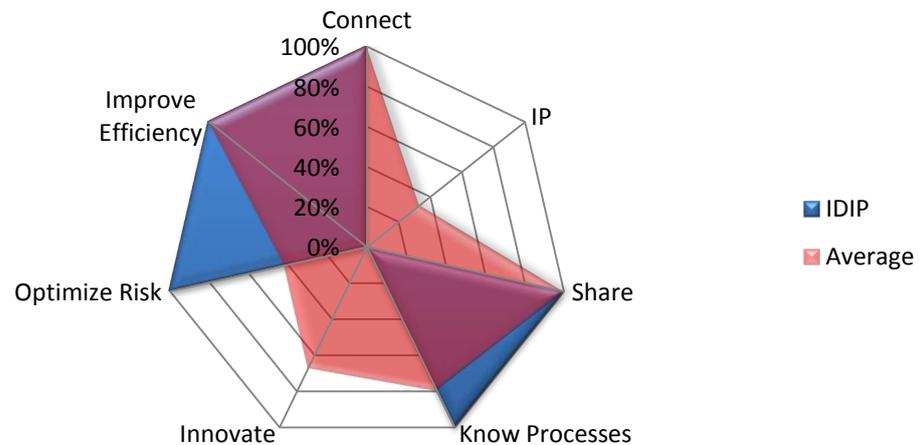
Figure D-8: Relative Presence of Requirements Specified: All Networks vs IDIP

If the feedback regarding the formality of the Requirement Statement is considered (refer Table D-5), it is again what one can expect, given the history of each network:

- The Jochem personal network is informal and has no formal requirements statement.

- The EE Group evolved over several years, and also has no formal requirements statement.

- IDIP is a formal program, managed within the formal guidelines of governmental projects, and have therefore a very formal requirements statement.

- CIRP also evolved over a very long period (more than 50 years), and the requirements for the network activities therefore have no formal status. It is, however, documented on a high level in the vision and strategy document.

- VRL-KCiP, due to the formal EU FP6 proposal process, has a very clear requirements statement contained within the proposal documents.
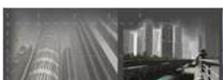
D.2.6 Design

If a Knowledge Network has a formally documented and approved design, that is a derivative of the Vision, Strategy and Requirements, the KN is better structured and positioned to provide value to the stakeholders and serve the originally intended purposes of the network.

The questionnaire therefore assesses the following aspects:

- Whether a formal design document for the Knowledge Network exists.

- Whether the design was formally approved by all the Knowledge Network Stakeholders.

- Whether the design has been updated over time, to fit the changing environment the Knowledge Network may be exposed to.
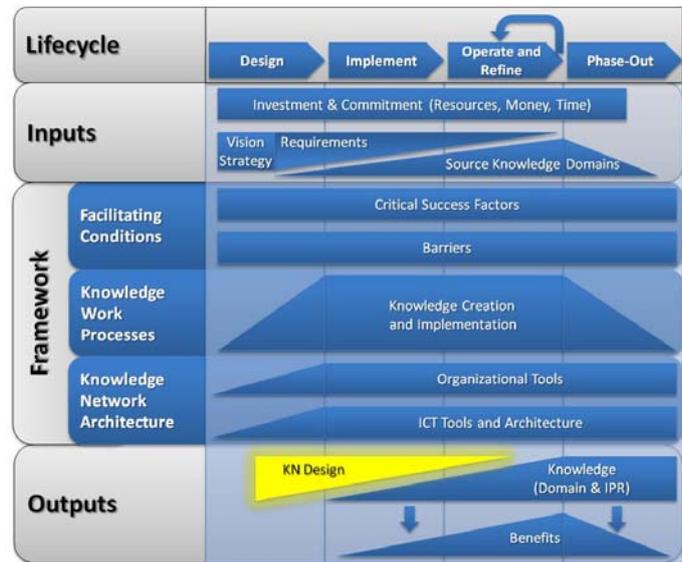
Table D-6: Questionnaire Responses Summary: Design

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
6.1	Was there a formal design document for the network?	No	No	Yes	No	No	Yes
6.2	Was the design approved by the stakeholders before the network was commissioned?	No	No	Yes	No	No	Partly
6.3	Has the design been updated?	Partly	No	Yes	No	Yes	No

The questionnaire responses are summarized in Table D-6. As can be expected, results are very similar to those addressing the existence of a formal Requirements Statement. The relative presence of the design aspects is shown in Figure D-9.
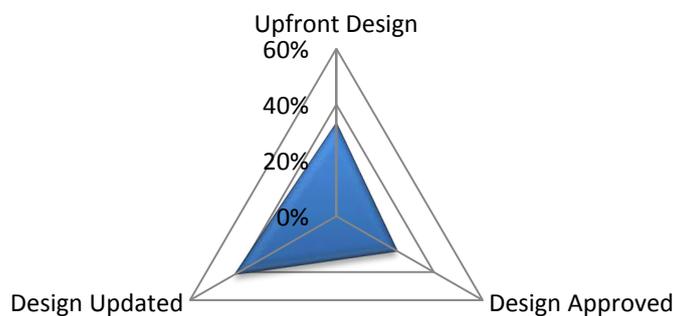
Figure D-9: Relative Presence of Design Aspects

D.2.7 Presence of Key Success Factors

A successful Knowledge Network methodology should encourage and ensure the presence of identified Key Success Factors.

The Forfás Innovation Network Report [1] lists a number of key success factors in the formation of networks. The same Key Success Factors have been used to verify the Knowledge Network methodology in Chapter 7.

