Enterprise Knowledge Infrastructures

2nd Edition

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Ronald Maier · Thomas Hädrich · René Peinl

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Preface for the Second Edition

Nearly four years have past by since the first edition of our book was published and we are very happy that the book has found its market and even more about the feedback from those readers who took some time to share their opinions about the first edition with us. As time has gone by, a lot has happened both in the development and adoption of technologies powering enterprise knowledge infrastructures and in the professional and personal lives of the authors. After our joint time at Martin-Luther-University of Halle-Wittenberg, life paths of the authors split again, so that our team turned into a virtual one, geographically spread from Hamburg via Hof to Innsbruck. Co-authoring this edition provided us with numerous opportunities to reinforce our excitement about how convenient it is to collaborate across locations. We have gained plenty of new experiences in research as well as in practice and several of them have been included in this new edition.

One surprising experience is that despite all changes in information technologies, like the advent of Web 2.0 and the corresponding acceleration of browser-based applications as well as the explosion of user-generated contents, the core proposition of the book still remains an attractive and challenging one. The need for integration of existing systems instead of introduction of new isolated ones is unchanged. It typically takes many years until new technologies are adopted, particularly in traditional businesses and organizations. There are many reasons for this phenomenon which has been profoundly described in numerous technology-adoption models in the literature. The majority of enterprises does not qualify as IT innovators and thus refrains from investing into what could be a hype without prove that there are measurable benefits to be gained. Integration efforts are especially challenging endeavors because they are often spanning organizational units and need sponsors and champions that think in a more holistic way instead of single system classes. Not only technical boundaries have to be bridged, but also organizational boundaries with people fearful about loosing power over their system if it is integrated into the overall infrastructure. So, enterprise knowledge infrastructures can be seen as complementing organizational efforts to bridge departmental boundaries with process-orientation, in this case knowledge processes, not business processes as with ERP solutions.

The second edition reflects this understanding of enterprise knowledge infrastructures by rearranging knowledge services into the 5-I model of knowledge maturing. This new substructure of the book is intended to allow for better teaching and learning. It takes on a more dynamic, process-oriented perspective on knowledge and knowledge services. The authors hope that the major additions to knowledge services make the vision of the book more comprehensible. The edition has been profoundly extended and completely revised throughout all chapters. Product examples and overviews have been updated to the latest market data. Updated definitions and conceptual foundations ease understanding of the subject matter. Case examples have been added for each main chapter and, last but not least, the general didactic approach of the book has been improved.

Such an effort in addition to three full-time jobs is only possible with numerous helping hands for proof-reading, suggestions for further improvements and taking over some other

tasks unrelated with the book in order to free time which we could invest in thinking, discussing and writing. The latter is especially true for our partners who have been most understanding about us indulging into writing a book which cannot be taken for granted at all. We also like to thank our students and colleagues, the team at the Dept. of Information Systems, School of Business at the University of Innsbruck, and especially Nadine Amende, Dominik Grimm, Andreas Kaschig, Tanja Kohn, Alexander Sandow and Stefan Thalmann. Some of them are former students who have decided to take on an academic career and have expanded our social network to new universities and renewed the links to colleagues with established relationships. We find it essential to keep exchanging opinions, especially with those having different professional backgrounds as they bring in new ideas and different views. We hope that you, the readers, find the book inspiring for further exploring ways how IT can increase productivity of knowledge work in the 21st century. Finally, we would like to invite you to share your opinion about our book and the ideas behind most easily by email (ronald.maier@uibk.ac.at, thomas.haedrich@opentext.com, rene.peinl@hotmail.de).

Ronald Maier
Thomas Hädrich
René Peinl

Innsbruck, Hamburg, Hof and
many places with Internet connections, November 2008

Preface for the First Edition

Both, academics and practitioners alike have spent considerable efforts during the last years to establish ICT support for the handling of knowledge, an idea that is almost as old as the field of computer science. Not surprisingly, the solution is still not there and many businesses trying to implement these technologies have been frustrated by the fact that the technologies certainly could not live up to the overly high expectations. However, there are still numerous projects in organizations that try to tackle the fundamental challenge of how to increase productivity of knowledge work. People do not believe in quick solutions to this problem any more - and they are right. Knowledge management is dead. Long live knowledge management!

Central hypothesis of this book is that the implementation of KM technology in organizations has entered a new stage. In the last years, many vendors jumped on the bandwagon and insisted that their products had "knowledge management technology inside". More recently, however, it seems that many technologies provided by avantgarde systems to support handling of (documented) knowledge, finding of, collaboration between and learning by people doing knowledge work, were weaved into the enterprise infrastructure implemented in many organizations. It is not anymore the quest for the best individual tool targeting a specific KM problem that organizations should engage in. Organizations should strive for improving their information and communication infrastructures so that they are able to handle semantic descriptions of integrated, semi-structured data and offer advanced knowledge services on top of them.

Within this field, the book combines a thorough treatment of the vision of an ideal enterprise knowledge infrastructure on the one hand with a comprehensive description of concepts, standards, tools and systems that are already available and can help to implement this vision on the other hand. We hope that the book will help you to understand the complex matter, that you will enjoy the ideas presented here, discuss them in teams and communities, gain new insights by answering the questions and exercises and that you will be motivated to develop them further. Additional support and contents can be found at the supporting Web site. Please visit: URL: http://www.wiwi.uni-halle.de/maier/EKI/. You can also contact us by email. Any comments are most welcome at: [maier, haedrich, peinl]@wiwi.uni-halle.de!

The book presents the results of the development of courses and programs in knowledge management (systems) for the University of Regensburg, Danube-University of Krems, Austria, and Martin-Luther-University of Halle-Wittenberg. In the last two years, the authors have jointly developed five courses that together present and train to use the concepts in this book at the Department of Management Information Systems, Information Systems Leadership of the Martin-Luther-University of Halle-Wittenberg. During this period we also established a basic knowledge infrastructure at our Department that helped us to exchange ideas and step-by-step develop the concepts that are now part of this book.

