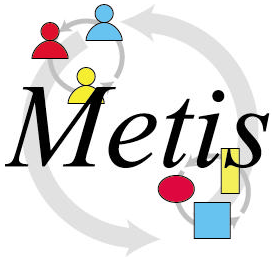

Effective Knowledge Management in Project-Based Organizations

Colophon

Date :	October 10 2003
Version :	1.0
Change :	1
Project reference :	Metis/D UvT
TI reference :	TI/RS2003/071
URL :	https://doc.telin.nl/dscgi/ds.py
Access permissions :	Public Report
Status :	Final
Editor :	M.T. Smits (m.t.smits@uvt.nl)
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Synopsis:

In Metis 2002 Smits and De Moor presented a model to analyze the effectiveness of knowledge management (KM) in organizations. In 2003 the model was applied in two knowledge intensive organizations. This report presents the first findings on how measurements of knowledge resources and knowledge development can increase the effectiveness of KM. The cases showed a variety of linkages between KM (in layers), knowledge resources, portals, and communities. We found that the answer on 'when is KM effective' depends on the level and objectives of KM, as distinguished in the Knowledge Development Framework. Measuring in the sense of 'determining quantitative values over periods of time' was not found for every aspect of knowledge resources, knowledge development and KM.

Preface

Knowledge is a remarkable substance. Unlike other resources, most forms of knowledge as well as their economic value grow rather than diminish with use (Adler, 2002), creating a challenging environment for the management of knowledge resources.

Over the past decades knowledge management (KM) has received a lot of attention in business. In fact we could say that it is now in the post-hype phase. Many companies have experimented with (and implemented) knowledge management instruments such as e-learning tools, communities, document management systems, and various policies to stimulate knowledge sharing among the workforce. Although these efforts have helped KM and increased awareness about KM, the mood among knowledge managers is that more needs to be done (Swaak, 2003).

In 2002 we outlined an approach and a model to analyse KM, distinguishing between (i) types of knowledge, (ii) processes of knowledge development and social learning, and (iii) indicators and metrics for (i) and (ii). Three levels of KM were distinguished: operational KM, maintenance KM, and long-term KM [De Moor and Smits, 2002].

This report presents the model, named the Knowledge Governance Framework (KGF), as it was further developed in 2003 and applied in two knowledge intensive organizations. We tested the hypothesis "*measurement of knowledge resources increases the effectiveness of KM*". More specifically, we investigate how organizations define, measure, and use key performance indicators for knowledge management.

We focus on the current practice of KM in organizations in order to identify:

- How KM takes place in organizations ('what are the targets'; 'which processes are distinguished'; 'which systems and technologies are used'; 'which explicit measures and indicators are used for KM '; etc.),
- How KM is linked to business strategy and competitive advantage,
- How KM contributes to knowledge development and social learning,
- Recommendations for improving knowledge management.

Management Summary

The objective of the Metis program is to support companies to transform from ‘organizations with smart people’ into ‘smart organizations’. This report focuses on knowledge management (KM), more specifically on measuring and managing knowledge in knowledge intensive, project based organizations, including their communities of practice.

Our hypothesis is that ‘measurement of knowledge resources increases the effectiveness of KM’.’ This hypothesis leads to two questions: (1) ‘when is KM effective?’ and (2) ‘are measurements necessary to realize effective KM?’ We investigate (a) how KM takes place in an organization (‘what are the targets’; ‘which processes are distinguished’; ‘which systems and technologies are used’; ‘which explicit measures and indicators are used for KM’), (b) how KM is linked (if at all) to business strategy and competitive advantage, and (c) how KM contributes to knowledge development and social learning,

We define ‘knowledge governance’ as the process of controlling knowledge resources aiming to achieve organizational objectives. We develop the ‘knowledge governance framework’ defining the organizational context of KM processes. It distinguishes between three KM levels in the organization: Operational KM, Maintenance KM, and Long-Term KM.

We analysed one very small (FP) and one very large organization (EP), using the ‘knowledge governance framework’. In this paper we present the first findings and preliminary conclusions. In practice we find that KM is divided into two tasks: (1) development and maintenance of technologies, databases, and portals and (2) development of knowledge in the business activities. Good functioning of and alignment between these tasks are important for successful knowledge governance.

We found that the answer on ‘when is KM effective’ depends on the level of KM, as given in the knowledge governance framework. Effects of KM can be evaluated on three levels: (1) the operational level: is the project successful (FP, EP), did the experts learn from each other (EP), did communities grow (EP), are knowledge resources used (FP, EP), (2) the level of maintenance KM: are the portals and databases used (FP, EP), (3) the level of long term KM: the business cases to decide on portal development (EP) and portal valuation to decide on continuation (FP).

Are measurements necessary to realize effective KM? Measurements in the sense of ‘determining quantitative values over periods of time’ were not found for most aspects of knowledge resources, knowledge development, and KM. We found that KM objectives can be qualitative, implicit, and emergent (FP) as well as explicit (the use of business cases for portal investments in EP). Additional research in the cases might lead to the identification of more quantitative measures, but the usability of measures in KM practice must then still be proven. We hypothesize that quantitative indicators are used in long-term KM and in formal KM styles and not (or less) in other KM contexts.

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1 Introduction

1.1 The METIS research program

Over the past decades knowledge management (KM) has received a lot of attention in business. In fact we could say that it is now in the post-hype phase. Many companies have experimented with (and implemented) knowledge management instruments such as e-learning tools, communities, document management systems, and various policies to stimulate knowledge sharing among the workforce. Although these efforts have helped KM and increased awareness about KM, the mood among knowledge managers is that more needs to be done (Swaak, 2003).

The *general approach* of the Metis program –started in January 2002- is the development of knowledge on how to use KM in enhancing business by focusing on collaboration between people, business activities and content. The *objective* of the Metis program is to support companies to transform from 'organizations with smart people' into 'smart organizations'. The challenge for the Metis program in 2003 is to test the business relevance of the research questions developed in 2002.

In 2003, the METIS program distinguishes between three broad KM issues:

- *'Locating knowledge and people'*, including knowledge mapping, the role of task ontologies in knowledge mapping, ranking data from heterogeneous collections, and the role of context in knowledge maps.

- *'Connecting people and building knowledge'*, including learning and knowledge management in the supply chain, project memory, and knowledge sharing in communities. These include the impact of *product knowledge representation* in learning from customers, the role of *systems vs. communities* in knowledge exchange between projects, and the factors and processes influencing the *motivation and ability of people* to share knowledge within geographically dispersed e-communities.

- *'Supporting* and *measuring KM'*. This issue includes existing tools for 'just in time' KM, 'measuring and managing knowledge development', and 'the role of financial indicators and knowledge development indicators in project portfolio selection.

1.2 The CRISM contribution to METIS in 2002

The Centre for Research in Information Systems Management (CRISM) of Tilburg University joined the METIS program in August 2002 to perform two research tasks, both related to 'supporting and measuring KM':

Task 1. Key performance indicators and metrics for knowledge management. We outlined an approach and a model to analyze KM, distinguishing between (i) types of knowledge (Nonaka and Takeuchi, 1995; Boisot, 1998), (ii) processes of knowledge development and social learning [Senge, 1990; Nonaka et al, 2000; Boisot 1995), and (iii) indicators and metrics for (i) and (ii). We proposed to apply the model in communities of practice because these are regarded to play an important role in knowledge intensive organizations [De Moor and Smits, 2002].

Task 2. Optimizing total revenues and knowledge development in projects. Building on the Intellectual Capital Method, a linear programming model was developed to support assigning –scarce- knowledge resources to projects in order to optimize total revenues and knowledge development (Daniels and De Jonge, 2002). In order to incorporate knowledge as a factor in a model for project selection, it is necessary to measure 'knowledge'. Typically, we found that project managers in a knowledge intensive environment tend to focus mainly on financial indicators (short term results), putting other knowledge indicators (long term results) in second place.

We concluded –based on literature and initial case analysis in tasks 1 and 2- that:

- KM is related to knowledge resources and knowledge development in several ways. First, KM implies identifying *types of knowledge* in a community and the scales on which the types are or will be measured. Second, knowledge management implies identifying the *knowledge creation processes* (or Social Learning Cycles (SLC)) in a community and the existing *learning (dis-) abilities*, according to Nonaka and Senge.

- KM can exist in different forms in organizations, varying from very explicit and formal to implicit and emergent. Research into 'measuring knowledge' and 'effective KM' (Swaak et al, 2000) assumes the explicit and rational type, including (1) decisions on 'target values' for the scales of the knowledge types and (2) decisions on the organization and management of the knowledge creation processes. Three types of KM can be distinguished (fig 1), defined in METIS 2002 as follows (Smits, 2002):

    - *Operational KM* assigns available knowledge resources to business activities to fulfill customer needs. This can take place in the form of a project consisting of knowledge workers, coming from the knowledge resources of the organization.

    - *Maintenance KM* evaluates the actual (internal and external) existing (free and in use) knowledge resources and decides on training and other maintenance techniques. Maintenance KM therefore uses a map representing actual knowledge resources.

- *Long-term KM* evaluates the findings of maintenance KM, operational KM, and the business strategy of the organization at hand and gives guidance to maintenance and operational KM.

- Knowledge development typically occurs in communities, where people work in a mix of project and other activities (see e.g. Blackler 2002, p 63). In projects a mix of experts work together for some time to create a product or service that meets some customer requirement. Project members can come from the knowledge resources of the service providing company, the client organization, or other –external- sources. After the project participants return to their 'home base' adding the knowledge acquired in the project to the 'shared knowledge resources' of the community. How to effectively manage knowledge in communities of practice in a project environment is an open question.

In 2003, we do not specifically focus on communities of practice. Good surveys of factors to be taken into account have been made in earlier TI reports, in particular Verwijs et al. (2001) and Efimova (2002). From these reports, it is clear that communities of practice are very complex socio-technical systems, of which healthy structure and behavior is governed by many cultural, political, social and technical factors. In this report, we have chosen to focus on a single issue, which so far has been still relatively under-investigated: projects. Our focus, therefore, is on taking the complex existence of communities of practice as a given, and investigate how their involvement in project environments contributes to organizational knowledge development and social learning.

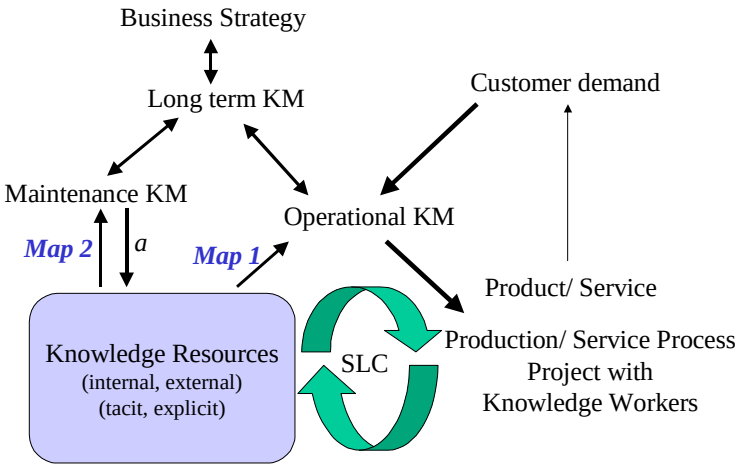

Fig. 1. Three types of knowledge management, linking knowledge resources to business strategy. This figure is the old version of the model as presented in December 2002 (Smits, 2002). It is further developed into the Knowledge Governance Framework, described in this paper.