The following Key Success Factors were assessed in the questionnaire:
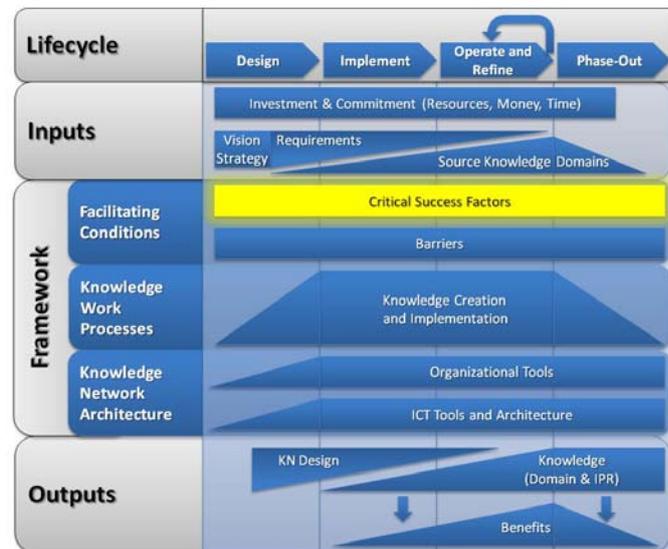
7.2.1 **Clear Need:** An important condition for the development of a network is that the members perceive that there is a clear need to belong i.e. the network can achieve something that the individual members cannot achieve on their own.

7.2.2 **Objectives:** Related to the requirement that a network should have clear needs, there is also the requirement that it should have objectives that primarily reflect the needs of the member organizations.

7.2.3 **Leadership and Vision:** Networks that have a leader who is able to articulate clear and concise goals are more likely to be successful then those networks whose members are unclear as to the network's future direction. The leader should not only be able to communicate the network's long term goals, but must also be able to translate those goals into a realistic programme of action.

7.2.4 **Early Successes:** The research has indicated the importance of achieving early successes in order to get member organizations to continue their involvement in the network. It is vital, therefore, that networks structure their objectives and work programme to ensure that members can see a return for their investment in the short term.

7.2.5 **Trust:** On paper, a grouping of companies in a sector might make the ideal candidates for a network. However, the successful development of networks has been found to be very dependent on the level of trust between and among member organizations. Since the network involves members who normally act on their own, the implementation of network activities requires a certain level of trust by the members. The gaining of trust is particularly important in those networks whose membership includes companies that compete against each other.

7.2.6 **Ownership**: If the network is to succeed, it will be necessary for them to take ownership of the development process and drive the network forward. If the companies do not have ownership of the network they will not be committed to it. They will perceive that it will have an agenda that may not approximate to their own

7.2.7 **Time:** The formation of a durable network can take time. A considerable period can elapse before the members have developed trust and confidence in the network to undertake joint activities. Member organizations need to interact socially before they can commit themselves to working with other members.

7.2.8 **Critical Mass:** The lack of critical mass can delay the outputs from a network.

7.2.9 **Key Player:** Related to the issue of critical mass, the presence of a major player with the vision and resources can be influential in driving the network forward.

7.2.10 **Communication/Branding:** The development of a clear identity for a network can be critical for its longevity.

7.2.11 **Facilitation**: To be successful, networks need on-going facilitation. The inputs of a network manager in terms of supporting the network, brokering the needs of individual members, coordinating what is a complex process and implementing the network's work programme can have a significant bearing on its long term viability.

7.2.12 **Social Factors:** An aspect often over-looked in the development of networks, is the importance of social interaction.

7.2.13 **Top-Down Incentives or Pump Priming:** The provision of State funding, where submissions involving two or more applicants can obtain higher scoring points, has been found to be very helpful in the development of networks.

7.2.14 **Process:** While the concept of networks is easy to grasp, operationally a network is both complex and challenging to operate. The key success factor is the process or the "how" factor i.e. how companies are attracted to participate in a network, how their commitment is gained, how the process of developing the network is managed, how it is structured, how decisions are made, how communication is handled or how action programmes are delivered.

The questionnaire allowed respondents to rate the presence of each Key Success Factor on a scale. Respondents were also given the opportunity to list their own additional Success Factors.

The results of the questionnaire responses are summarized in Table D-7.

Table D-7: Questionnaire Responses Summary: Presence of Key Success Factors

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
7.1	**What were the main Key Success Factors:**	1 or 2 person drivers Regular events / activities Attractiveness of topics / domains	Existing research platform, Government, Academic and industry agreement (THRIP) Academic freedom to explore. Industry enthusiasm	Logframe. Measurable - documented		Known as a professional organization Uniqueness Closed in - for research only Attractive for people to participate	EU Money Level of Cooperation Engage people To create something
7.2	**Were the following Key Success Factors present?**						
7.2.1	**Clear Need**	100%	50%	100%	100%	100%	50%

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
7.2.2	Objectives	100%	100%	100%	50%	100%	100%
7.2.3	Leadership Vision	100%	100%	100%	100%	100%	75%
7.2.4	Early Success	0%	100%	100%	100%	75%	100%
7.2.5	Trust	50%	50%	100%	100%	100%	75%
7.2.6	Ownership	100%	100%	100%	50%	0%	25%
7.2.7	Time	100%	100%	100%	100%	100%	100%
7.2.8	Critical Mass	100%	100%	100%	50%	75%	100%
7.2.9	Key Player	100%	100%	100%	100%	100%	100%
7.2.10	Communication Branding	50%	50%	100%	100%	100%	100%
7.2.11	Facilitation	100%	50%	100%	100%	100%	100%
7.2.12	Social Factors	100%	100%	100%	50%	100%	100%
7.2.13	Incentives	0%	50%	100%	0%	0%	50%
7.2.14	Process	100%	100%	100%	100%	100%	100%

By averaging the responses, a Key Success Factor profile can be determined for these networks, as illustrated in Figure D-10.
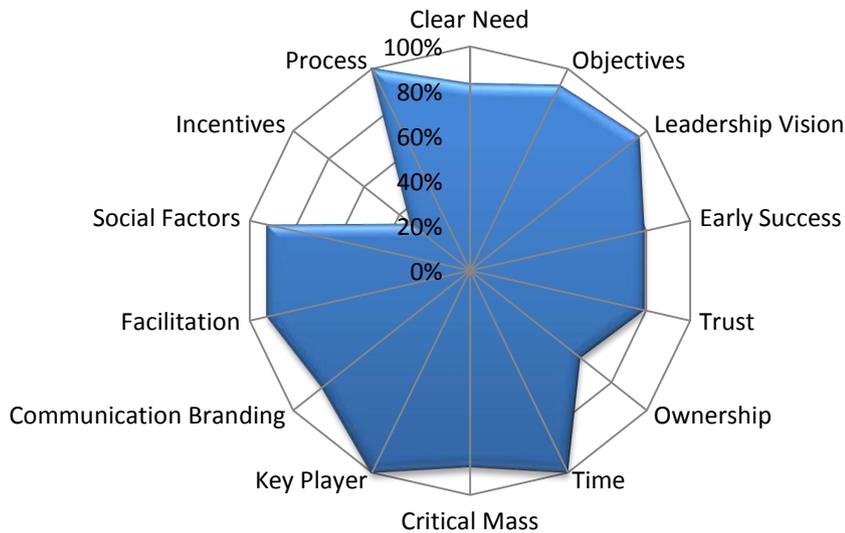

Figure D-10: Relative Presence of Key Success Factors

D.2.8 Barriers that Inhibited Success

The Forfás Innovation Network Report [1] lists a number of barriers that can inhibit or stifle the successful deployment of a knowledge network.