Many people have contributed to our thoughts on enterprise knowledge infrastructures. We would like to thank our students for sharing their experiences gained in many organizations implementing KM technologies who inspired us to come up with a book that consis-

tently presents the material scattered across a large number of sources, our teaching assistants for drawing some of the figures, for their support in implementing some of the tools and for numerous remarks on the material and last but not least all colleagues at our Department as well as our friends working in other Departments spread all over the world for many fruitful discussions and proofreading of the manuscript.

Ronald Maier
Thomas Hädrich
René Peinl

Halle / Saale, February 2005

Contents

1 Foundation

Knowledge

Information and communication technologies (ICTs) to support handling of *knowledge* in organizations have been discussed for quite a long time. In the beginning of applying ICTs, it was routine work that was first prone to automation. ICTs gradually broadened their scope and have been extended to embrace highly valued work that years before hardly anybody would have believed that it could be supported by ICTs. Back in the 50s to 80s of the last century, various waves of systems applying artificial intelligence (AI) technologies had a powerful impact on concepts of knowledge, not only in the discipline computer science, but also in fields, such as cognitive psychology. However, many business organizations trying to implement these technologies, first advertised as "general problem solver", were frustrated by the fact that the technologies could not live up to the overly high expectations. Instead, they showed comparably high complexity and difficulties in applying them to business challenges. Thus, AI technologies survived only in special and narrow application fields.

Knowledge work

In the 90s, after a period of high attention to increasing efficiency, organizations were faced with the transformation of society into a *knowledge society*, of economy into a *knowledge economy* and its challenges to significantly increase the speed of innovation and improve the way organizations handle distributed and fragmented knowledge. For those countries that have not (any more) the possibility to exploit some form of natural resources, it is primarily or even only knowledge that creates wealth. Knowledge work requires a high level of skills and expertise from employees and an organizational design that creates an environment conducive for this type of work. Increasing productivity of knowledge work is topical in a time of increasing knowledge intensity of processes in businesses and organizations. It requires continuous and consequent commitment from all organizational levels.

Knowledge management

Concepts of *knowledge management* (KM) have been suggested to meet these challenges, starting with highly innovative work by authors such as Davenport, Nonaka, Sveiby or Wiig, just to name a few. Many authors from a variety of disciplines have created, applied and reflected a number of approaches, concepts, methods, tools and strategies for knowledge management. In its short history, knowledge management has absorbed a wide array of research questions which has made it interesting and attractive for a large community as diverse as its authors with backgrounds in management science, organization science, psychology or computer science. At the same time, however, the field of knowledge management has struggled with numerous terms used differently, incommensurable approaches and its lack of clear profit impact in a business context.

Knowledge management phases

During the last twenty years, businesses have faced four distinctive phases of KM. The first phase could be termed human-oriented KM. Organizations realized the value of their "human capital" and bundled a number of instruments aiming at the individual knowledge worker and her productivity. The next phase was backed by tremendously increased opportunities offered by ICTs and could be called technology-oriented KM. Organizations were eagerly experimenting with new ICTs in attempts to benefit from the promised changes that would come about by implementing KM tools and systems. In a third phase which primarily was fueled by the emphasis on business processes typical for German-speaking countries, KM methods, tools and instruments were repositioned as knowledge processes and linked to knowledge-intensive business processes. Thus, KM initiatives could be designed with the same language as used in organizational design and IT support of business activities in general, the language of business processes. After human-oriented, technology-oriented and process-oriented KM, recently a fourth KM phase has reached businesses backed by the hype keywords Web 2.0 and social software: collaborative KM. While in many organizations knowledge workers are busy trying out new alternatives for production of contents, for networking and for self-directed learning, questions arise how these activities can be coordinated or guided so that they are in line with organizational goals.

Knowledge management systems

Backed by tremendous interest in KM in academia and business practice, vendors of ICT systems as well as researchers showed prototypes, tools and systems to support KM called knowledge management systems (KMSs). This term, however, is a misnomer. On the one hand, knowledge in many definitions (section 1.1.2, 15ff) is either bound to people or extracted from an expert and made available in specially designed systems, so-called knowledge-based systems. On the other hand, management is a term that denotes the software-supported handling, e.g., storing, administering, updating and retrieving of (business) objects when used in connection with ICTs. Examples are database management systems or document management systems. However, strictly speaking, KMSs neither contain knowledge nor do they manage it. The term KMS has been a strong metaphor for developing a new breed of ICT systems, though. In this view, KMS combine, integrate and extend a number of heterogeneous ICTs, e.g., AI, communication, coordination and collaboration systems, content, document and learning (content) management systems, search and visualization systems. Given the complexity of these technologies, it seems obvious that the development of KMSs is a complex undertaking.

Knowledge infrastructure

In the last years, many vendors have insisted that their products have "knowledge management technology inside". More recently, however, it seems that many technologies that have been used by employees to support knowledge work have been woven into the ICT infrastructure implemented in many organizations. Whereas enterprise resource planning sys-

tems target the informational representation of business transactions, *enterprise knowledge infrastructures* (EKIs) create an ICT environment for *knowledge work* throughout the organization.

Overview

Chapter 1 provides the foundation for the numerous technologies that can be used to build EKIs. Section 1.1 discusses the term knowledge and distills specifics that are required to understand its use in connection with the terms management, work and infrastructure. Section 1.2 reflects on the underlying characteristics of the type of work that has to be supported by EKIs called knowledge work. Section 1.3 discusses the most important approaches and concepts of knowledge management. Section 1.4 specifically targets instruments that have emerged from 20 years of research on knowledge management and can more or less readily be applied in organizations. Finally, section 1.6 introduces the key term in this book, EKI.