1.3 The CRISM contribution to METIS in 2003

The two tasks of CRISM in 2002 were continued in 2003. This report presents the findings of the first six months of 2003 of task 1: 'Managing knowledge development and social learning in communities of practice', taking the four conclusions from 2002 as the point of departure.

The key question in task 1 in 2003 was originally 'how to effectively manage knowledge in communities of practice in an organizational environment'. As indicated above, we have refined this question to *'(how) do measurements of knowledge resources and knowledge development increase the effectiveness of KM'*. Swaak et al (2000) state that 'one has to *measure* in order to be able to effectively *manage* knowledge'. We note that this reflects a rather technical and formal perspective on management. Successful management can exist without the presence of clear and quantifiable indicators (Mintzberg 1973; Kotter, 1982; Wrapp 1984). So we might find that successful KM uses 'qualitative aspects' or even no aspects at all. Chun Wei Choo and Bontis (2002) address less explicit forms of KM when they indicate the importance of 'cycles of sense making, knowledge creation, and decision making'. Emergent and implicit forms of KM are also mentioned by Ciborra and Andreu (2001; see also Spender, 2002) as alternative ways for managing knowledge required in different organizational contexts[1]. Brazelton and Gorry (2001) also support the advice to avoid precise and complex indicators for KM when they say that complex questions of responsibility, commitment, and reward should not necessarily be used in communities. Instead, they advise to create the conditions for a knowledge-sharing community to emerge.

Our **hypothesis** in this report is that '*measurement of knowledge resources increases the effectiveness of KM*' and we evaluate this hypothesis by using literature and the analysis of two cases. The hypothesis leads to two questions: (1) 'when is KM effective?' and (2) 'is measuring necessary to realize effective KM?'.

In this report we select and combine KM theory, and focus on key performance indicators in KM in organizational communities of practice and projects. We have two objectives. First, we want to test the hypothesis given above and, second, we aim to develop recommendations and practical guidelines for effective KM in practice. More specifically, we investigate how organizations define, measure, and use key performance indicators for KM.

We focus on the current practice of KM in organizations. We extended and applied the framework of figure 1 and apply it in two cases in order to identify:

- How KM takes place in organizations ('what are the targets'; 'which processes are distinguished'; 'which systems and technologies are used'; 'which explicit measures and indicators are used for KM '; etc.),

- How KM is linked to business strategy and competitive advantage,

[1] No evidence is currently available on which type of KM (implicit or explicit) is effective in which type of organizational context.

- How KM contributes to knowledge development and social learning,

- Recommendations for improving knowledge management.

The research questions in 2003 are:

- How are the actual knowledge resources in an organization (or a community of practice) managed by operational, maintenance, and long-term KM?

- What are the catalysts and inhibitors of knowledge development and social learning in a community of practice in an organizational environment?

- Does ‘effective knowledge management in an organization’ imply that it can be explicitly determined how knowledge development is measured?

The paper is structured as follows. First, we elaborate the framework of figure 1, linking it to literature on communities, KM, and governance, leading to the Knowledge Governance Framework (chapter 2). In chapter 3 we use literature on measuring to support management by distinguishing between aspects, indicators, measurement, and diagnosis. Chapter 4 describes the findings on knowledge governance in two cases on project-related knowledge management in a very small and a very large organization. In chapter 5 we analyse the measurements in the two cases. Discussion, conclusions, and recommendations for further research are given in the final chapter.

2 Knowledge Management and Governance

Before applying the Knowledge Governance Framework in case studies, it is necessary to clarify the constructs in the model, and to develop a set of open questions that can be used to interview stakeholders in the KM practice. In this chapter, we develop and define the building blocks of the research model to create a lens with which to address the research question *'(how) do measurements of knowledge resources and knowledge development increase the effectiveness of KM'.*
The following assumptions guided us when looking for relevant theory:

1. As the level of analysis for KM we take communities of practice and projects in organizations. The reason why communities of practice are so important is that they are engines for the *creation of knowledge resources*. For example, they are used to produce innovations, give technical advice on unique problems, are used as general think tanks, and so on.

2. *Knowledge resources* include both *data* stored in, for example, databases or on web pages, and *tacit knowledge* possessed by the community members. Not all knowledge can, nor should, be made explicit, as many applications require human interpretation and subtle background knowledge. This knowledge creation process is *continuous* and *expanding*: as the community matures, it accumulates and applies knowledge, resulting in an internal learning process.

3. KM refers to influencing knowledge development and creation of knowledge resources. KM processes do not take place in a void, but in an *organizational context*. For KM processes to be effective, links must be present between these processes, the knowledge resources that they influence, and the organizational goals and workflows.

4. Measurements of KM effectiveness in such an organizational context should ensure that appropriate *knowledge aspects* are measured. Aspects can apply to knowledge creation *processes* as well as to the *products* that are transformed in these processes. Many aspects can be measured, but not all are relevant or feasible. *Indicators* are measurable operationalizations of aspects. The selected aspects should be measured with the right indicators (effective in terms of contributing to the knowledge management goals, and efficient in terms of easy to conduct and in terms that are understood by the organizational members).

5. As knowledge management continuously evolves in a community of practice, it is essential that anomalies can be detected and interventions can be done to refocus knowledge management practices. *Diagnostic processes* must be available to detect problems and prescribe solutions so that healthy knowledge management can be ensured.

In this chapter we elaborate on items 1 to 3 ending with our Knowledge Governance Framework. In the next chapter we focus on items 4 and 5

2.1 Communities of Practice

Communities of practice are playing an increasingly important role in modern, knowledge-intensive organizations (Preece, 2000; Gongla and Rizutto, 2001; Millen et al, 2002; Spender, 2002). CoPs can be viewed as a set of relationships where people interact socially for mutual benefit (Smith, 2002). Wenger et al (2002; p 27) state that all communities share a basic structure despite the variety of forms they take. Following Wenger et al we define a CoP as a unique combination of three fundamental elements: 'a *domain* of knowledge which defines a set of issues', 'a *community* of people who care about this domain', and 'the shared *practice* that they are developing to be effective in their domain. Because of the combination of the three elements CoPs differ from other social and organizational structures such as business units, functional units, project teams, informal networks, communities of interest, and professional associations.

More specifically, CoPs and project teams are different social structures because project teams are more purposeful to accomplish a specified task, have people with a direct role in accomplishing the task, have clear boundaries, are kept together by project goals and milestones, and have a predetermined ending. On the other hand, project teams and CoPs are linked together because the coordinator(s) of a CoP can bring people together, enabling the CoP to find direction, may charter a team or a project in the course of developing it's practice (Wenger at al, 2002).

Gongla and Rizutto (2001) observed over 60 communities and describe CoP as 'knowledge networks, referred to as institutionalized, informal networks of professionals managing domains of knowledge'. CoP foster knowledge development and creative interactions amongst highly specialized experts and help to channel their efforts to where they are most needed (Talbott, 1995; Millen et al, 2002). In this way, CoP are a key element in the learning organization. Being at the core of these companies, and knowledge being one of their key assets, a structured process of *knowledge management* is essential to assure the efficacy of CoPs (Wenger et al., 2002).

Although a large body of literature exists on knowledge management in general (Davenport and Prusak, 1998; Wiig, 1995; Grover and Davenport, 2001), so far not much specific theory has been formed about knowledge management in communities of practice, let alone on the role that performance indicators play in them. On the other hand, in industry, some successful cases exist (e.g. Shell (2001) and IBM in Gongla and Rizutto, 2001; Wenger et al, 2002). Still, many other organizations have failed in their efforts. Because of the lack of theory, it is not clear yet what aspects are specific to the company, and which can be generalized and applied more universally.

An extensive literature exists on the structure, operations, and evaluation of Communities of Practice (CoP) (e.g. Gongla and Rizzuto, 2001; Miller et al., 2002; Wenger et al, 2002). However, these communities are often examined in general terms of being productive, sociable, and so on, but not from a perspective of knowledge management in an organizational context. Such a view is necessary if knowledge management structures, processes, and guidelines are to be recognizable and successfully implemented by

management and members of organizational CoPs. In other words, it is not sufficient to talk about abstract knowledge management procedures, and social learning processes: these constructs need to be embedded in clear goal, task, and organizational structures.

2.2 Knowledge resources, knowledge creation, and knowledge development

Knowledge is a remarkable substance. Unlike other resources, most forms of knowledge grow rather than diminish with use (Adler, 2002), affecting the economic value of knowledge (see e.g., Varian and Shapiro, 1999). Knowledge 'resides in' databases as well as in relationships. Swaak et al (2000) present the KnowMe model in which there is an indirect relationship between KM and knowledge creation. Organizations can do KM investments in social infrastructures, IT infrastructures, relationships, and external sources in order to facilitate learning processes. Knowledge creation and development will then take place in learning processes where people share knowledge when working together within organizations and with customers.

Starting point of our literature base is the well-known *SECI* (Socialization-Externalization-Combination-Internalization) *model* of cyclical knowledge creation of Nonaka et al. (1995, 2000). They adopt an epistemological dimension in their model, distinguishing between tacit and explicit knowledge that are continuously converted in a social learning process. The *SECI model* distinguishes between tacit and explicit knowledge in the organization, and the interplay between these two, leading to processes of knowledge conversion, expansion, and innovation (Fig.2). *Tacit knowledge* is personal and context-dependent*, explicit knowledge* can be expressed in formal and systematic language and shared in the form of data.

Knowledge is created in a continuous cycle (the spiral in figure 2) of socialization, externalization, combination, and internalization, in which knowledge is produced. *Socialization* is the process of creating new tacit knowledge out of existing tacit knowledge through shared experiences, for example in informal social meetings. Socialization leads to *sympathized knowledge*. *Externalization* is the process of articulating tacit knowledge into explicit knowledge, for example concept creation in new product development. Externalization leads to *conceptual knowledge*. *Combination* converts explicit knowledge into more complex and systematic sets of explicit knowledge, called *systemic knowledge*. This is where databases and computer-supported analysis comes in. *Internalization*, finally, is the process of turning explicit knowledge into tacit knowledge, for example by training. This type of knowledge is called *operational knowledge*.