A Knowledge Network methodology must attempt to avoid and discourage barriers that may inhibit the development of the Knowledge Network. Such barriers were therefore also used to verify the Knowledge Network methodology in Chapter 7.

The following barriers were assessed in the questionnaire:
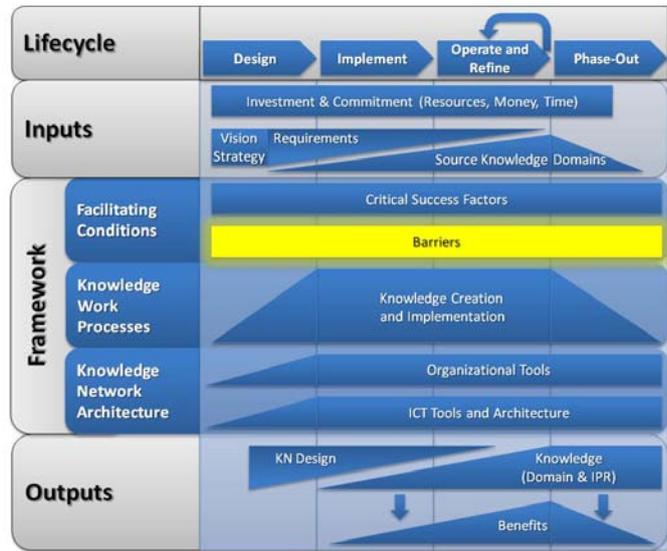
8.2.1 **Unawareness of Network Benefits:** There is a general lack of awareness as to the benefits of networks (as distinct from networking) among the business community;

8.2.2 **Reluctance to commit time:** There is a reluctance to commit time and resources to a process that is not well understood, or the results of which are not clear;

8.2.3 **"Networking Perception":** Networks are too closely aligned with 'networking' in the mind of business managers and seen as a quasi-social activity rather than an important business function;

8.2.4 **Unwilling to share information:** There is a reluctance to share information and knowledge with other enterprises, especially competitors;

8.2.5 **Unable to identify Network Opportunities:** Enterprises are not always well placed to identify the opportunities for network relationships with other companies, since their knowledge and information base may be limited to their own contacts;

8.2.6 **Lock-in:** Membership of a network may expose companies to the danger of "lock-in" where excessive focus is placed on the affairs of the network to the detriment of events in the outside environment;

8.2.7 **Lack of Skills:** Even where managers foresee a benefit in establishing a network relationship they may not have the skills or resources to facilitate or co-ordinate the actual implementation of the network. This has been referred to (Dixit and Nalebuff) as the 'collective action problem', where a group of individuals or enterprises may frequently fail to achieve co-operation, even where it would be beneficial to every individual in the group.

The questionnaire allowed respondents to rate the presence of each barrier on a scale. As before, respondents were also given the opportunity to list their own (additional) barriers that hampered the development and deployment of their Knowledge Networks.

Table D-8 contains a summary of the questionnaire responses. By averaging the responses, a barrier profile can be determined for these networks, as illustrated in Figure D-11.

From the feedback received, it is clear that the most significant barriers present are:

- **Inability to identify Network Opportunities:** Networks were not always well positioned to identify the best possible opportunities for network relationships with internal and external participants.

- **Lack of Skills:** Even when network participants could foresee a benefit in establishing a relationship, the skills were absent to exploit these relationships successfully.

Table D-8: Questionnaire Responses Summary: Presence of Barriers

Ref	Questions	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
8.1	What were the main Barriers?	Lack of time Availability of participants	Lack of user maturity in use of ICT Lack of "big research picture" at some participants			Dis-satisfaction amonst members Too rigid Difficult to generate Enthusiasm & Energy	Lack of time High profile people often have lack of time Lack of Trust and Transparency No Common Goal
8.2	Were the following barriers present?						
8.2.1	Unawareness of network benefits	50%	100%	0%	0%	50%	0%
8.2.2	Reluctance to commit time	100%	0%	0%	50%	50%	50%
8.2.3	"Networking" perception	0%	50%	0%	0%	50%	0%
8.2.4	Unwilling to share info	100%	0%	0%	0%	0%	50%
8.2.5	Unable to identify network opportunity	100%	0%	100%	50%	75%	100%
8.2.6	Lock-in	0%	0%	0%	0%	50%	75%
8.2.7	Lack of skills	100%	50%	100%	100%	75%	0%
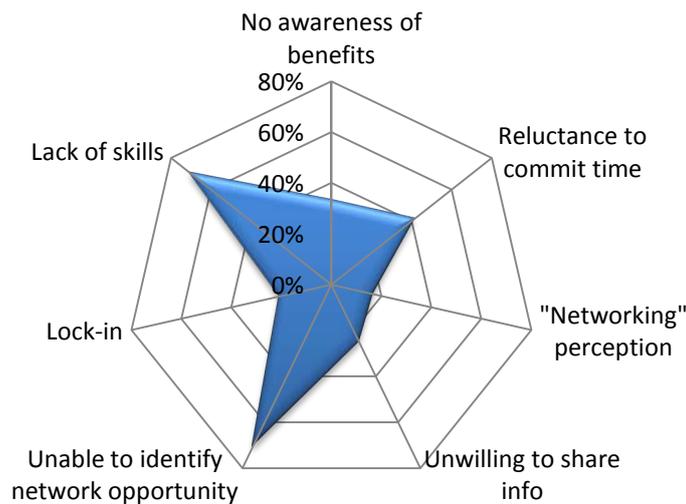
Figure D-11: Relative Presence of Barriers

D.2.9 Presence of Knowledge Work Processes

Knowledge Work Processes are the social interaction and communication processes on an individual and group level, which can advance knowledge evolution to an organizational and inter-organizational level.