Learning objectives

On completion of this chapter, you should be able to

- define the most important KM concepts and approaches,
- identify the many facets that the term knowledge has in different perspectives and analyze the challenges for its systematic management,
- employ the presented framework to classify knowledge along a number of important dimensions,
- analyze the potentials of KM in organizations,
- appreciate the need for a systematic handling of knowledge to improve productivity of knowledge work,
- identify the changed requirements for the design of ICT posed by knowledge work,
- describe state-of-the-art KM instruments applicable in organizations,
- define the concept of architecture and discuss its benefits,
- distinguish types and alternatives of architectures in organizations,
- define the concept of (Web) service that is at the core of a service-oriented architecture,
- explain the EKI concept and relate it to the broader concept of an organization's information and communication landscape,
- identify EKI layers and services.

1.1 Knowledge

Roots in philosophy

The importance of knowledge for societies and particularly organizations is rarely questioned and has been studied for a long time. The foundation for Western thinking about knowledge can be traced back to Greek philosophy. However, this book cannot give a comprehensive overview of defi-

nitions of knowledge because even a limited review of work done in philosophy would fill books, nor can it give an all-encompassing definition.

Organizational perspective

Instead, some important conceptualizations of knowledge which have made their way into various classes of KM approaches will be reviewed from an organizational perspective (section 1.1.1). Due to the major role that organizational knowledge plays, there are a number of related terms that have to be clarified, such as capability, competence, expertise or intellectual capital. Some facets of the term knowledge will be selected to discuss the implications on the definition, the design and the implementation of EKI. Then, the term is defined in the context of EKIs (section 1.1.2). Also, important dimensions will be distinguished that help to classify knowledge used in organizations.

1.1.1 Knowledge in Organizational Settings

Knowledge transforms organizations

The transformation of organizations into knowledge-intensive and knowledge-aware organizations takes place at an ever-increasing pace. Knowledge as the key resource, not labor, raw material or capital, changes production functions in organizations significantly. *Knowledge* represents the key concept to explain the increasing velocity of the transformation of social life in general and the way businesses and social institutions work (Drucker 1994).

Use of the term knowledge

The term *knowledge* is used widely, but often quite vaguely, even within the KM field. There are many definitions which differ not only between scientific disciplines contributing to KM, but also within these disciplines and thus also within the KM field. Moreover, the definitions of knowledge lead to different perspectives on organizational knowledge and, thus, to different concepts of interventions into an organization's way of handling knowledge.

Relation to other concepts. Knowledge is related to many other concepts. The most often cited relationships are those to data and information. Figure 1-1 shows a common depiction of the relationships between data, information and knowledge.

Data

Data refers to symbols, e.g., characters or numbers, ordered to an elementary description of a person, thing, event, activity, transaction or state in the perceived reality or imagination of persons. Data can be recorded, classified and stored, but are not organized to convey any specific meaning. Data items can be numeric, alphanumeric, figures, sounds or images. With respect to ICT, data items are stored in organized databases.

Information

Information is seen in a multitude of ways, but most definitions draw the line between data and information with respect to meaning, the semantics that are commonly assigned to interpreted data, also called information, but not to (raw) data. There are basically two main perspectives:

- Information is data that have been organized so that they have meaning and value to the recipient. The recipient interprets the meaning and draws conclusions and implications.
- Information is the result of a person's interpretation of signals from the environment, whereby the result depends on the person's knowledge and the context of the interpretation.

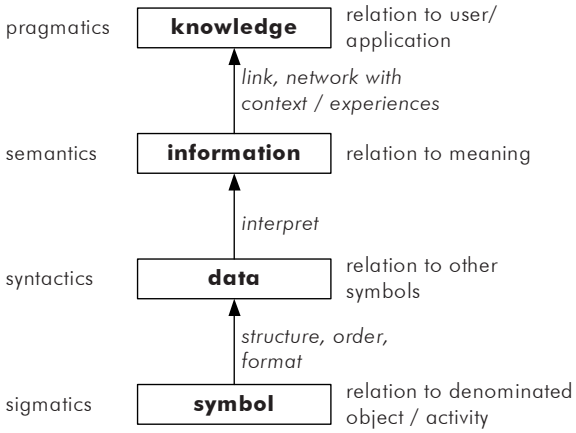

Figure 1-1. Data, information and knowledge as hierarchy of terms

Classes of knowledge

Many classifications of the term knowledge use a dichotomy to describe one type of knowledge and its opposite. Table 1-1 presents some examples for important classes of knowledge that are organized with respect to person, organization, context and ICT (Maier 2007).

Agreement about important dimensions

The variety of definitions of the term knowledge is due to the variety of research subjects which require more or less focus on knowledge. At least to some extent, there is agreement among KM researchers about the most important dichotomies and characteristics of knowledge, such as individual versus organizational, implicit versus explicit, organization-internal versus organization-external knowledge (section 1.1.2).

Consequences for KM. In the following, some important characteristics of knowledge are summarized which have consequences or provide challenges for EKI design:

Economic differences to information

Unlike information, knowledge is not easily transferred. The costs for the "distribution" of knowledge can be very high. Unlike information transfer, it takes time for individuals to reconstruct knowledge because this process not only requires interpretation as in the case of information, but also requires learning. Thus, it takes substantially more effort to implement a systematic management of knowledge transfer as compared to the transfer of information. There are a number of institutions that provide an

environment conducive to knowledge transfer and thus to learning. This environment can be viewed as an activity system in which "knowledge seekers", "students" or "apprentices" not only directly learn from "knowledge providers", "teachers" or "masters", but also from participating in a community of practice of all the knowledge seekers and knowledge providers in a joint setting, e.g., schools, universities, management centers, corporate universities, industry organizations offering apprenticeships.