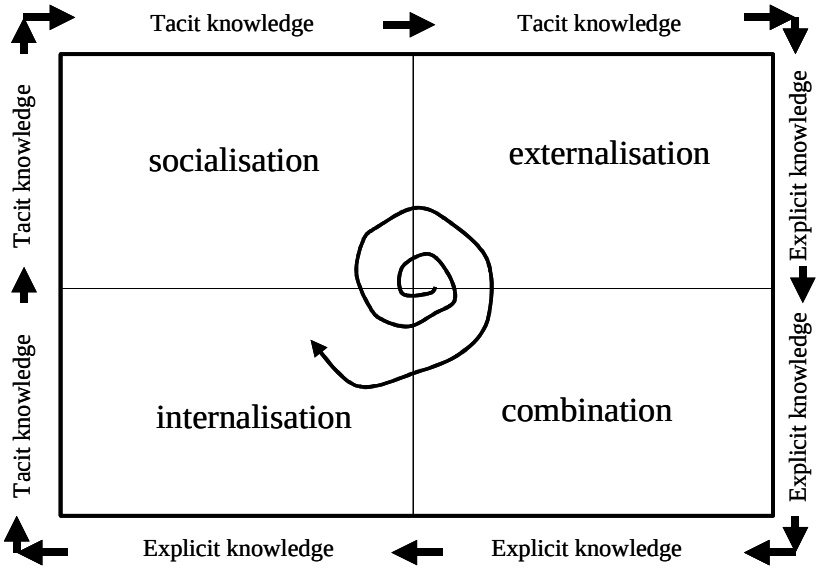

Figure 2. Types of knowledge and the knowledge creating process (Nonaka and Takeuchi, 1995)

Knowledge can be *individually owned, or shared*. Nonaka et al. (1995) distinguish an ontological dimension in their model, indicating how knowledge over time diffuses from individuals into the organization as a whole. This extra dimension complicates knowledge creation processes, as differences in individual and group perspectives easily emerge when multiple human actors are involved in knowledge (ex-) change. Some interpretations of the same knowledge entity may differ, such as the personal evaluation of how well a report is written. Other interpretations must converge, however, such as ensuring that a joint view is developed about the course of action an organization is to take.

Knowledge creation does not take place by itself. To ensure that the SECI process can take place, Nonaka et al (2000) and Senge (1990) have defined certain necessary conditions in the form of guidelines for effective knowledge creation. Nonaka and Takeuchi (1995) have come up with a set of 7 guidelines for effective knowledge creation, containing principles as 'develop a knowledge crew', 'adopt middle-up-down management', and 'switch to a hypertext-organization'. In field research, we have found that these principles are useful to make a quickscan of the readiness of the organization for sophisticated knowledge management practices (Dijkstra, 2002). To ensure that the necessary conditions for successful knowledge creation have been satisfied, the implementation of each guideline needs to be critically assessed in the organization being examined (De Moor and Smits, 2002).

2.3 Knowledge management

Knowledge management is defined according to Fu (2001) as the management of the information, knowledge and experience available to an organization – its creation, capture storage, availability and utilization - in order that organizational activities build on what is already known and extend it further.

A common definition of knowledge management is “The collection of processes that govern the creation, dissemination and leveraging of knowledge to fulfil organizational objectives” [Ching Chyi Lee et al. 2000]. KM is a framework within which the organization views all its processes as knowledge processes.

Davenport and Prusak (2000) define KM as: ‘to identify, manage, and value items that the organization knows or could know: skills and experience of people, archives, documents, relations with clients, suppliers and other persons and materials, often contained in electronic databases. Davenport and Prusak (2000; page ix) state that for most knowledge-managing companies today, the challenge that lies ahead is to integrate knowledge management with the familiar aspects of business: strategy, process, culture, behaviour. They distinguish five challenges:

- Linking knowledge management (KM) and fundamental business strategy, making KM the link between business strategy and business performance. For some organizations this means making knowledge the product of the organization. For organizations where knowledge is not the product this means formulating a business strategy supported by knowledge.

- Linking knowledge to work process. This should be done by ‘baking’ the KM process into key knowledge work processes (page xi).

- Linking knowledge to culture, by installing measures to stimulate knowledge development and sharing.

- Linking knowledge to behaviour, by promoting the use of knowledge instead of only ‘stocking knowledge on the shelves’.

- Linking knowledge to the physical business environment, by creating a physical workspace that stimulates knowledge creation and transfer. They recall Thomas Allen’s ‘thirty meter rule’: two scientists or engineers whose desk are more than thirty meters apart have a communication frequency of almost zero.

We build on the three definitions of KM given above (particularly on the one given by Davenport and Prusak), where KM is related to different organizational groups and levels. *KM on an operational level* (day-to-day basis) is indicated by Davenport and Prusak (2000, p 110), including technical tasks such as writing HTML and PERL scripts for websites, structuring and restructuring knowledge bases, and installing and maintaining knowledge-oriented software packages like Lotus Notes. They further state that pure technology alone is not enough and that technologists should have a strong focus on how to make knowledge content appealing and how to persuade those who have knowledge to put it into a rich knowledge base. Other operational KM tasks are found in new knowledge jobs like knowledge integrators, librarians, synthesizers, reporters, and editors. The *middle level of KM* is occupied by the manager of knowledge projects (Davenport and Prusak, 2000, p 112).

The organizational context that ties KM processes to the organization in which they operate, is still undeveloped in the literature and in practice. In practice there is a need to know how to create an organizational context that fosters effective KM. How exactly management processes and knowledge resources tie to strategic, tactical, and operational business objectives, workflows is often left implicit or not addressed at all (Chun Wei Choo and Bontis, 2002). To specify these relationships, we have developed the *Knowledge Governance Framework* (fig. 3). Before filling in the various parts of the model we relate KM to governance. Our analysis of the term governance is based on Peterson (2002).

2.4 Governance

From a general systems perspective, an organization is viewed as a complex open social system, interacting with its environment, and consisting of a set of interdependent subsystems that produce a purposeful whole (Daft, 1998). Interacting subsystems in a social system imply that stakeholders (individuals, groups, organizations, and communities) are interdependent, and need to work together in order to achieve objectives. Building on general systems theory, De Leeuw (1990) presents the governance paradigm, resembling the cybernetic model of organizations. Governance is a purposeful intervention in order to achieve a desired output, and describes a subsystem of decision-making units for directing and coordinating operational subsystems.

According to Peterson (2002) the term ‘governance’ comes from ‘Gubernare’ (Latin) and ‘Kubernan’ (Greek) meaning ‘to steer’ and ‘he who steers and provides overall direction’. ‘Kubernan’ and ‘Kubernetes’ denote the process of Kubernesis, i.e. the task of keeping a ship on its course in the midst of unexpected changing circumstances. Norbert Wiener (1956) conceived the word cybernetics, the science describing goal-directed systems, and the guidance of a system under changing conditions. The governance paradigm is based on a general systems approach of organizations (Ashby, 1956).

To view organizations as cybernetic systems is to emphasize the importance of operations, governance, and strategy (Scott, 1998). Figure 3 shows the strategy center (‘strategy’) setting the goals for the governance center (‘governance’) depending on information from the environment and the operational center (‘operations’). The strategy center provides a strategic context for the governance center, which directs and monitors the operational center. The governance center consists of interdependent and interrelated decision making units that share information from the strategy- and operational center. The operational center is concerned with the transformation of raw materials into products and services.

In this governance model, KM can be positioned in the middle box ‘governance center’, getting inputs from the strategy center (being the business objectives and the organizational context), and providing inputs to the operational center (being the knowledge development processes and the knowledge resources).

Governance gives direction and control in an organization. Two monitoring loops can be distinguished in the system, the primary loop applies existing decision rules to the operational center and the secondary loop determines whether it is necessary to redefine the value, upon

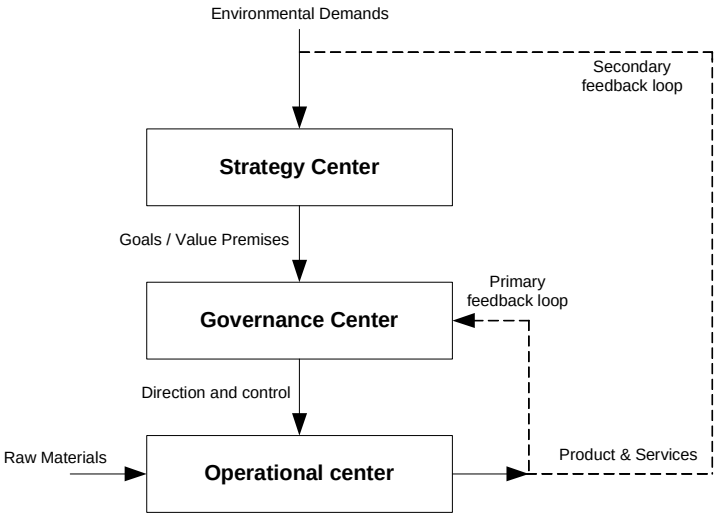

Fig. 3. Cybernetic model applied to organizations (Scott (1998), Peterson (2001))

which the decision-making is based. Primary loop control is also known as single loop learning, handling disturbances in degree by applying existing decision rules. Secondary loop control is also known as ‘double loop learning’ handling disturbances ‘in kind’, determining whether it is necessary to redefine the value premises upon which decision making is based (Argyris and Schon, 1978; Scott, 1998). Single loop control can be regarded as operational and maintenance KM, double loop as long term KM using business feedback to evaluate operational and maintenance KM objectives

The cybernetic model is the basis for many classical and contemporary organization design paradigms and models (Daft, 1998). Organizations, however, are not mechanical thermostats or machines. Scott (1998) indicates that the cybernetic model of organizations gives the impression of a ‘taut machine’. More realistic is that errors are only selectively detected, due to bounded rationality, and corrected in satisfying manners instead of the optimal solution (Simon, 1961). Also, information is not shared across decision-making units as frequently and unambiguously as suggested by the cybernetic model (Daft, 1998). For our Knowledge Governance Framework this means that it can on the one hand be regarded as a cybernetic KM model, resembling the formal and technical perspective on control. On the other hand KM activities exist in different organizational units, leading to less formal varieties of control.

2.5 Knowledge Governance Framework

In this chapter we describe the Knowledge Governance Framework, including how it is operationalized in a questionnaire, and applied in a case study approach. Analysis of knowledge development and management will be based on interviews with key actors (knowledge managers, knowledge workers), including the description of typical knowledge intensive projects and products in the organizations.

Previous frameworks have been published to link business objectives to knowledge resources. Gongla and Rizutto (2001) introduced the IBM knowledge management framework ‘to link or align a community with the organizational goals, management, value system, and

infrastructure'. We add to this model by distinguishing different types of knowledge management activities, together regarded as 'knowledge governance'

We define knowledge governance as the process of controlling knowledge resources aimed at achieving organizational objectives. Our Knowledge Governance Framework defines the organizational context of knowledge management processes. It distinguishes between three levels of knowledge management in the organization: operational KM, Maintenance KM, and Long-Term KM. In figure 4 these levels, their interrelationships, and the relationship with organizational context are explained. Links between elements are either *control processes*, including guidelines and objectives, or *maps.* A map is a collection of relevant indicators of knowledge resources to be used in a knowledge management process. A map might be regarded as a management report.

Note that all functions from these three levels might be combined in one person/ professional (in a small firm) or distributed among many professionals or departments (in larger firms).

- *Operational KM.* An operational knowledge manager takes care of the customer demand for knowledge intensive products or services and forms a project team consisting of knowledge resources and specialized employees who will implement these orders. After a customer request has been received, operational KM needs an *availability map,* an up-to-date overview of the free and available knowledge resources to create an optimal project team. If there is a difference between the actual needs of Operational KM and the available resources, the gaps will be communicated to Maintenance KM via the *deficiency map*.