As discussed in Chapter 4, these Knowledge Work Processes are embodied in the four Network Reference Types in a Knowledge Network:

- **Experiencing Network**: The embodiment of the Socialization Knowledge Work Process in a network with the purpose of exchanging Tacit Knowledge between and among individuals in order to convey personal knowledge and experience.

- **Materializing Network**: The embodiment of the Externalization Knowledge Work Process with the purpose of exchanging and converting Tacit Knowledge into Explicit Knowledge.

- **Resystemizing Network**: The embodiment of the Combination Knowledge Work Process, with the purpose of transforming explicit knowledge into more complex and more systematized explicit knowledge through Combination or Systemization.

- **Learning Network**: The embodiment of the Internalization Knowledge Work Process with the purpose of converting organization-wide, explicit knowledge into implicit knowledge of an individual through internalization.

(Refer to paragraph 2.4 for a definition of Socialization, Externalization, Combination and Internalization.)

This part of the questionnaire thus tested for the presence of each of these Knowledge Work Processes in each Case Study Network. Table D-9 on page D-41 contains a summary of the questionnaire responses.
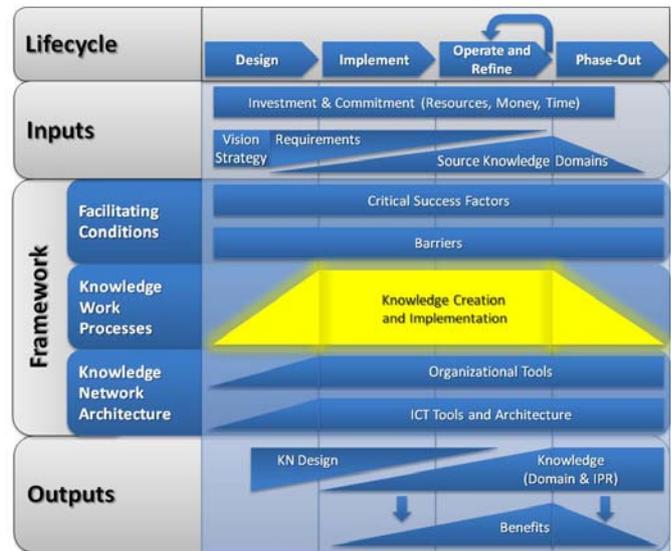
## Table D-9: Questionnaire Responses Summary: Presence of Knowledge Work Processes

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
9.1	**Experiencing Network**: The exchange of Tacit Knowledge between and among individuals in order to convey personal knowledge and experience.						
9.1.1	Individuals are **encouraged** to participate in joint activities (Nonaka: socialization) with the purpose of sharing tacit knowledge. The term "socialization" is used to emphasize the importance of joint activities in the process of converting new tacit knowledge through shared experiences. Since tacit knowledge is context specific and difficult to formalize, transferring tacit knowledge requires sharing the same experience through joint activities.	100%	100%	100%	100%	100%	100%
9.1.2	Joint Socialization activities are **formally organized** in the network. (as opposed to encouraged)	0%	50%	100%	100%	100%	100%
9.1.3	What organizational mechanisms or tools are used for exchanging Tacit Knowledge?	No tools - only discussions and e-mails		Quarterly "pitmeeting" on provincial level. Focus Group discussions	Dialogue Sessions	Conferences But must be interested in the common vision and strategy	Workshops, Training sessions, Conferences, Knowledge Maps - see website Wine, Party, Formal Dinners, conferences etc
9.1.4	The network members are aware of the importance of sharing tacit knowledge, and the complexities involved to successfully transfer tacit knowledge.	100%	100%	100%	75%	100%	100%

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
9.2	**Materializing Network**: Converting Tacit Knowledge into Explicit Knowledge. This means the conversion of implicit into explicit knowledge, and the exchange of knowledge between individuals and a group.						
9.2.1	Tacit knowledge is externalized by expressing and translating it into forms such as metaphors, concepts, hypotheses, diagrams, models, or prototypes so that it can be understood by others in the network.	100%	100%	100%	100%	100%	100%
9.2.2	There is a formal plan and direction to materialize the tacit knowledge in the network.	50%	100%	100%	50%	100%	100%
9.2.3	What organizational mechanisms or tools are used for externalizing Tacit Knowledge?	In Interop VRL - knowledge maps, tutorials and joint papers		Toolkits and Models	Actions with volunteers	CIRP journals CIRP conferences	Training session, Web tools, Software, Navigator WPs on dissemination with all partners
9.2.4	The network members are aware of the importance of externalizing tacit knowledge.	100%	100%	100%	75%	75%	100%
9.3	**Resystemizing Network**: The transformation of explicit knowledge into more complex and more systematized explicit knowledge through Combination or Systemization.						
9.3.1	Explicit knowledge converges into more complex and systematic explicit knowledge in the network.	100%	100%	100%	0%	100%	100%
9.3.2	Knowledge is exchanged and combined through such media as documents, meetings, telephone conversations, or computerized communication networks.	100%	100%	100%	100%	100%	100%
9.3.3	What organizational mechanisms or tools are used for systematizing Tacit Knowledge? (eg meetings, telephone conversations, documents, computerized communication networks)				Writing Guidelines	Working Groups Organization of STCs in Tracks	Documents, Training, s/w tools. See web. Software, KM tools, Sharing Tools, Specialized s/w

Ref	Question	Jochem	EE Grp	IDIP	DBSA	CIRP	VRL-KCiP
9.3.4	The network members are aware of the importance of systematizing explicit knowledge.	100%	100%	100%	100%	100%	100%
9.4	**Learning Network**: the conversion of organization-wide, explicit knowledge into the implicit knowledge of the individual through internalization.						
9.4.1	Members are given the opportunity and encouraged to recognize personally relevant knowledge within the network.	100%	100%	100%	100%	50%	100%
9.4.2	What mechanisms or tools are used for internalizing Tacit Knowledge? (eg workshops, meetings, hands-on experience, animations, etc)			Workshops, Focus Groups CoP for Change Case Studies	Workshops, Meetings, Hands-on	Create opportunities for internalizing	Training workshops. GA. Demonstrations Workshops, Books, Training, Websites, Communities, Joint Educational Programmes
9.4.3	Network members realize that when knowledge is internalized into individuals' tacit knowledge bases in the form of shared mental models or technical knowhow, it becomes valuable assets.	100%	100%	100%	100%	75%	88%