Table 1-1. Classification of knowledge

area	**dimension**	**values**
context	abstraction	narrative/concrete - scientific/abstract
	generalization	particular - universal
	representation	declarative - procedural
ICT	access	accessible - inaccessible
	medium	electronic - non-electronic
	codability	codable - non-codable
organization	relevance	relevant - irrelevant
	authorization	informal - formal
	security	private - public
	ownership	internal - external
person	value	valuable - not valuable
	awareness	implicit/tacit - articulated/explicit
	support	supported/dominant - unsupported/minority
	existence	knowledge - not knowledge

Figure 1-2. Classification of knowledge

"Transfer" of knowledge

Several authors dealing with ICT support for KM have written about systems supporting transfer or distribution of knowledge. In this area, not only explicit knowledge is considered which can be transferred with the help of, e.g., documents, but also the tacit side of knowledge. The latter can only be handed on directly from teacher to learner (socialization).

Transfer of data vs. transfer of knowledge

According to most definitions of data, information and knowledge *only data can be transported or communicated* which in turn is interpreted by individuals or social systems. Therefore, even knowledge infrastructures essentially contain and support communication of data, not knowledge. However, the "transfer" or "sharing" of knowledge denotes the simplified and shortened process including interpretation of the message (information) and actualization or extension of knowledge by the receiving system.

Figure 1-3 shows the complete communication process of data, information and knowledge. Transfer of knowledge implies that the sender is quite certain that the receiver will be capable of interpreting the data accordingly, (re-) construct the knowledge and use it to actualize the receiver's knowledge in a way that the sender intends.

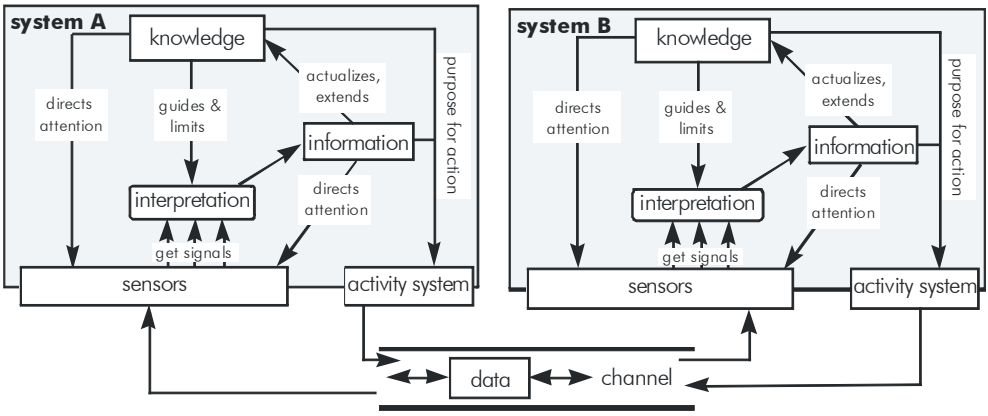

Figure 1-3. The transfer of information and knowledge

Reconstructing knowledge

Note that the sender cannot be sure that the receiver will interpret the data as intended by the sender. Additionally, according to modern theories in the cognitive sciences with each transfer of knowledge, the knowledge itself is changed not only at the receiving end, but also at the sending end of the communication as it is not just "retrieved" in memory, but reconstructed and the knowledge's context is thus changed with each transfer.

Relation to context

Knowledge is developed in a cultural context with social, political, economic and ideological dimensions that exert continual forces on both the substance and the process of scientific knowledge creation. What has been said about scientific knowledge creation is all the more true in organizational settings. Organizations are not regularly striving for absolute truth, but for a socially constructed reality that allows for successful organizational actions. Knowledge cannot be separated easily from the context of its creation, reception and application.

Protection of knowledge

Another important challenge in organizations is protecting valuable knowledge, e.g., against industrial espionage. Examples for measures that prevent the unwanted use of organizational knowledge are classification or property laws and organizational instruments such as incentives, conduct rules or postponing of rewards because a great deal of knowledge valuable to an organization resides with single employees.

In some cases, it is opportune for organizations to share knowledge with competition (coopetition) and thus systematically manage diffusion of otherwise restricted, i.e. patented, classified or confidential knowledge,

e.g., through mechanisms such as visiting each other's production facilities, consortia or benchmarking. One implication on the design of EKI is that valuable knowledge must be protected from leaving the organization unintentionally, so it might not be appropriate to make it completely transparent, e.g., to publish it on the organization's Intranet, but to disaggregate the knowledge so that it cannot be taken easily to a competitor.

Knowledge as product vs. process

Knowledge can be conceptualized as a product or as a process. Both concepts are important, though they have differing implications on the design of EKI. Basically, explicit knowledge can be documented and stored in knowledge repositories whereas (more) implicit knowledge has to be supported indirectly through ICTs used to broker and handle communications.

"Right" quantity of knowledge

Many KM approaches implicitly hold the presupposition that *the more knowledge* an organization holds*, the better* for the organization. Applying this simple equation can be dangerous because it does not consider, e.g.,

- that knowledge created in an organization might not be useful,
- that communicating knowledge expects quite a lot from the receiving system (individual or social), namely that the system rebuilds its knowledge structures,
- that knowledge is in a sense provisional and is held until better knowledge is created,
- that more measurable knowledge in terms of, e.g., publications or documents not necessarily means that the organization can act or interpret more intelligently,
- that knowledge increases "not knowledge" which causes the paradox that the more an organization knows, the more knowledge it demands which in turn leads to less efficient daily operations.

As a consequence, EKI have to consider this danger of information overload and inefficient "oversupply" of knowledge. Attention has to be paid to, e.g., contextualization, filtering, profiling and to determining the optimal portion, level and granularity of knowledge that is presented.