- *Maintenance KM.* A maintenance knowledge manager maintains an optimal level of knowledge resources by comparing the capacity map, the total set of knowledge resources present in the organization with the deficiency map. As a result, the knowledge resources may have to be adapted. This can be realized, for example, through training, hiring, buying, development of knowledge products, social learning, and linking to other resources.

- *Long-Term KM.* A long-term knowledge manager evaluates summaries of Maintenance and Operational KM in the form of aggregated maps. These results will be matched with the business strategy and objectives, so that a long-term planning can be made. This planning, which is communicated to the other KM processes, contains the KM objectives to be reached and the costs and profits that will be realized.

Obviously, to make this model relevant for practice, the professionals executing these tasks must be identified, as well as the ways they cooperate (or not)[2]. In Metis this issue is addressed to some extent as the role of the Chief Knowledge Officer (Efimova) and Just in Time KM (Wagenaar), but without distinguishing KM levels as above.

[2] The Information Management discipline addresses this issue as 'alignment' between business activities (Henderson and Venkatraman, 1993).

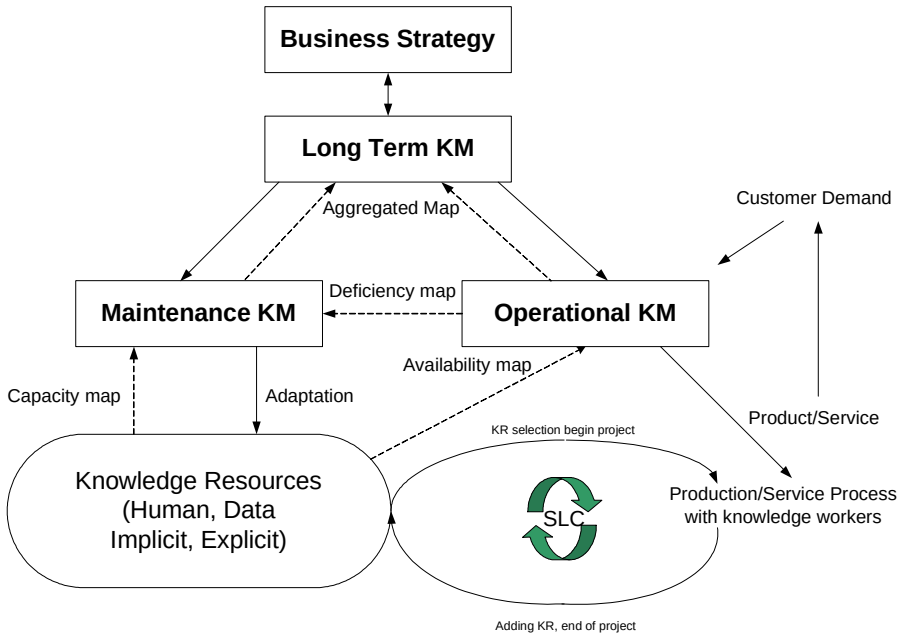

Fig. 4. The Knowledge Governance Framework

Grover and Davenport (2001) edited a special issue of the Journal of MIS on Knowledge Management fostering a research agenda. They distinguish between a process framework and a market framework for knowledge management research. The process framework is a pragmatic one in which the knowledge generation process (including codification, transfer, and realization) is used to guide research on 'how knowledge creation and use can be managed'. The market framework takes a transactional perspective where knowledge exchanges occur in a market place (Davenport and Prusak, 1998). The market framework uses concepts such as information asymmetry, efficiency of markets, and standardization, thus framing knowledge management as the problem of creating an effective and efficient knowledge marketplace. The knowledge governance framework fits the process framework since it focuses on how knowledge creation and use can be managed. The framework might also fit the market framework in the sense that knowledge resources (in a CoP) are represented to various knowledge managers (using different maps) thus creating a market for knowledge exchange. (We check this to some extent using question 3, bullet 3.)

The knowledge governance framework is further operationalized with a questionnaire consisting of five open questions to be applied in interviews with managers in case studies:

1. What are the key knowledge resources in your company?
2. Which communities (of practice, interest or others) are relevant for your company?
3. With respect to Operational Knowledge Management (see figure 3):
    - Who decides which (knowledge) resources will be assigned to a project (customer/ product/ process)? (Obviously, we first check whether the organization uses projects to perform business activities).

- How does this person determine the amounts and types of resources needed? Which goals does (s)he want to achieve? How are the goals evaluated?
- How is the availability of (free) resources indicated?
- In case of lacking or insufficient resources: how and with which person(s) is this communicated? Does your company (managers) use specific threshold values for resources?

4. With respect to Maintenance Knowledge Management (see figure 3):
   - How are knowledge resources created? Who maintains the resources, and how does maintenance take place? How is the availability of resources indicated?
   - With which person(s) does communication take place on necessary knowledge resources? What are the objectives of these people?
   - In case of lacking, insufficient (or excess of) resources: how and with which person(s) is this communicated? Does your company (managers) use specific threshold values for resources?
5. With respect to Long term Knowledge Management (see figure 3):
   - How is Knowledge Management linked to business objectives and business strategy? (e.g.: Why did your organisation start the Intranet (community of practice)? Why did your organisation decide to stop Internet activities (stop offering knowledge-based services)?)
   - How is the availability of knowledge resources indicated on the organisational level? In case of lacking or insufficient resources: how and with which person(s) are these communicated? Does your company (managers) use specific threshold values for resources?

Case analysis is further based on documents, web, and desk research. An interview was planned with one or two managers that are responsible for (part of) the KM in the organization. Web and other documents were then selected and used to prepare some questions particularly focusing on the KM practice in the organization. A report was made covering the answers to the five interview questions. The report was checked by the interviewees and then used for further case analysis.

3 Knowledge Management and Measurement

In this chapter, we explore the relation between measurement and KM. In this chapter we now assume effective management to be rather technical, formal, and based on measurements, instead of the informal and less explicit forms mentioned in 1.3 and chapter 2.

First, we briefly introduce how measurement and KM are interrelated in the business context. We then explain our research methodology and present the generic conceptual model that has guided us in our empirical research on measurement.

3.1 Management and Measurement

Measurement can have many objectives, including providing feedback, making a business case, learning, and developing benchmarks for future comparisons and others. For KM it is important to focus measures on factors that affect the ability to achieve strategic objectives, ensuring that knowledge development and KM processes are continuously assessed at all levels of the organization (Navy, 2001). To ensure that the organization becomes effective, continuous interactive learning needs to take place between leaders (strategic learning), staff (operational learning), and customers (policy learning). For a true learning organization to emerge, it is essential that all these levels are measured regularly and rigorously (Garratt, 2000).

However, measurements must not be applied naively in knowledge management: experience has shown that it is best to use a few focused measures aligned with strategic objectives; measure critical characteristics of the business processes; and recognize that measurements are only tools, not the products of KM (Navy, 2001). Moreover, for good performance measurements to be developed, the enterprise knowledge management needs must be understood clearly: is the focus codification (access and reuse of existing (explicit) knowledge), personalization (capture of tacit knowledge and developing an environment of collaboration throughout the organization), or integration of these two knowledge management strategies (Bixler, 2002). So far, much attention has been on codification strategies, possibly because they are easy to measure. Support for personalization strategies, for instance in the form of a community interaction model seems equally, if not more important (Swan et al., 1999). It is clear that different types of measurements are needed and that the usage of these measurements may vary according to the knowledge management strategy adopted.

3.2 Research Methodology

As one goal of our report is to open up the question of what the role of measurement in effective KM in organizations is, we decided to use an inductive approach to analyze the measurement problem, in the sense that many of the detailed constructs could emerge during the data collection and analysis phase (Creswell, 1994). Of course, some initial broad theoretical measurement framework is needed. However, this framework was only partially

filled in with measurement constructs, as our interest was in finding out what detailed measurement constructs and processes are actually used in the real business world.

Starting point in our investigation was the Knowledge Governance Framework, as this defines our research focus on effective KM. In addition, we adopted a generic conceptual approach of measurement, derived from approaches widely adopted in the measurement and quality literature (Fig.5). In particular, we were inspired by the meta-model of software quality measurement that is used in the Dutch QUINT (Quality in Information Technology) project, which was developed by the Dutch Software Engineering Research Centre (SERC), and sponsored by various large corporations[3]. Key concepts of the model are *aspects*, *indicators* to measure those aspects, *procedures* to do the measurements and *actions* that can influence the aspects. In addition, various kinds of meta-aspects, relationships and quality criteria have been defined on these core measurement constructs, such as the degree to which one aspect reinforces or weakens another aspect, the degree to which an indicator is a valid measurement for an aspect, and the type of scale used for an indicator (Paulussen et al., 1992). Although the QUINT project was specifically aimed at software quality, the meta-model has wider applications, such as for KM measurement.

Based on the interviews, we have populated the constructs of this generic approach with case data. Two cases, of course, do not provide enough data to make substantial generalizations. However, by taking two knowledge-intensive organizations at the extreme ends of the size-spectrum, we hope to at least sketch some of the issues related to the measurement of KM that are most relevant to business practice.

3.3 Conceptualizing Measurement in Knowledge Management

In our measurement model, we are interested in the following main concepts:

- *Aspects* of knowledge management, knowledge resources, and knowledge development.
- *Indicators* for making these aspects measurable.
- *Measurement*: what measurement procedures are used? What are target and measured values? What is the role of benchmarks?
- *Diagnosis:* what can we learn from these values? Are they within range? If not, what actions, if any, must be taken to improve knowledge management activities?

Note that these steps also relate to the cycles in the cybernetic control model (fig. 3) and governance (section 2.4). Figure 5 shows how knowledge management and its measurement processes are connected and how the measurement concepts are interrelated. In this chapter, we focus on the right part of Figure 5.

[3] http://www.serc.nl/resources/publicaties/qnt-boek.shtml#QUINT

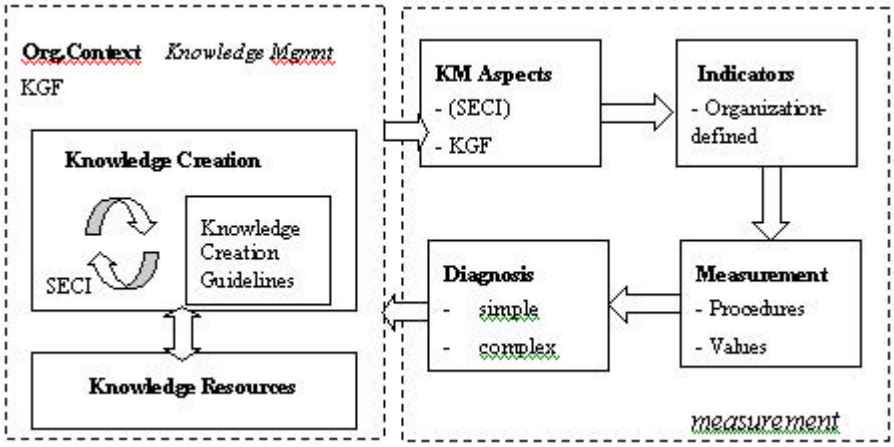

Fig. 5. Knowledge Management and Measurement in an Organizational Context

3.4 KM Aspects

Knowledge aspects concern the key KM concepts that are to be measured with indicators. These aspects are often organized as *aspect trees*, in which a hierarchy from broad, generic aspects to very detailed sub-aspects is defined. However, there are often problems with these hierarchies, such as how to group aspects and the existence of all kinds of lateral connections between aspects (Paulussen et al., 1992). For example, increasing the completeness of a knowledge base, often results in decreasing its timeliness.