By averaging the responses from Table D-9, it was clear that all the Networks supported all Knowledge Network Reference Types and Knowledge Processes, and that participants were aware of the importance of all four Knowledge Work Processes.
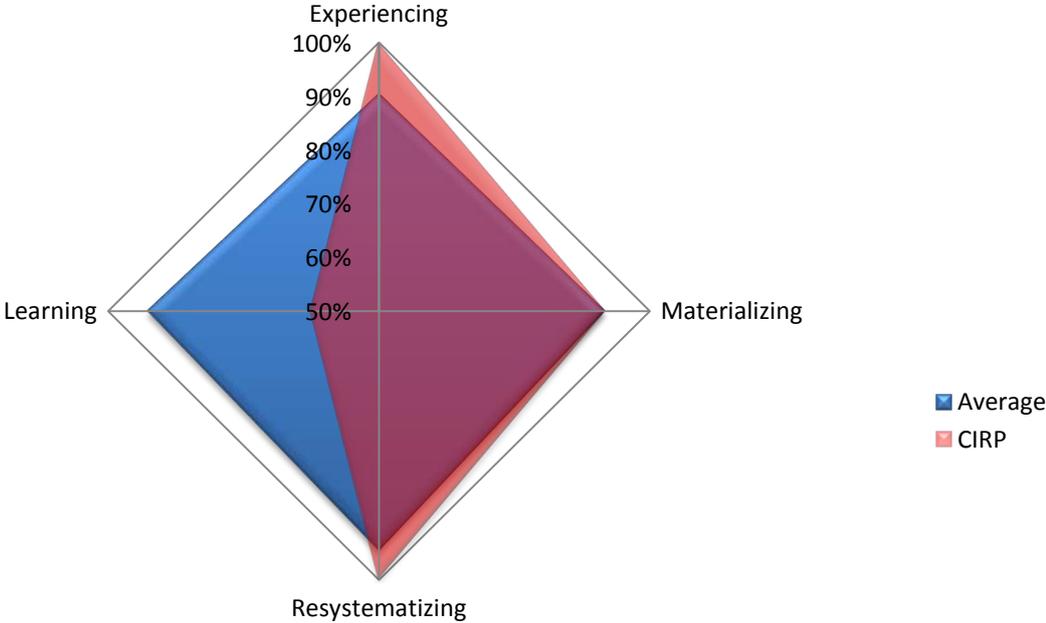
Figure D-12: Relative Presence of the Four Main Knowledge Work Processes

In the interviews with the CIRP network respondents, a desire was expressed that the network should be more involved transferring the knowledge gained in the network back to the student community at the respective academic institutions. This is consistent with the outcome of the questionnaire, in that the network scored itself relatively low in the Learning Knowledge Work Process – see Figure D-12.

D.2.10 Domains of Source Knowledge

The questionnaire also gathered the main sources from where the original knowledge was sourced, and the mechanisms used to procure and protect the IPR of the sourced knowledge, if required.

Not all participants completed this part of the questionnaire. The responses are summarized in Table D-10 below.
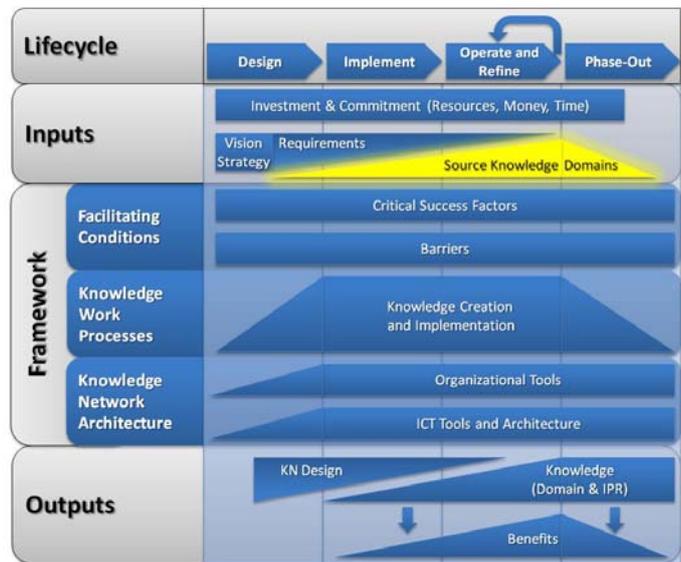
**Table D-10: Questionnaire Responses Summary: Source Knowledge Domains**

Ref	Question	Jochem	IDIP	VRL-KCiP
10.1	Knowledge is sourced from the following domains	Public Private User	Public Private User	Public Private User
10.2	Types of Public Knowledge Domains accessed as sources:	Internet Science and Technology Government Universities Libraries	Government International	Internet Science and Technology, Government, Databases Libraries Repositories Patent Offices
10.3	Types of Private Knowledge Domains accessed as sources:	Internal Participating Organizations Competitors Suppliers	Consultants	Internal, Participating Competitors Personal Experience Personnel
10.4	Types of User Knowledge Domains accessed as sources:	Users Clients Market	Market Government	Users Clients Market
10.5	How is Source Intellectual Property procured?	Per law, agreements, confidentiality references	Most are in Public Domain - Law on Public access	By description, defining IPR upfront. Mostly academic.
10.6	How is source Intellectual Property protected?	Yes – see above	See above	Contractual agreement between parties, Academic Process

D.2.11   Generated Knowledge

The questionnaire also gathered basic information about the knowledge that has been generated by the network:

- Whether the generated knowledge exists in the private, public or user domains.

- Whether the network is operating in a competitive or pre-competitive phase.

- Whether and how intellectual property of the generated knowledge is protected.