Multi-faceted knowledge

EKIs differ in design and implementation from more traditional application systems. The term knowledge as used here comprises among others valuations, opinions or forecasts, whereas more traditional application systems focus more or less exclusively on hard data. Also, the design of EKI has to consider the multiple electronically available sources of data such as documents, files, messages, contributions in newsgroups, multimedia elements or links to these sources which all might contain useful knowledge once structured, linked and contextualized. Thus, EKI can be combined with an organization's already existing information systems (IS).

Role of knowledge in different types of organizations

Classifications of knowledge can be used to postulate different requirements or perspectives for KM initiatives and supporting ICTs. Table 1-2 shows four types of organizations that differ with respect to the focussed type of knowledge and thus require support by different ICT.

The distinction uses the organizational level from which the primary contributions to the fulfilment of organizational goals is expected, i.e. individual versus collective, and whether the focus is on familiar or on novel problems. Empirical analysis suggests trends that organizations are transformed from type I, II and III into type IV organizations.

Table 1-2. Organizations according to types of knowledge (Blackler 1995, 1030)

	Type I: expert-dependent	**Type II: knowledge-routinized**	**Type III: symbolic-analyst-dependent**	**Type IV: communication-intensive**
level	focus on individual	focus on collective	focus on individual	focus on collective
type of problems	familiar problems	familiar problems	novel problems	novel problems
type of knowledge	embodied competencies of key members	knowledge embedded in technologies, rules and procedures	embrained skills of key members	encultured knowledge and collective understanding
characterization	performance of specialist experts is crucial; status and power from professional reputation	capital, technology or labor-intensive; hierarchical division of labor and control	entrepreneurial problem solving; status and power from creative achievements	key processes: communication, collaboration, empowerment through integration
example	professional bureaucracy, e.g., hospital	machine bureaucracy, e.g., traditional factory	knowledge-intensive firm, e.g., software house	adhocracy, innovation-mediated production
role of ICT	computer displacement of action skills	computer integrated work systems	information support and XPS design	development of cooperation systems (CSCW)

Strategic aspects of knowledge

In the context of management science, concepts can be distinguished that stress the importance of knowledge as a strategic organizational resource. It is well worth to briefly review these concepts and their theoretical basis because the distinctive definitions of knowledge and related concepts help to understand the different perspectives taken in the literature and also allow for a characterization of KM approaches.

Resource-based view

This perspective is called the resource-based view and builds on ideas presented in the theory of the growth of the firm (Penrose 1959, Wernerfelt 1984). Central idea of the resource-based view is that an organization's success is determined by the existence of organization-specific unique resources. As opposed to the market-based view (Learned et al. 1965, Porter 1980), competitive advantages are not due to superior positioning of an organization in an industry, but due to superior quality of resources or a superior use of the organizational resources. Heterogeneity of resources between organizations enables sustained competitive advan-

tages and is determined by individual historic developments of organizations, by developing specific material and immaterial resources and by creating complex organizational routines which cause specific historical trajectories and lead to unique idiosyncratic combinations of resources.

Enduring resources

Another central assumption of the resource-based view is that in uncertain and dynamic competitive environments, products and services demanded in the market change quickly, whereas resources and capabilities are more enduring. As a consequence, proponents of the resource-based view suggest to base a strategy on resources rather than on product-market combinations as suggested in the market-based view. Resources are seen as platforms for developing varying products and services.

Knowledge-based view

A more focused version of the resource-based view is called the knowledge-based view, stresses the importance of knowledge as an organizational resource and plays a role in embedding KM into corporate strategy.

Terms stressing strategic relevance

In order to avoid confusion with the traditional view on the term resource and stress the strategic relevance of organization-internal assets, several terms have been proposed which are discussed in the following.

Organizational resource. A firm's resources at a given time could be defined as those (tangible and intangible) assets which are tied semi-permanently to the firm. This organization-specific element is what distinguishes resources in the resource-based view from the traditional viewpoint in economics or business administration with its primary production factors land, labor and capital. Resources in the resource-based view typically have to be built and cannot be bought.

Classification of resources

Organization-specific resources can be classified in a multitude of ways similar to knowledge (see Figure 1-2 on page 6). Figure 1-4 presents a typical classification of resources and gives some examples. *Tangible resources* are detailed in financial and physical resources. *Intangible resources* are classified into person-dependent and person-independent ones. *Person-independent resources* are further divided into intangible and organizational assets. *Intangible assets* have a relationship to the organization's environment because they are either legally secured, e.g., patents, intellectual property, or refer to business partners, e.g., networks, customer relationships, reputation. *Organizational assets* refer to the organization's culture, e.g., willingness to share knowledge, perception of service and quality, and routines, e.g., learning cycles, managerial systems, and do not have a direct relationship to the organization's environment.

Classes overlap

The detailed classes overlap to some extent, especially with respect to the dimension person-dependency as, e.g., smooth functioning of networks, classified here as person-independent, certainly depends on contacts of single employees.