Many classifications of aspects to be measured in organizational knowledge management exist in the literature. The Balanced Scorecard distinguishes between customer, internal, learning & growth, financial, and vision & strategy aspect classes of aspects. The Knowledge-Centric Organization model distinguishes three main aspect classes to assess different levels of knowledge management impact: outcome (enterprise or overall value), output (project or task), and system (technology tool) aspects (Navy, 2001).

Basing ourselves on Nonaka and Takeuchi's model of organizational knowledge creation, two key classes of aspects, which we investigated in earlier case research in (De Moor and Smits, 2002) concerned the knowledge creation *processes* and the knowledge *products* created. The processes investigated were the four SECI processes of socialization, externalization, combination, and internalization. The knowledge products were their direct outputs, such as conceptual and systemic knowledge. However, in the current research stage, we have expanded the potential range of aspects to be researched. The angle we have taken is to identify *aspect classes*, such as knowledge resources, knowledge management levels, and maps that follow from our Knowledge Governance Framework, then investigate in the case studies conducted this year whether and how these classes are actually used in a real world context. By doing so, we hope to serve two purposes of contributing to: (1) answering the research question on the exact role of knowledge measurement in the knowledge

management of project-based organizations, (2) help focus measurement on those aspects that are considered useful in daily business practice.

3.5 Indicators

Indicators are the measures for the various knowledge aspects. Note that in the literature, aspects and indicators are often joined into single constructs. We explicitly distinguish between *what* is to be measured and *how* it is measured, however. This allows for measurement processes to be more precisely defined, and inefficiencies and other problems to be diagnosed better. For example, sometimes it is important that organization members are simply aware of key knowledge management aspects, but there is no need to measure them. On the other hand, often multiple indicators are needed if much weight is attached to measurement. Relationships between these indicators and the aspect they measure may then need to be examined in detail.

Many different classifications of indicators or metrics exist. Quantitative measures provide hard data to evaluate performance between points, whereas qualitative measures use context information to provide a sense of value. Such measures may include measures like stories and scenarios (Navy, 2001). Another classification of metrics is whether they are subjective (based on perceptions of stakeholders), or objective (data collected in automated ways), although the subjectivity-objectivity distinction remains a conceptual minefield, which we will not enter here. According to (Pipino et al., 2002), objective assessments can be task-indepent or task-dependent. Task-independent metrics reflect states of the data without the contextual knowledge of the application, for example on accessibility. Task-dependent metrics are used in specific application contexts, such as defined by business rules. An example would be a metric that checks the timeliness of data for the task at hand.

To be interpretable and comparable, indicators need a measurement *scale*. One common distinction is whether the indicators are *nominal* (values belong to specific category), *ordinal* (values are chosen from a set of ordered categories), *interval* (ordered values have a fixed distance), or *ratio* (interval values have a meaningful zero). Nominal and ordinal indicators are often used for qualitative measurements, interval and ratio-indicators for quantitative measurements. In business practice, however, it is often observed that such scales are not clearly defined, which is one reason for confusion about the value and role of measurements.

The *quality* of indicators is crucial. Depending on their importance, different quality requirements can be made. Some of the interesting examples given by Watts (1987) are that indicators must be:

- *Objective*: the measurements must be free of the subjective influences of the person measuring

- *Reliable*: a measured indicator must give stable and precise results, no matter how often the measurement is repeated.

- *Valid*: an indicator must be a measure for the aspect to which it is linked

- Comparable: the results must be comparable with other indicators for the same aspect.

- *Useful*: an indicator must meet a practical need.

3.6 Measurement

Once relevant aspects and their indicators have been defined, the actual measurement process can take place. Both to measurement procedures and to values sufficient attention needs to be paid. However, given the many different approaches in, for example, the general quality literature, we have left open for our empirical investigation what are considered 'best practices in practice'.

Issues to be taken into account in measurement procedures include the amount of effort a measurement takes, the timing of the measurement, the reliability and objectivity of the measurement (Paulussen et al., 1992). Measured values often need to be compared with target values or benchmarks in the diagnostic stage, so care must be taken that their formats agree. Benchmarks of various kinds exist, ranging from intra-company to world-wide best of the best-standards (Foster, 2001). Such benchmarks allow the learning process to measure the differentials and redeploy scarce resources to achieve the strategic goals of the organization (Garrat, 2000).

Care must be taken that measurements and benchmarks are made readily available to all relevant parties in an easily understood format. If not, measurements will not contribute to effective knowledge management (White, 1996).

3.7 Diagnosis

Many measurement systems provide too much data and too little analysis (Santos et al., 2001). Diagnosis, comparing measured values with the norms, and taking appropriate action to remedy problems, is essential.

There are two main types of diagnosis in organizations, which we refer to as simple and complex diagnosis.

In *simple diagnosis*, basic target-measured value comparisons take place on individual indicators. The popular Plan-Do-Check-Act (PDCA)-cycle is often used in this way. In the Plan-stage, a change is planned by defining a problem and identifying and evaluating its possible causes. In the Do-stage, a change that may deal with the problem is determined and implemented. In the Check-stage, the change is tested to see whether it worked. If the change worked as expected, permanent action is taken and the change embedded in the organization in the Act-stage (Ozkan, 2001). Such approaches, in which single changes are

studied for their direct effects on specific aspects, we consider examples of single-loop learning.

However, to improve the way measurements contribute to organizational performance, the relations between them are to be better understood. In this way, more attention can be paid to (1) what are appropriate measures and (2) the trade-offs between the various performance measures. In addition, due to the dynamic complexity inherent in organizations, the measurement systems must also be able to evolve. To deal with this dynamic complexity, system dynamics can help in the design of evolving measurement systems that can handle double-loop learning (Senge, 1990; Sterman, 2000; Santos et al., 2001). For example, (Ballou et al., 1998) conceptualize knowledge management in the organization as information manufacturing systems. They aim to produce better quality information products by examining the effects of various values of the key aspects timeliness, data quality, cost, and value. Thus, some form of *complex diagnosis* will be needed in the business organization.

4 Knowledge Management in two Cases

The purpose of the case studies was twofold. First, the cases should provide answers to the research questions. Second, the questionnaire was tested in two distinct business environments, to check whether the concepts and questions could be used to evaluate KM. We applied the framework in two very different cases:

(1) FP, a young and small (20 employees) company in the financial service sector. The basis of this analysis is a case study done by Dijkstra (2002) (see also De Moor and Smits, 2002) and interviews based on the questionnaire in June 2003 with the same manager as in 2002, thus providing a longitudinal perspective.

(2) EP, the division Exploration and Production of a large company in the oil industry, with branches in 40 countries worldwide and 15.000 employees. The analysis is based on Van Dijck et al (2003) and interviews based on the questionnaire in June 2003.

The interviewees in FP were a senior manager and an operational manager, both involved in business practice and in IT support for the FP community. The interviews in EP were an accounting service manager (with information management background) and a knowledge manager (formerly the CIO of the business unit). Interviews took about 90 minutes each. Afterwards a transcript of each interview was send for verification. Both companies also verified the final case descriptions given in 4.1. and 4.2.

4.1 Case 1: FP

FP is a young Dutch organization operating in the financial industry (figure 6). FP key activities are the design, development, and exploitation of investment funds. Investment funds are highly complex and knowledge intensive products, with many specialized roles, such as brokers, portfolio managers, various kinds of analysts, fund sponsors, accountants, administrators, and custodians. FP acts as an intermediary in this web of roles. FP is a young company, established in 2000, when around 15 experts in different fund domains were employed from three large financial institutions. FP had about 15 staff in 2002. The basis of the organization is the team of investment fund specialists, who form the majority of employees.

FP two main business activities are:

- Creating highly specialized investment funds (e.g., hedge funds) by bringing together and maintaining a network of ‘manufacturers’ for the various components of a investment fund (like custodians and portfolio manager)

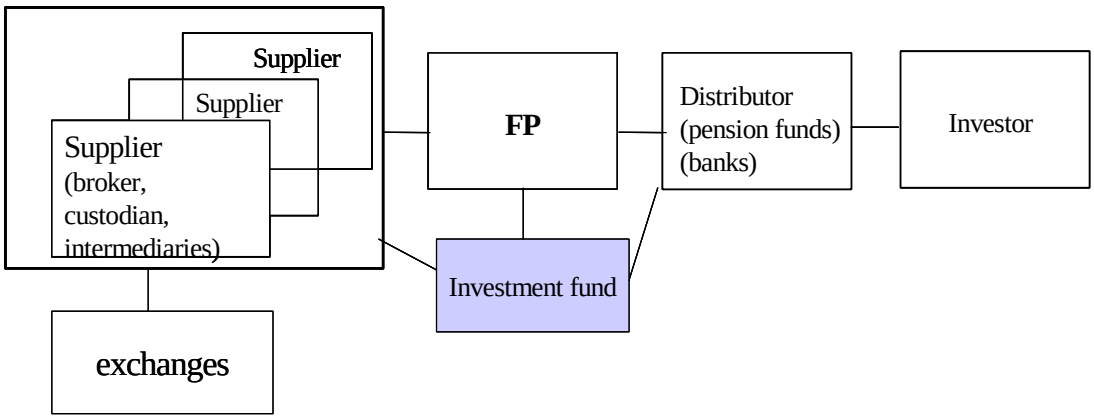

Fig. 6. The FP value chain: FP designs, creates, and exploits investments funds.

- Exploitation of these funds for the customers. Customers of FP are pension funds, large institutional investors, and other distributors of financial products that often do not have the necessary product development skills in-house.

Another business activity –until June 2003- has been the FP portal. The portal was developed in 2001-2002 aimed at making transparent the investment fund industry and sharing knowledge between FP employees and with customers. By doing so, FP aims to become the hub in a network of expertise. Suppliers are all parties, like those mentioned above, who contribute financial and management services (such as fund management, custodian services, securities management) to an investment fund. Distributors are organizations like banks and pension fund organizations that offer investment funds to investors, such as end-consumers and financial intermediaries.

Apart from the development and maintenance of the e-business portal, activities are organized around fund development projects. All specialists have their own expertise in the development of investment funds, and are responsible for selecting and communicating with the specific suppliers related to their field of expertise. Since FP is a small organization, with a high degree of interdependence and collaboration between its members, a de facto community of practice exists. However, there is room for further optimizing structure and operations of this community, something of which the organization is well aware.

FP is a niche player in the financial market, offering specialized services. Its core competence is described as ‘the expertise to develop tailor-made investment funds, requiring the ability to anticipate on trends in the investment fund industry’ (such as ‘hedge funds’, ‘click funds’, ‘sector funds’, ‘self select funds’). To be able to do so, continuous innovation is required.

Thus, FP can be considered a knowledge intensive organization in which knowledge is the key asset that needs to be properly consolidated (Fig.3), in which there is a de facto community of practice, and in which new knowledge needs to be continuously created for the company to survive. It is thus a good candidate as a case to apply our theoretical framework. One senior IS specialist and one financial specialist were interviewed at location.