Not all participants completed this part of the questionnaire. The responses are summarized in Table D-11 below.
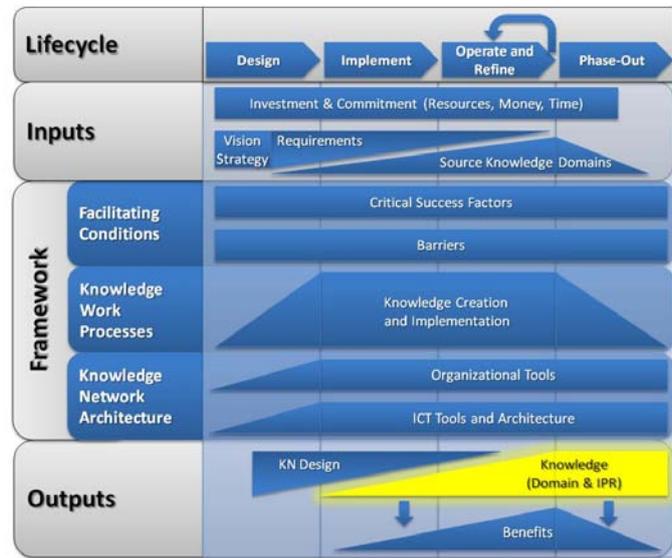
Table D-11: Questionnaire Responses Summary: Generated Knowledge

Ref	Question	Jochem	IDIP	VRL-KCiP
11.1	The knowledge created within the network are within the following domains:	Public Private User	Public Private User	Public Private User
11.2	If the network is currently operating in a Pre-competitive or Competitive mode:	Pre-competitive	Pre-competitive	Mostly Pre-competitive Some Competitive
11.3	How is created Intellectual Property protected?	Confidentiality agreements etc	Public Domain	Contracts, Patents, Academic Process

As can be expected, the VRL-KCiP network that was transformed into a commercial entity operated initially in a pre-competitive phase, but some work was considered a competitive advantage, that was protected.

Jochem's network is purely an academic network, and knowledge generated is considered to be mostly pre-competitive.

IDIP is a government network, and everything is therefore pre-competitive, and for transparency purposes, intended to be completely in the public domain.

D.2.12   Organizational Tools

As described in Chapter 4, each network needs an architecture consisting of Organizational and ICT tools, to enable the Knowledge Work Processes.

This section of the questionnaire focused on the presence and use of the organizational tools used in the network for the following activities:

- Knowledge discovery.

- Knowledge capturing and categorization.

- Communication and Knowledge sharing.

Table D-12 contains a summary of the questionnaire responses.
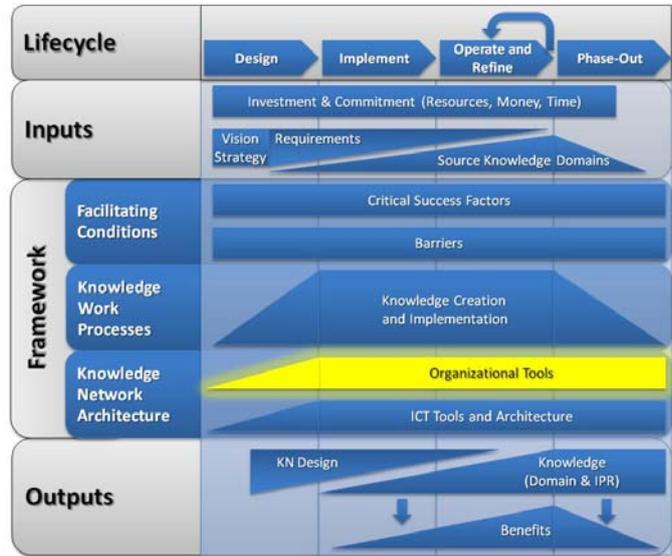
#### Table D-12: Questionnaire Responses Summary: Organizational Tools

Ref	Question	Jochem	EE Grp	IDIP	VRL-KCiP
12.1	**The Following Organizational Tools are used for Knowledge Discovery**				
12.1.1	Meetings	33%	67%	67%	100%
12.1.2	Conferences	33%	33%	0%	67%
12.1.3	Seminars and Workshops	33%	33%	33%	67%
12.1.4	Time allocated for research activities	100%	100%	33%	84%
12.2	**Knowledge Capturing and Categorization**				
12.2.1	Seminars and Workshops	0%	0%		84%
12.2.2	Time allocated for research activities	100%	100%		84%
12.3	**Communication and Knowledge Sharing**				
12.3.1	Meetings	33%	67%		100%
12.3.2	Conferences	33%	33%		67%
12.3.3	Seminars and Workshops	33%	0%		67%
12.3.4	One-to-one	100%	100%		84%

Interestingly, as illustrated by Figure D-13, Knowledge Discovery in the case study networks still mostly occurs in the personal time allocated for research activities, and most networks do not yet fully leverage the network potential for knowledge discovery.
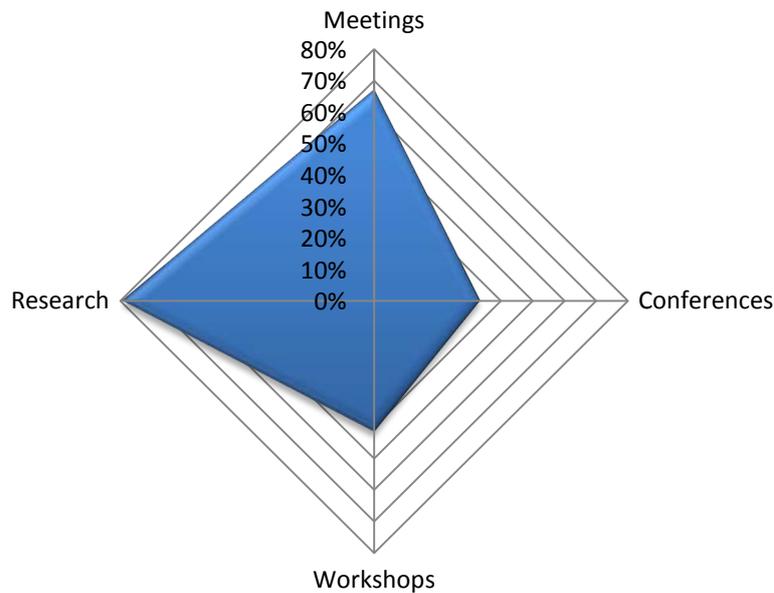
Figure D-13: Relative Use of Organizational Tools in Knowledge Discovery