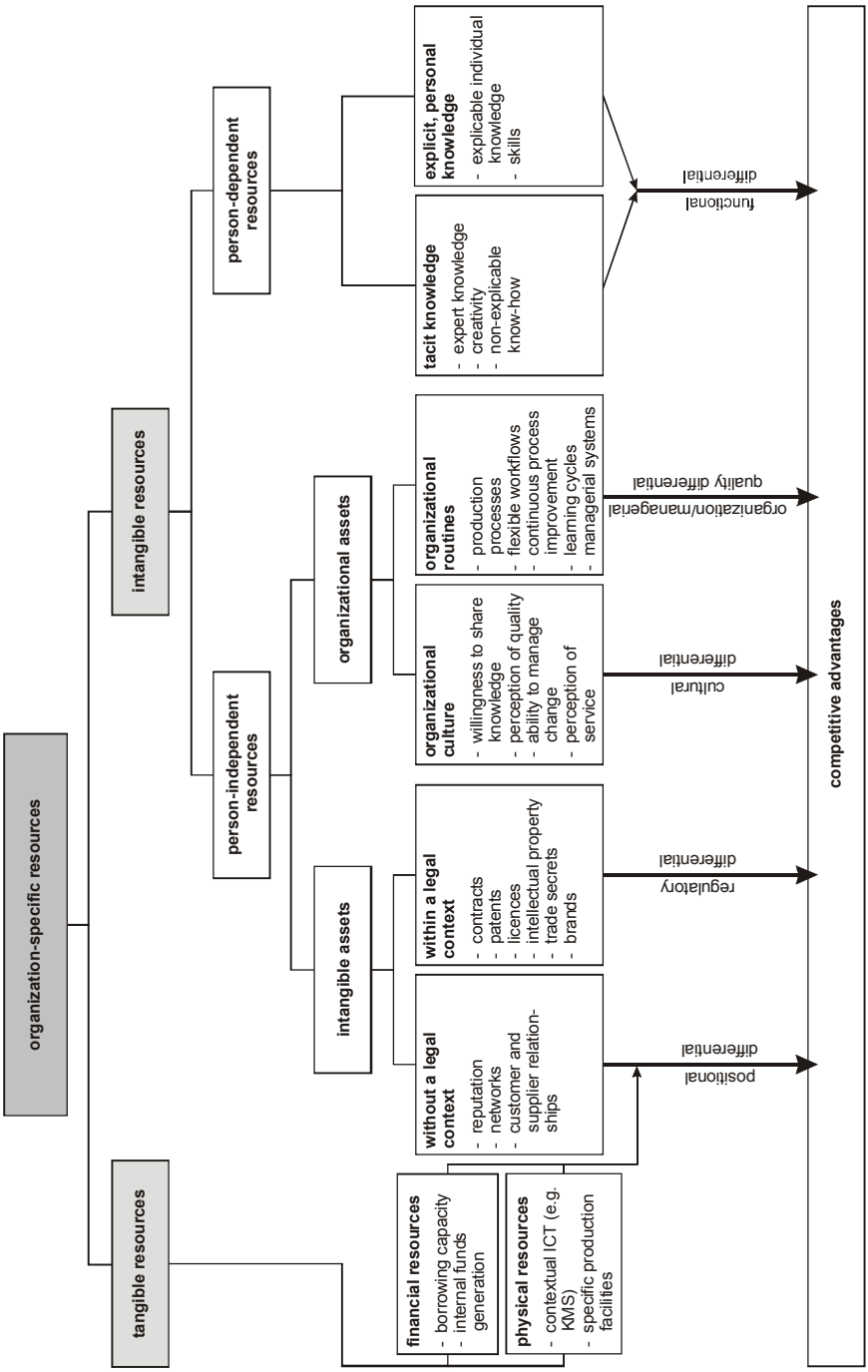

Figure 1-4. Classification of resources (Maier 2007, 99)

Organizational capabilities. Resources are combined, consolidated or applied in an organizational context to form capabilities which are "teams" of resources working together or an interconnected set of knowledge collections in the sense of a tightly coupled system. In situations of quickly changing complex environments, dynamic capabilities are crucial which are defined as a firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments.

Capability differentials

Figure 1-4 also shows that the value of sets of interconnected organizational resources has to be determined in relation to the competition. A comparison reveals so-called capability differentials. Five types of capability differentials can be distinguished:

- *functional/business system differentials*: result from knowledge, skills and experience of employees and others in the value chain, e.g., suppliers, distributors, lawyers, agents working for the organization,
- *cultural differentials*: apply to the organizational culture as a whole; however, organizational routines are considered as functional differentials because they are transparent and subject to systematic and intended change as opposed to the organizational culture. Cultural differentials are also closely related to organization differentials,
- *organization or managerial quality differentials*: result from an organization's ability to consistently innovate and adapt more quickly and effectively than its competitors. As it is probably easier to systematically influence the quality of managerial systems than it is to influence the organizational culture, managerial systems might constitute a factor that can be distinguished from cultural differentials,
- *positional differentials*: are a consequence of past actions which build reputation with business partners, especially customers,
- *regulatory/legal differentials*: result from governments limiting competitors to perform certain activities. Regulatory differentials thus are based on those resources that are legally secured, such as patents, contracts, licences or trade secrets.

To sum up, resources are the basis for capability differentials. Capability differentials provide competitive advantages which can be leveraged in order to produce superior products and services.

Depreciation of knowledge

As organizational capabilities are determined with respect to competitors, it is only a certain time frame during which they provide competitive advantages. The speed with which innovations penetrate entire industries creates the need to reduce the cycle-time with which new processes and technologies are applied and turned into new products or services.

Characteristics of strategic resources

Strategic capabilities or (core) competencies. Capabilities and competencies are often used synonymously. Organizational competencies, however, are focussed on knowledge as resource, therefore on the functional/business system differential. They are directly related to an organization's

strategic choices and are based on a combination or integration of the (individual and common or organizational) knowledge. In order to be *strategically relevant* and capable of providing sustained competitive advantages, resources must have the following characteristics:

Scarce

(1) Resources must be rare, otherwise competitors can access them easily and no competitive advantage can be gained from their use.

Competitively superior

(2) Resources must either enable organizations to create value for their customers, thus contributing significantly to the perceived customer benefits or to substantially improve effectiveness and efficiency of the organization's processes. Additionally, the value of a resource depends on the relative advantage it bears when compared to the competition.

Multi-purposeful

(3) Resources must provide potential access to a variety of markets. In other words, resources must be applicable in a multitude of products and services and a multitude of markets in order to be of strategic relevance.