We now summarize the answers to the five interview questions.

(1) What are the key knowledge resources in your company?

FP distinguishes between the following five categories of knowledge resources:

- *Knowledge related to FP products*. FP has knowledge on three product types: 'traditional funds', 'structured products (e.g., guaranteed funds)', and 'hedge funds'. Most of this knowledge is TACIT, but FP maintains a large database of EXPLICIT knowledge covering the business details of all hedge funds of a special type (600 funds). Databases with explicit knowledge on (all or a parts of) the 65.000 funds in Europe are for sale but FP is not willing to buy these.

- *Knowledge on the production of funds* regarded as knowledge on the FP suppliers. FP keeps EXPLICIT knowledge in small databases on Custody services (there are only about 5 custody service providers in Europe), fund administrator services (there are only about 30 service providers in Europe). FP also maintains papers and manuals as EXPLICIT knowledge on 'how to make an investment fund' etc, also known as 'soldier's handbook'.

- *Knowledge in people (personnel).* FP distinguishes between experts with 'product related knowledge' and experts with 'process related knowledge'. Product experts cover one of the following fields: 'hedge funds', 'structured funds', and 'traditional funds'. Process experts cover one of the following fields: fund administration, custody services, IS/IT services, risk management, treasury management, and legal services. All experts have valuable TACIT knowledge on the selection of external experts in specific (financial) domains, and knowledge covering the first two categories of knowledge resources. This tacit knowledge supports 'make or buy' decisions for financial products and services in FP.

- *Knowledge on customers:* FP keeps a large database (EXPLICIT knowledge) on the customers (pension funds, banks, integrated asset managers), including emails, letters, contacts etc, to enable reports on customers and on processes, such as 'status of leads', 'current and previous relations', 'status of the order pipeline or projects per customer' (CRM).

- *Knowledge of financial markets including hypes.* The market of making and selling funds is an example of a slow market: large financial institutions ask for special financial products and services, and allow provider like FP enough time for product design and development. FP has structured the knowledge on the financial industry in more or less fixed themes that form the basis for the FP database (portal) and the automatic text categorization. (EXPLICIT knowledge).

(2) Which communities (of practice, interest or others) are relevant for your company?

The only real community (of practice; including two-way communication) in FP is the internal network of experts. There are no communities between FP and its clients or communities around products or processes, no communities around literature, and no living discussion groups on financial themes relevant to FP. Most external relationships are characterized by single channel client-provider communication. Other possible communities would be specialist meetings (seminars etc), creating a discussion platform for the issues in the pension world (through their yearly non-commercial pension summit and discussions with regulators, pension funds etc). FP does not know why these communities do not exist, but assumes that it does not fit the financial industry cultures.

(3) With respect to Operational Knowledge Management:

- *Who decides which (knowledge) resources will be assigned to a project (customer/ product/ process).*

FP distinguishes (like many other organizations) between customer related projects and product-push projects (internal projects). The project managers (two in FP) assign resources to customer related projects. The product group assigns resources to product-push projects. When resources are scarce, then product-push projects will wait in favor of customer projects.

- *How does this person determine the amounts and types of resources needed? Which goals does (s)he want to achieve? How are the goals evaluated?*

FP aims for high product quality (not (mainly) on low costs). In a small firm like FP, the allocation of resources to a project is an informal process, without using a database or CV matching, history matching, etc. This can result, however, in missing (forgetting) valuable and available resources in a project, but FP does not regard this as a big risk, and assumes that FP management does not need a formal system because of the limited size of the company.

- *How is the availability of (free) resources indicated?*

Project managers use the ‘standard FP guidelines’ (the soldiers’ handbook; explicit knowledge), their (tacit) knowledge on human resources, their tacit and explicit knowledge on the customer(s). But the method used depends also on the personal preferences of the project manager. FP does not actually measure the usage of available knowledge resources in categories a, b, d, e. FP only measures the usage of the human resources category. Of course the database keeps record of ‘what is stored’ and there is a category in the database (portal) on ‘what is hot or not’

- *In case of lacking or insufficient resources: how and with which person(s) is this communicated? Does your company (managers) use specific threshold values for resources?*

This is an informal process in a small firm like FP. FP has recently decided not to include financial hype-themes in the database; in other words, FP has decided not to restructure its EXPLICIT knowledge, nor to hire hype-experts to expand the human resources, adding TACIT knowledge. FP has concluded that the best business chances would come from using the available resources (= existing database themes and existing experts).

(4) With respect to Maintenance Knowledge Management.

- *How are knowledge resources created?*
- *Who maintains the resources, and how does maintenance take place?*
- *With which person(s) does communication take place on necessary knowledge resources? What are the objectives of these people?*
- *How is the availability of resources indicated?*
- *In case of lacking, insufficient (or excess of) resources: how and with which person(s) is this communicated? Does your company (managers) use specific threshold values for resources?*

Different groups and actors in FP manage the five knowledge resources listed under question 1. Knowledge on FP products and production processes are created and maintained by de various FP experts (knowledge workers). Knowledge in personnel is maintained by FP management, for instance, by making the decisions to hire or fire specific experts. Knowledge on customers is maintained in a customer database filled by experts and support staff. Knowledge of financial markets is maintained almost automatically by using automatic text categorization of a large amount of external data.

Communication on necessity of knowledge resources takes place within the community of practice in socializing processes.

(5) With respect to Long term Knowledge Management:

- *How is Knowledge Management linked to business objectives and business strategy? (e.g.: Why did your organization start the Intranet (community of practice)? Why did your organization decide to stop the portal activities?*

The portal use was satisfactory at about 100 hits per day (internal and external) and about 200 (external) subscribers. The portal-related newsletter covering the top-stories in the portal and fund-bytes (interesting quotes) was sent to 120 addresses each week. FP has stopped the newsletter and the automatic updates of the external portal per June 2003. The web site it self was not stopped, because news is still categorized, stored, and used by FP internally. Only the external portal services have been stopped, because the portal did no longer support business objectives: (1) markets are difficult for portals nowadays, (2) the services did not

contribute directly to the sales of funds, (3) the revenues from portal subscriptions did not sufficiently help to cover the costs of portal development. FP still keeps its portal and website including material and information on various topics, but without the updates.

FP uses customer contacts like client reactions; subjects of seminars, to find out 'hot issues'. Last year it appeared that there was a growing interest in alternative investment instruments. This did not result in the (long term) decision to put a new filter in the Smart Haven search engine that performs the automatic text categorization for the portal. It did result in a set of individual searches on this subject in the existing knowledge base without changing the structure. The answers were then used to present reflections on 'hot issues' to the customers.

- *How is the availability of knowledge resources indicated on the organizational level? In case of lacking or insufficient resources: how and with which person(s) are these communicated? Does your company (managers) use specific threshold values for resources?*

This is an informal process in a small firm like FP. FP has recently decided not to include financial hype-themes in the database; in other words, FP has decided not to restructure its EXPLICIT knowledge, nor to hire hype-experts to expand the human resources, adding TACIT knowledge. FP has concluded that the best business chances would come from using the available resources (= existing database themes and existing experts).

Summarizing, FP is a small knowledge intensive firm that distinguishes between five knowledge resources, several (internal and external; automatic and manual) processes of knowledge development, one community of practice, and one portal for internal and –until June 2003- external use. Three types of KM can quite easily be distinguished[4], as well as the key aspects for the three levels of KM. Quantitative indicators in FP KM are seldom found.

[4] The questions on the three types of KM were easily answered by the respondents, giving insight in the linkages between knowledge resources, using these in projects, maintaining the resources, and matching the resources to business needs over time.

4.2 Case 2: EP

EP is a division of a large company in the oil industry. EP has branches in 40 countries worldwide and 15,000 employees (and 15,000 as subcontractors and other indirect employees). The analysis is based on a paper by Van Dijck et al (2003) and interviews based on the questionnaire in June 2003 with two EP employees: a Knowledge Manager and an Accounting Services Manager, both from 'Commercial and Finance', one having a business and information management background, the other a former CIO of EP.

(1) What are the key knowledge resources in your company?

People are the key resource. When an employee leaves, EP uses an exit procedure: the personal network and key documents are stored. The KM objective of EP is to store human (TACIT) knowledge in databases (EXPLICIT) so that it can be used also after the people are gone. Many employees move to new positions, people often stay only 2-3 years in one position, leave the company, or retire. Human/ tacit knowledge is thus typically constructed over a period of three years. To preserve this tacit knowledge, it must therefore be transformed into EXPLICIT knowledge, distinguishing between:

- Knowledge on personal networks (informal and formal). An example is the worldwide 'who-is-who in EP' system.

- Knowledge on procedures and working processes. An example is the Global Document System (GDS) of EP, covering many EP documents, including geographical maps, and various links with internal and external libraries. GDS also stands for Global Dissemination Services, the department that provides document and information services to EP, having links with various internal and external information providers.

  Note that EP uses 12 instances of Livelink software logically operating as one system. There is one instance for each business unit and one instance for maps, charts, and drawings. All stored documents are available on-line.

The latest actual knowledge (TACIT and EXPLICIT) is covered in twelve forums (12 CoPs), supporting the formation of project teams, having 23,000 listed members of closed discussion groups (supervised by moderators). Additionally, various internal focused discussion groups and/or portals exist on themes like 'finance', 'GEO', Procurement Global Network, Benchmarking Global Network, (Business) Intelligence global Network, 'Finance', TaxNet, and GEO. These discussion forums are the most important tools to obtain answers to business questions.

EP aims to get EP employees worldwide to communicate. Therefore many tools are used.

- Explicit knowledge resources came into existence many years ago with external on-line information providers, which have since then transformed into 'one' (logical) library,

including search engines. In 2000, a project was started to create a ‘global virtual library’ with a portal as a tool for access and database integration.

- Currently also ‘external factual on-line services’ are provided. These have been integrated into an XML based data search environment on ‘business information’, ‘information on competitors, sister-organizations, and countries. Standards are the Tulsa thesaurus/ ontology with 64000 elements in 5 levels of which the first three are used for indexing. This development has lead to legal issues (Van Dijck et al , 2003) regarding screen scraping, copy rights, and laws on global software licenses.

- Portals are a special type of tools. Discovery.com is an EP portal (EP, 2003), introduced in 2003 to enable staff (geoscientists and well engineers) to share subsurface and well-related data and documents across three Operating Units. The portal was originally developed in 2000 on a smaller scale and scope, with limited functionality for one EP cluster. Early 2002, the scope was widened and users from two other clusters were included. Further roll out is planned in these two clusters in 2003. The portal provides access to well and petroleum engineering information, geological, geophysical, and production data. Users can search for fields, well bores, seismic and concession data. It also has a link to document management systems and it contains a geographical information system to show maps on which users can select an area and see the wells in that area. Main benefits of the portal are

    - ‘Harnessing and harmonizing knowledge by giving users access tot data rapidly’

    - ‘Enabling important data to be shared’

    - ‘Making the community feel connected’, while they are in three locations and are supposed to work together and share information. Discovery.com is a tool that helps them to identify with each other.