Even knowledge sharing activities still occurred in these networks mostly on a one-to-one basis, as illustrated in Figure D-14. It thus seems as if the full networking potential of the networks have not been realized in the case study networks, and that the traditional mechanisms of knowledge sharing and discovery are still dominant in these networks.
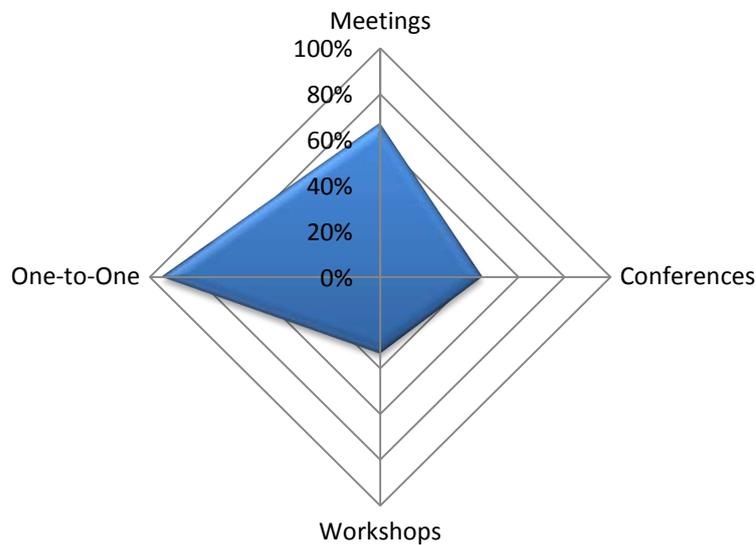
**Figure D-14: Relative Use of Organizational Tools in Knowledge Sharing**
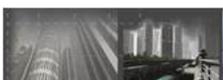
D.2.13   ICT Tools and Architecture

As described in Chapter 4, each network needs an architecture consisting of Organizational and ICT tools, to enable the Knowledge Work Processes.

This section of the questionnaire focused on the presence and use of ICT tools in the following activities:

- Knowledge discovery
- Knowledge Capturing and Categorization
- Communication and Knowledge sharing

Table D-13 contains a summary of the questionnaire responses.
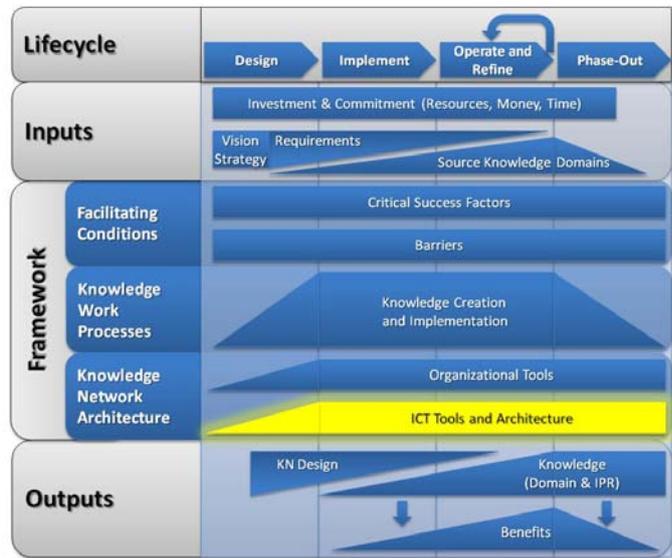
Table D-13: Questionnaire Responses Summary: ICT Tools and Architecture

Ref	Question	Jochem	EE Grp	IDIP	VRL-KCiP
13.1	**Knowledge Discovery Technologies**				
13.1.1	Open Internet Search Facilities (Google, Scholar.google etc)	100%	100%	100%	67%
13.1.2	Subscription Internet Search Facilities (eg Subscription based journal databases)	67%	67%	0%	100%
13.1.3	Local / Intranet Search Facilities (eg Wiki, Content Management system, Knowledge Management system, Document Management System)	33%	67%	0%	67%
13.1.4	Text Mining Utilities	0%	33%	0%	67%
13.1.5	Combined collaborative technologies eg Eden™	0%	33%	0%	50%
13.2	**Knowledge Capturing and Categorization Facilities**				
13.2.1	Document Management	0%	67%	0%	50%
13.2.2	Knowledge Management	0%	67%	0%	33%
13.2.3	Content Management System	100%	33%	0%	17%
13.2.4	Wiki	0%	33%	0%	17%
13.2.5	Combined collaborative technologies eg Eden™	0%	100%	33%	50%
13.3	**Communication and Knowledge Sharing**				
13.3.1	E-mail	100%	100%	100%	100%
13.3.2	Instant Messaging	0%	0%	0%	34%
13.3.3	VOIP	33%	67%	0%	84%
13.3.4	PSTN	100%	100%	100%	67%
13.3.5	Tele-conferencing	33%	67%	67%	67%
13.3.6	Video-conferencing	33%	33%	0%	84%
13.3.7	Internal Forums	33%	0%	0%	0%
13.3.8	Open Internet Forum	0%	0%	0%	0%
13.3.9	Social Networks (eg Facebook)	33%	0%	0%	0%
13.3.10	Combined collaborative technologies eg Eden™	0%	67%	0%	50%

As can be seen from Figure D-15, Knowledge Discovery in the Case Study networks is dominantly influenced by Open Internet access, and the benefit that may be possible with other ICT technologies does not yet have a significant influence.
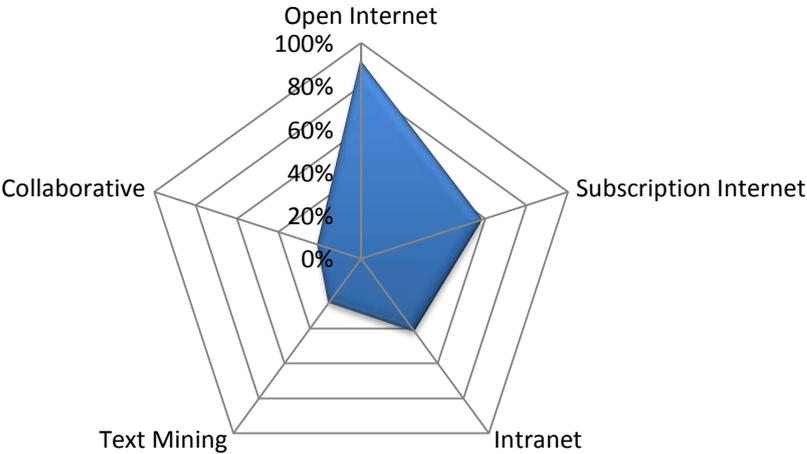