Non- or imperfectly imitable

(4) Resources must not be easily replicated in rival organizations. Replication is difficult, e.g., due to *unique historical conditions* in creating the resources, *causal ambiguity*, i.e. imperfect information or lack of transparency, *social complexity*, i.e. several individuals jointly provide competitive advantages, or *embedding in organizations*, i.e. several resources can be complexly interrelated and integrated within an organization's routines or culture. Thus, there exist so-called barriers to imitation in analogy to the entry or mobility barriers in the market-based view.

Non-substitutable

(5) Resources must not be easily substituted by other resources in order to generate sustained competitive advantages. Thus, a variety of other resources can threaten strategic relevance of a resource.

Non-transferable

(6) A competitive advantage will be the more sustained, the more difficult it is to acquire the resource, e.g., in cooperation with other organizations. The reasons for a lack of transferability are partly the same as the ones presented for lack of imitability, e.g., geographical immobility, imperfect information or the fact that resources are firm-specific.

Durable

(7) Longevity of competitive advantages depends upon the rate at which the underlying resources depreciate or become obsolete. Durability varies considerably, e.g., technological resources depreciate quickly due to the increasing pace of technological change whereas reputation and brands are more durable.

Appropriable

(8) Resources must be legally undisputed. Profits from a resource can be subject to bargaining, e.g., with business partners, such as customers, suppliers or distributors, and employees. The more knowledge work is on the rise, the more employees know of their capabilities and negotiate with their employers about the value of their contributions. The more an employee's contribution is clearly identifiable, the more mobile this employee is. The easier an employee's contributions to capabilities can be transferred to other organizations, the stronger is the employee's position in negotiations with the organization.

From resources to competitive advantage

Figure 1-5 depicts a framework showing the chain of arguments used in the resource-based view for conceptualizing the relationship between resources and the more recent concepts of organizational capabilities or competencies and in turn their relationship with competitive advantages. Consequent management of organizational resources thus has to identify, select, develop, synergistically connect, transform and retain organizational resources and integrate them into strategically relevant capabilities.

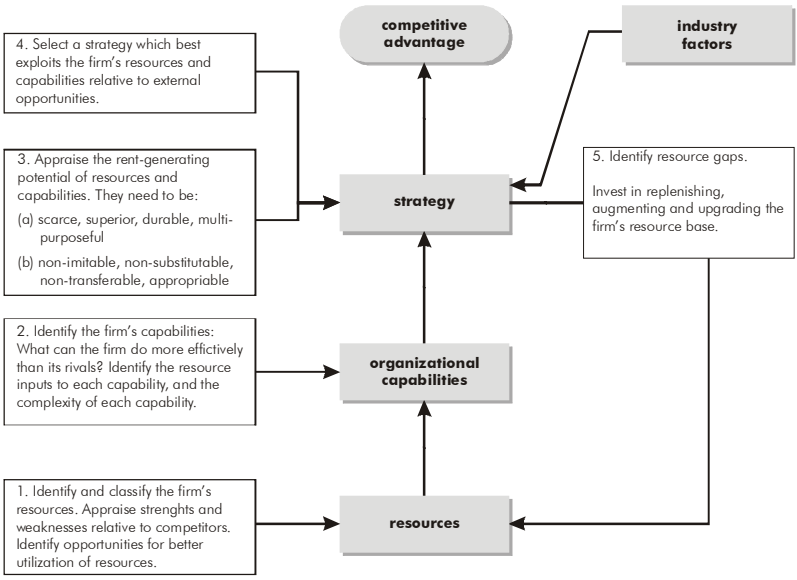

Figure 1-5. Relationship between resources, capabilities, competitive advantages and strategy (Grant 1991, 115, 1998, 113)

According to the knowledge-based view, competitive advantage of an organization depends on how successful it is in exploiting, applying and integrating its existing capabilities and in exploring and building new capabilities that can be applied to the market.

Expertise. Experiences or expertise are concepts that refer to an individual's knowledge base rather than the organizational connotation of terms such as capability or competence. Research on expertise has a long tradition in psychology and pedagogy. Results show to what extent problem solving or information processing by experts differs from novices or intermediates. Expertise relates to a domain in which the expert intuitively applies highly inter-connected, or encapsulated knowledge in order to interpret situations and propose solutions. Expertise is grounded on long-standing experience in the domain, many sources speak of ten years of continuing experiences needed although this view has been challenged

with respect to the fast-moving domain of IT. Experts are often widely recognized as a reliable source of knowledge. This can even have legal implications in that employees can officially back their actions by an expert's opinion or expertise, used here as a homonym in the sense of a written account about a certain topic, without having to fear legal prosecution. Experts are critical resources in organizations so that their contributions need to be carefully handled. Also, experts supposedly require different support by EKIs than novices. The challenges in designing EKIs that consider experts in organizations will be discussed in section 4.2.5, 281ff.

Intellectual Capital. One of the most prevalent questions in the KM area widely discussed in literature and practice is how to determine the value created and the benefits gained by such initiatives. Apart from traditional measures for firm performance such as ROI, ROA, ROE or EVA, several approaches for measuring performance in KM can be distinguished, e.g., human resource accounting, the balanced scorecard or the intellectual capital (IC) approach.

The IC approach is a general, holistic perspective to the intangible assets, i.e. the intellectual or knowledge capital, of a company. The approach is based on the observation that the market value of a company[1] is usually higher than its monetary and non-monetary assets represented in traditional accounting. IC comprises immaterial values created by intellectual activities, e.g., human capital, customer capital, process capital and intellectual property. Some organizations, the best known probably being Skandia, have extended their reports on firm performance to include non-financial indicators, indicators of intellectual capital.