- EP-one portal is another important EP resource (see also Van Dijck et al, 2003). EP-One portal had 3000 users per May 2003 (out of 30.000 max) and is intended to become the main access to EP knowledge resources and communities. The business driver for the portal is mainly, in addition to above, to significantly improve informed decision making, reduce response times and as such improve competitive edge. The portal supports using existing knowledge (scattered over many dispersed groups and individuals) to develop new technologies (such as new drilling techniques). Key value is that the portal is linked to the personal workflows and systems of employees.

The portal is regarded to be an interface between data sources and many different users, each having an individual profile and information needs. To be effective the portal must have many (or at least a certain number of) users. The user base is enlarged by making the portal single log-on, role based, offers distributed search, filter and alert, etc. the technologies used are the EP Global Infrastructure Desktop (worldwide standard interface components), Single logon, Distributed federative search, Unified database connection, Filter and alert, Integrated

reporting, Drag and relate, GEC (General Embargoed Countries) compliance, user and location dependent accessibility, role-based functionality, and portal tools like search engines, taxonomies, knowledge bases, user profiles, etc.

Key tools and resources for the portal are a mix of old (who is who and email) and new technologies (Van Dijck et al, 2003, p. 9-10), including "Sniffers" to perform automatic XML-indexing of documents; taxonomy basis is the Tulsa-thesaurus (see above) which will be linked in 2003 to individual user profiles; and an attribute model with 50 elements as coordinates (GIS), copyright, retention date, export control.

Interestingly, the issue of 'authentic data source' is not relevant for the portal. Data on a specific subject can come from multiple sources, which are all presented (in a sequence that depends on the values of the sources). If a user is not satisfied with the data from some sources, he/she will disregard these data (this is logged and leads to lowering the values of the sources), or will contact the source individually, or reports to the help desk. However, the helpdesk is not very busy: with 3000 users there is only 1 call per hour. There are peaks when new user groups are added to the portal, but 'floor walking' by a help desk employee in the first and fourth week helps to prevent high numbers of calls and stimulates portal use.

Scalability of the portal is not a big issue. Only much –not very expensive- extra hardware is needed (in addition to the existing EP infrastructures), but logical flaws in information retrieval are not known. The portal is scalable up to over 100,.000 users by using user profiles, role-based filtering, and defaults.

(2) Which communities (of practice, interest or others) are relevant for your company?

There are now (2003) 12 *forums* (12 CoPs) in EP, covering the latest actual knowledge in specific domain, having 23,000 listed members in closed discussion groups (supervised by moderators). Additionally, various *internal focused discussion groups and/or portals* exist on themes like 'finance', 'GEO', and 'SAP'. All communities are virtual and use LiveLink software or dedicated tools like Alta Vista type of threads. The size of a community is typically between 100-1000 persons.

The forums support knowledge development in EP but are also important for business managers in supporting the formation of project teams across EP.

(3) With respect to Operational Knowledge Management:

a) *Who decides which (knowledge) resources will be assigned to a project (customer/ product/ process)?*

b) *How does this person determine the amounts and types of resources needed? Which goals does (s)he want to achieve? How are the goals evaluated?*

c) *How is the availability of (free) resources indicated?*

d) *In case of lacking or insufficient resources: how and with which person(s) is this communicated? Does your company (managers) use specific threshold values for resources?*

Operational KM in the sense of assigning knowledge resources to business activities, traditionally takes place in business clusters by VPs or cluster managers. Additional interviews are planned. With a change in organizational structure to matrix models, the role of discipline heads was introduced. They are responsible for assigning staff to projects and staff development in operational entities. Resource needs are determined together with the technical leads and depend on project type, scope, objectives, timing, etc. The discipline heads keep track of resource availability.

Project teams are created by using 'Orchestra', which also helps to track progress of projects. This is a project area management tool, using a simple taxonomy. People don't email documents but upload these in the tool. Typically projects have 10-20 people; projects run for about two years, but this depends on the project type. Four types are distinguished:

- *blue sky projects (innovative);* these are funded through a global service fee.
- *moon landing* projects, with a fixed target ('in 5 years we should be able to ….');
- *step-line* (problem driven/ solving);
- *opportunity* projects.

Processes are in place to list, evaluate, and prioritize project proposals by EP management (for example a process known as the Business Aligned Architecture). Added value of projects is determined through workshops with the business units

(4) With respect to Maintenance Knowledge Management:

a) *How are knowledge resources created? Who maintains the resources, and how does maintenance take place? How is the availability of resources indicated?*

b) *With which person(s) does communication take place on necessary knowledge resources? What are the objectives of these people?*

c) *In case of lacking, insufficient (or excess of) resources: how and with which person(s) is this communicated? Does your company (managers) use specific threshold values for resources?*

Skill pool managers manage the overall needs of EP staff together with the Human Resources function. They are responsible for overall staff availability, staff development together with the Learning & Development function and career prospects.

Staff development is appraised at least once a year against a Competency framework, and development tasks and targets for each individual defined for the coming year.

When staff/ engineers leave, user profiles are created and audit trails of problem solving sequences are recorded. New personnel can be trained faster. (1 month instead of 1 year)

EP stimulates the usage of the portal by 'selling' the portal to the business clusters and by creating short tailor-made reference guides and introductory courses. Usage is measured as 'the number of searches', 'the frequency of searches' (Van Dijck et al, 2003; p 25).

Maintenance of the portal is relatively easy; does not use many resources. Hardly any format changes are made in practice on the database level (although many users/ database owners say that these are often changed...).

Portal maintenance uses the 'beep system': corrections are only done when users start complaining about data quality, interfaces, and/or performance. The help desk then contacts the database owner. Complaints come in irregularly: on average 1 help desk call per hour

The Portal steering group and the Enterprise portal program management (Van Dijck, p9) can be regarded as parts of maintenance knowledge management. Additional interviews are planned to elaborate this aspect.

Another maintenance role is fulfilled by ITCT, this is the IT competence centre giving global IT support for KM, specifically for portals.

(4) With respect to Long term Knowledge Management:

a) *How is Knowledge Management linked to business objectives and business strategy? (e.g.: Why did your organization start the Intranet (community of practice)? Why did your organization decide to stop Internet activities (stop offering knowledge-based services)?)*

b) *How is the availability of knowledge resources indicated on the organisational level? In case of lacking or insufficient resources: how and with which person(s) are these communicated? Does your company (managers) use specific threshold values for resources?*

A governance body is in place for EP, which provides the basis for a single global KM process, relevant global standards and best practice identification, dissemination and assurance. In addition portfolio boards ascertain alignment with overall business objectives and strategy.

The EP portal business case was first based on recommendations made by a study, which assessed the efficiency and effectiveness of Knowledge Management in EP (two groups of knowledge workers had to answer a question, one group supported by the portal, the other

group without portal support. The portal supported group needed minutes to give a perfect answer (evaluated by another department), the other group needed several hours).

- General management requested further evidence of the business value of the portal before deciding on implementation. A pilot experiment in which 200 users from EP (all scientists, engineers, and knowledge workers) participated showed savings of at least 10% personnel, as reported by the business managers.

- In total, eight business cases were made for the EP-one portal. 3D graphical outputs are regarded to be one of the key values of the portal. Also, the portal helps to train new personnel much faster. Training time is now about 1 month and the productivity of personnel in the first year has doubled!

- After the pilot study business managers were asked to estimate the business impact of the EP-one portal to justify further investment in portal technology. . They estimated direct personnel cost savings of 10%. Over 2000 users (a $80k) this would add to $16m per year. In addition, significant indirect benefits were expected. Additional savings for instance are the reduced costs for the use of external databases (Van Dijck et al, 2003; p 6, 17). Expectations more than offsets portal costs, which are $120 per user per year.

- After several months 75% of the users say the portal is good/excellent and 70% acknowledges to save more than 1 hour per day because of portal use.

- The portal costs approximately 120 US$ per user per year of which 35% is for support, 35% for licences, 18% for new hardware (not including the existing large IT infrastructure of EP), 12% overhead.

Global business workshops are used in EP to decide on projects and go/ no go once per year in each business unit.

Summarizing, EP is a large knowledge intensive firm, operating on a worldwide scale, and focusing on the development and use of knowledge to find and win oil. Much knowledge is implicit and resides in many experts and professionals; other knowledge is explicit and available in the form of very large databases. Various communities flourish in EP, also linking EP to external groups and resources. EP uses a variety of technologies to support knowledge development in communities. We interviewed two employees belonging to the IT services domain in EP, resulting in a strong focus on IT tools, specifically portals, to support knowledge development and use. Investment decisions in portals show how EP uses business objectives to evaluate the value of knowledge development. Three types of KM can be distinguished in EP, but additional interviews are needed to discover how knowledge resources are actually managed.

5 Measurement in two Cases

After the analysis of KM in the two cases FP and EP we now analyze the measurements in both cases, using the approach given in chapter 3 and figure 5. Table 1 summarizes the findings for case FP, table 2 for case EP.

Only those *aspects* are identified which emerged from the interviews, assuming these are the aspects for which measurement is most essential. Example *indicators* are given, some of them hypothetical. Future research will have to show which indicators work best in practice, as well as which scales to use and quality criteria to apply. However, these examples seem reasonable illustrations of the measurement requirements emerging from the case analysis.

Table 1. Analysis of measurement in the FP case

Emerging aspects	**Example indicators**
• *Business Strategy* The mission is stable: creating and maintaining investment funds. No measurements needed here.	-
• *Customer Demand* The market of making and selling funds is a slow market: large financial institutions ask for special financial products and services, and allow FP enough time for product design and development. FP has structured the knowledge on the financial industry in fixed themes that form the basis for the FP portal and automatic text categorization. FP keeps a large database on its customers, including emails, letters, contacts, to enable reports on customers and on processes.	Time for product design and development # new terms in online thesauri; # requests for existing products 'status of leads', 'current and previous relations', 'status of the order pipeline', 'projects per customer'
• *Knowledge resources* A key resource is the database maintained of all hedge funds of a specific type. Keeping this database complete and up-to-date is essential. Knowledge on external experts is tacit, and distributed among the various employees. As this knowledge is essential for make or buy decisions, knowing who has external expert contacts is key. Knowledge on products, production of funds and customers is kept in large database. Accessibility of this information when needed is key.	-# of new items in related dbases; avg. # of dbase updates; avg. rating of users (subjective) - top 3 topics / expert (in this way, external contacts can be approached indirectly, by knowing the local expert on the topic) - Indices on these data to key topics, for example defined in an ontology. The amount and ranking of these indices form measurements of availability.