Figure D-15: Relative Use of ICT Tools in Knowledge Discovery

However, with Knowledge Capturing and Categorization, the more advanced use of ICT tools becomes apparent, such as the use of content management systems, and other collaborative technologies.
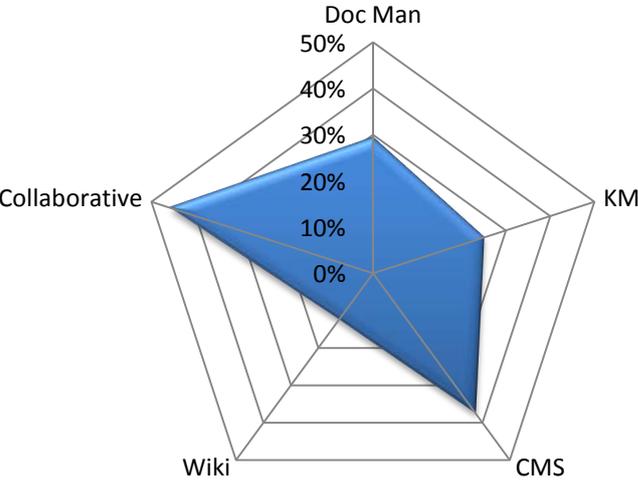

Figure D-16: Relative Use of ICT Tools in Knowledge Capturing and Categorization

When considering the use of ICT tools in the Knowledge Sharing activities, the most dominant knowledge sharing mechanism is e-mail, which also confirms the fact that one-to-one contact is the most dominant organizational tool used in Knowledge Sharing. The second most widely ICT

tool remained the normal voice land-line mechanisms (PSTN), most probably because it is a very convenient and quick way for communicating on a one-to-one basis.

However, in networks that were internationally dispersed such as VRL-KCiP, the use of newer technologies such as VOIP and Video-conferencing became more dominant. See Figure D-17.
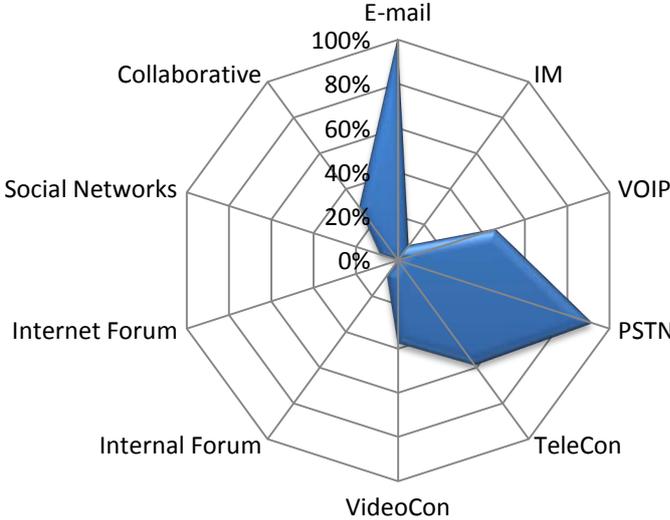

Figure D-17: Relative Use of ICT Tools in Knowledge Sharing

D.2.14 Verification against Methodology

At the time the questionnaire was compiled, an abbreviated version of the current methodology existed. However, the main components and aspects of the current methodology existed already at that time, and the latest methodology is mostly a restructured and expanded version of the version used in the questionnaire.

Respondents were asked if they performed certain activities in each of the four phases of the methodology, and based on their responses, it was possible to calculate a relative conformance to the methodology for each phase.
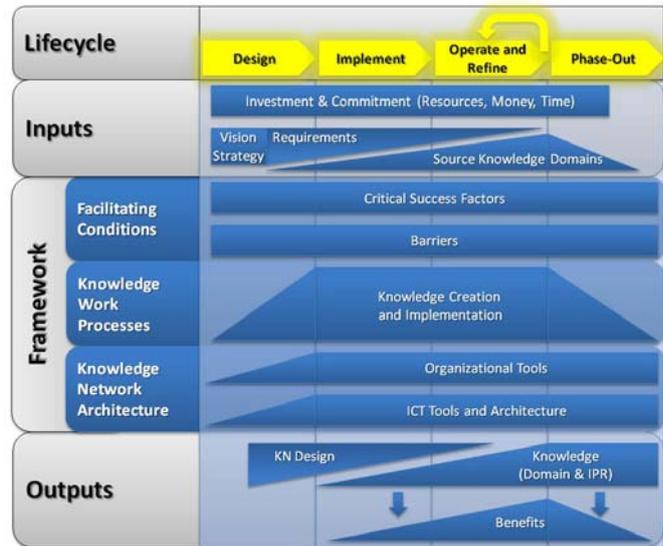
Table D-14: Questionnaire Responses Summary: Methodology per Phase

Ref	Phases	EE Grp	IDIP	DBSA	VRL-KCiP
14.1	Design	83%	94%	89%	88%
14.2	Implementation	53%	95%	68%	89%
14.3	Operate and Refine	25%	100%	83%	83%
14.4	Phase-out	N/A	N/A	N/A	100%

One needs to consider the history and characteristics of each network before conclusions are drawn:

- The EE Group is a relatively old network that evolved over several years. Initial design was therefore absent, but the network was refined over the years.

- IDIP is a new government funded network, and because of the political sensitivity of standardizing procedures across all provinces, a significant amount of time was spent designing and implementing the network.

- The DBSA network is still a fairly new network, and is still being implemented.

- VRL-KCiP was an FP6 funded network that went through the total life-cycle. Due to the procedures embedded in the FP6 program, as well as the organizations and personalities involved, this network scored well in all the phases of the methodology.