• *SLC (incl. community aspects)* The SECI processes and products are considered very important in FP. FP consists of a single, co-located community of practice. Its health is essential for effective business and KM performance	Indicators were defined in (Dijkstra, 2002). However, follow-up research has shown that detailed measurements are not considered useful in practice.
• *Operational KM* Operational KM is informal. However, mistakes can be made this way. More insight in available (human) resources could be useful.	- (per employee) # of unplanned hours in next month; # of projects involved in; self-assessment of hours available in next month
• *Maintenance KM* Five knowledge resources are distinguished in FP, managed by different groups and actors in FP: • Knowledge on FP products and production processes are maintained by FP experts. • Knowledge in personnel is maintained by FP management • Knowledge on customers is maintained in a customer database filled by experts and support staff. • Knowledge of financial markets is maintained almost automatically by using automatic text categorization of a large amount of external data. • Communication on necessity of knowledge resources takes place within the community of practice in socializing processes.	# manuals for products and processes. (implicit) frequency of use, # records added, deleted usage of portal
• *Long term KM* FP uses the portal as a strategic resource. It is important to know whether employee knowledge requirements coverage is still met. Also, key drivers in setting KM directions are (1) costs and benefits of portal use, and (2) contribution of knowledge resources to business objectives (add to the sales of funds)	Informal reactions during weekly internal meetings Total Costs of portal; informal indications of benefits

Measurement in FP

In (Dijkstra, 2002), nine objective indicators had been defined related to SECI processes and products. However, in the 2003 interviews it was found that these measures were not used anymore, nor considered useful in the longer term. The indicators currently used are related to explicit knowledge (on products, suppliers, customers, and markets (text categorization)) and implicit knowledge (in people). Indicators are not systematically measured.

Diagnosis in FP

Diagnosis does take place, but in a rather ad hoc and informal fashion, and based on subjective indicators only. Focusing on aspects and indicators suggested in the above table might lead to more systematic feedback and knowledge management improvements.

Table 2. Overview of findings in case EP

Aspects	Indicators
• *Business Strategy* Business strategy changes, and is decided in yearly global business workshops, by various project managers, and as teams are being formed. Awareness of business objectives is thus a key aspect.	business workshop minutes; lists of projects; summaries of project objectives;
• *Customer Demand* EP being a large, multinational, interdisciplinary and project-driven organization, most demands come from inside the company. Demands can be very complex, as shown by the stratification of project types. Thus, project objectives need to be clearly specified and continuously adapted as the project takes shape. Inter-project dependencies must be known, for example information about other project using or feeding into the current project.	project objective lists; project summaries; project planning; # of weeks ago that summary was updated; project sponsors/participant directories; lists of inputs provided by other projects; lists of outputs required by other projects
• Knowledge resources The data resources are centralized in the libraries and made accessible through the portal. Given the massive amounts of data available, it is impossible to manually index the collections. Key in making the libraries accessible is the thesaurus, which acts as a kind of ontology. Thus, one way to measurement efforts should be focused on thesaurus completeness and accuracy, and use. Human resources are key. The focus is not so much on individual but on joint performance. The contact networks of employees are strategic resources. Collaboration in the project teams and the communities of practice is essential for the success of the corporation. These communities are self-organizing.	# of queries; # of query refinements; # of index links to particular thesaurus terms; # of changes in thesaurus; # of thesaurus terms unused; # of jumps between libraries; most popular items in employee portal instances; types of customizations of portal defaults employee contact maps; social network analysis results (defining properties such as who are central nodes, linking pins, specialists, etc. in networks), FAQs, mailing list indices based on thesauri/ ontologies; avg. # of messages sent to list (indication of success/overload of network); avg. # of messages related to topic (indication of potential need for forming new communities/teams)
• *SLC (incl. community aspects)* EP has many virtual communities of practice. Their health is essential for effective business and KM performance Socialization is promoted, mostly in the various communities. It currently takes place mostly in an informal, per-need way. This is considered successful and does not seem to need extra measurement. Externalization of project data takes place in the Orchestra project area management tool. For intra-project purposes this may suffice. However, for related projects, various measurements on project updates could be very valuable. Using the thesaurus/ontologies to (partially automatically) index these data seems recommendable. Combination of project, library, employee, and group data	- See above - # of updates of project files; types of project file updates; authors of updates; documents related to project milestones One simple example is to have project files stored in folders indicating the project stage; the contents of their abstracts scanned by a sniffer, and indexed using thesaurus terms. This can be used to define the measure *colleagues currently actively working on problem/stage X*. This

offers great opportunities for productivity and collaboration improvements. The use of standard data mining techniques can already lead to large gains. For example, one important aspect may be the discovery of potential contributors when a project is dealing with a particular problem or has reached a certain stage. Internalization by definition has to be done by individuals. However, the risk in large, multiple project-driven organizations with much virtual collaboration across teams and communities, is that not enough time remains for this important process. More or less sophisticated indicators of employee internalization time could be constructed.	in turn can be very useful for operational KM. The range of possible indicators is very large. One relatively measure could be to make a weighted average of # of projects involved in, avg. # of billed average hours, and # of communities actively participating in.
• *Operational KM* Operational KM takes place by various managers. Information from the Orchestra tool can be helpful in calculating availability.	(per employee) # of unplanned hours in next month; # of projects involved in; self-assessment of hours available in next month; (per project) # of budgetted hours per stage; # of participants, avg. available hours of participants.
• *Maintenance KM* Maintenance of data resources largely takes place automatically: resources have been designed to be scalable, much of the indexing is done by automatic sniffers. However, portal use and effectiveness can be measured and advertised. One of the key assets to be preserved and made available are the individual contact networks and audit trails. These are now formalized upon exit of the employee. It might be worthwhile considering to record these networks also as the employee are still in their actual position. In this way, more active team and community formation can be promoted. When more insight is obtained in project activities and resources, as explaine above, project capacity and deficiencies will be much better assessable.	# queries, frequency of queries, # of complaints about data quality, avg. duration of complaint handling See also above under 'knowledge resources'; # last time that individual contact map was updated; similarity of patterns in audit trails of people doing the same task (can be used to define task templates, best practice workflows) Capacity and deficiency for a project can be better measured, when clearer indicators have been developed for the average workload (including community commitments) for the assigned project members.
• *Long term KM* Most long term KM is derived from the evolving stratified project planning, as done during the Global Business Workshops and by follow-up meetings of various managers. Business case success for various (expensive and risky) knowledge management initiatives needs to be demonstrated.	project portfolios; human resources assigned to projects; inputs from other projects; outputs into other projects; projected business benefits of initiative; pilot results

Measurement in EP

Not surprisingly, there seems to be a much larger need – and possibilities – for measurement in the EP than in the FP case. This can be explained by the larger size and virtuality of the EP organization. The measurements are a mix of quantitative and qualitative measures. Basic quantitative indicators play a role, but only an auxiliary one. Many measures are of the 'story' type, in the form of lists of objectives, project summaries, etc. However, in combination with (task-dependent) numerical indicators, powerful measurement instruments can be designed that directly influence workflows and business decision-making. Still, much of the potential

has not been realized yet, partially because the required data resources and information technologies have only recently started to mature, partially because the theories for pervasive KM at and between all levels (operational, maintenance, and strategic), are only now starting to develop. However, in the interviews, the need for experimentation and implementation of new, more sophisticated measurement instruments of the kinds illustrated has been clearly expressed.

Diagnosis in EP

Diagnosis is generally not an explicit, systematically supported process yet. Much of it takes place in the Global Business Workshops and at the managerial levels based on informal assessments of emerging problems or opportunities. Developing more advanced measurement processes, and carefully integrating them with existing business and knowledge management processes, many new opportunities for KM facilitation, application, and integration could be realized.

6 Discussion, conclusions, and recommendations

We investigated how KM exists in real cases, and focused on what knowledge intensive organizations regard to be effective KM and how they measure the effectiveness. In this paper we presented our first findings. Further analysis is necessary and additional interviews are needed to finalize our work, but some first conclusions can be drawn.

The hypothesis in this report was that '*measurement of knowledge resources increases the effectiveness of KM*' and we evaluated this hypothesis by using literature and the analysis of two cases. The hypothesis has lead to two questions: (1) 'when is KM effective?' and (2) 'is measuring necessary to realize effective KM?'

We found that the answer on 'when is KM effective' depends on the level of KM, as given in the knowledge governance framework. Effects of KM can be evaluated on three levels:

- The operational level: is the project successful (FP, EP), did the experts learn from each other (EP), do the communities develop (EP), and (on a department level) are knowledge resources used (FP, EP),

- The level of maintenance KM: are the portals and databases used (FP, EP),

- The level of long term KM: the business cases to decide on portal development (EP) and portal valuation to decide on continuation (FP).

Are measurements necessary to realize effective KM? Measurements in the sense of 'determining quantitative values over periods of time' were not found for most aspects of knowledge resources, knowledge development, and KM. We found that KM objectives can be qualitative, implicit, and emergent (FP) as well as explicit (the use of business cases for portal investments in EP).

Swaak et al (2000) also focused on quantitative aspects and suggest that measurements (including quantifications of subjective perceptions of knowledge workers) are necessary to be able to manage effectively. Indeed, in our cases we found some use of categories, aspects, and indicators, but not on the scale suggested by Swaak et al. Additional research in the cases might lead to the identification of more quantitative measures, but the usability of measures in KM practice must then still be proven. We hypothesize that quantitative indicators are used in long-term KM and in formal KM styles and not (or less) in other KM contexts.

Our point of departure differs significantly from Daniels and Melssen (task 2; see chapter 1) who assume the availability of quantifiable data on knowledge resources and develop a decision support tool that uses these data to choose the optimal project portfolio, assigning knowledge resources to project proposals. Our point of departure (task 1) is the search for

relevant indicators for KM. Therefore, the decision support tool (task 2) can only be applied after the indicators have been determined, and as long as the indicators are valid.

Obviously, tasks 1 and 2 also differ significantly in the scope of KM. We (task 1) see KM as a broad set of activities to guide the development and use of knowledge resources in an organization. Task 2 sees KM as the assignment of resources to a (business) project portfolio. This observation and literature analysis lead us to using the term 'knowledge governance' (and the 'knowledge governance framework' to investigate KM).

From the literature and the analysis of two cases we conclude that in most organizations, successful KM does not depend on measuring knowledge resources or quantitative analysis. For effective KM some parameters or relevant aspects might be selected, instead of aiming to measure everything. Our findings suggest that effective KM can result from informal forms of management without explicit measurements. This is in accordance with Chun Wei Choo and Bontis (2002) and Ciborra and Andreu (2001). More research is needed to find the conditions in which implicit and explicit coordination mechanisms for KM lead to success.

- Therefore we advice further research in knowledge intensive organizations (with high goal uncertainty and high goal diversity), varying in size (small, medium, large), varying in KM (implicit versus explicit in different management levels), with business results being the dependent variable.

We found that the forum-function of portals is important for communities of practice to enable the socialization process in knowledge development. The forum-function can be informal (like the collective Friday lunch in FP) or formal like the personal group pages found in the EP. Brazelton and Gorry (2001) state that complex questions of responsibility, commitment, and reward should not necessarily be used in communities. Instead, they advise to create the conditions for a knowledge-sharing community to emerge. This supports our findings that effective KM can result from informal forms of management without explicit measurements.

Finally, we analysed KM in one very small and one very large organization. In large companies KM is divided into 'tasks regarding developing and maintaining technologies, databases, and portals' and on the other hand 'tasks regarding the actual development of knowledge in the business activities'. Good functioning and alignment of the linkages between those two tasks are very important for successful knowledge governance. This resembles the classic information management challenges in the well-known strategic alignment model (Henderson and Venkatraman, 1993).

- We advise to apply KGF to the ABZ case and/or another mid-sized company in 2003 and to use the KGF framework for the analysis of case studies found in the literature. Also, before real conclusions can be drawn on 'how to realize effective KM', it is necessary to relate the analysis of the effectiveness KM to indicators of the effectiveness of the organization,

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