Examples for IC instruments

Even though the IC approach provides a sound theoretical basis to determine the value of knowledge in organizations, the corresponding methods of measurement are (so far) pragmatic ones. The more abstract the notion of knowledge is, the harder it is to estimate its value. Still, the approach is used widely. Examples for concrete instruments to measure the IC of organizations are the Intangible Assets Monitor, the Intellectual Capital Navigator, the Skandia Navigator, the Balanced Scorecard, the Austrian "Wissensbilanz" (knowledge balance sheet) mandatory for e.g., Austrian universities, as well as single measures assessing intangible assets, such as Tobin's q, the IC-index and the Calculated Intangible Value.

1.1.2 Definition

Keeping the abundant classifications of knowledge in mind, it is clear that the conceptualizations influence the design of KM initiatives and the

[1] The market value of a company is usually determined by the capitalization (value of the shares on the stock market) of a company.

implementation of EKIs in many ways. Thus, we define knowledge broadly here and discuss some implications in detail:

Definition of knowledge

Knowledge comprises

(1-nature)	all cognitive expectancies, no matter whether rational or used intentionally,
(2-abstraction)	i.e. observations about classes of phenomena
(3-justification)	meaningfully organized, substantiated and embedded in a context
(4-method)	through experience, inference or communication,
(5-relevance)	deemed valuable
(6-agent)	by an individual or organizational actor
(7-application)	to interpret situations and to generate activities.

Nature

(1) Knowledge is a cognitive entity and refers to expectations about future events, acts or states. In organizational settings, knowledge used for interpretation and action not necessarily is true and, in the event of tacit knowledge, the knowing person might not even be aware of using it. Thus, when one takes the concept of knowledge from the scientific world to organizational settings, the rationality assumption that is pivotal in most, yet still debated philosophical positions on scientific knowledge is relaxed in order not to exclude tacit knowledge that is used unintentionally and thus lacks rational reflection.

Abstraction

(2) Abstraction from individual situations, procedures, entities or generally phenomena is typical for modelling tasks that are at the core of the MIS perspective towards business organizations. The corresponding relationships between types and instances, entity types and entities as well as classes and objects point to the decision that although knowledge undoubtedly is bound to individual observations, knowledge focused in KM usually needs to be applicable for similar cases in order to be reusable.

Justification

(3) Cognitive expectancies are contextualized information entities. Justification is based on (a) organization, i.e. structuring knowledge and linking it with other knowledge elements, (b) substantiation, i.e. enriching with evidence or (formal) proofs in order to increase its credibility, and (c) contextualization, i.e. considering the context of knowledge creation and application. This distinguishes it from information with respect to designing knowledge infrastructures compared to information infrastructures.

Method

(4) Justification is a non-trivial task that can be based on experience of individuals, logical inference or communication between individuals in order to achieve inter-subjectively justified beliefs. All of these processes can be supported by ICTs.

Relevance

(5) Not all thinkable knowledge is valuable in businesses and organizations. In a pragmatic view, KM concentrates on the portion of knowledge available in or accessible by organizations deemed valuable by its agents.

Agent

(6) Agent is meant here in the sense of an actor. Thus, both individuals or social entities such as teams or communities or entire organizations might act as knowledge-handling entities[2]. Examples of knowledge are scientific findings and theories, heuristics, rules of thumb, techniques, experiences, opinions, cultural customs and norms, world views.

Application

(7) Agents are always part of a *social context* which influences handling of knowledge of the actor and thus both, interpretation and actions. Put in a nutshell, knowledge can be defined as the *capacity to interpret and act*.

Knowledge and EKIs

Figure 1-6 summarizes our discussion and shows four central perspectives on *knowledge in organizations*, *media* to which knowledge is bound in these perspectives, a selection of seven paired *types of knowledge* which are used in *knowledge processes* and are supported by an EKI *platform*. In the following, *types of knowledge* and the *medium* to which knowledge is bound are discussed in detail.

Types of knowledge. Figure 1-6 shows six types of knowledge which are discussed in the following.

Source

Source distinguishes between *organization-internal* and *organization-external* knowledge. Even though organizational boundaries are increasingly blurry, organization as a legal or social institution remains a focal point for the distinction between internal and external knowledge. Internal knowledge is knowledge that originates from within the organization either from its members or in the form of e.g., organizational routines or documented experiences. Organization-external knowledge is brought into the organization, either personally or in documented form.

Accessibility

The accessibility dimension contrasts *electronically accessible* and *electronically inaccessible* knowledge. Knowledge published e.g., in a document management system can be accessed by all members of the organization that have access to this system whereas documented knowledge that is stored on the individual hard disc of a single employee cannot be found by interested knowledge seekers. Additionally, it refers to access to experts that hold knowledge about a specific domain.

Security

The security dimension comprises *secured* and *unsecured* knowledge. Higher visibility of knowledge, experts, networks and structures increases the risk that important knowledge is disseminated to competitors and threatens competitive advantages. Security refers to legal mechanisms such as patents and licenses, copyrights and trade secrets, organizational mechanisms such as incentives to employees, employee conduct rules and job design to secure knowledge and IT measures that prevent unauthorized access to EKI and prevent loss and manipulation of knowledge.

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[2] The term *actor* is preferred to *agent* as in the MIS literature *agent* regularly also refers to computer systems (intelligent agents). The old question whether computers can "think" and thus process and apply knowledge is out of the focus of this book (for a brilliant treatise of this topic see e.g., Dreyfus/Dreyfus 1986).

Formality

The formality dimension ranges from *formal, institutionalized, approved* to *informal, unapproved* knowledge and reflects the degree of institutionalization of knowledge in an organization. Employees develop and apply knowledge independently of the formal approval system and might also share it within their community. This knowledge evolves as a group of employees commits to use knowledge in a specified way and is further institutionalized when knowledge is formally approved as part of the standard procedures in the organization. Business organizations rely on rules, roles and (standard operating) procedures, so there is a host of institutionalized knowledge which is applied by the organization's members. The informal part of an organization's knowledge base is rarely well supported and thus needs special treatment in EKIs.

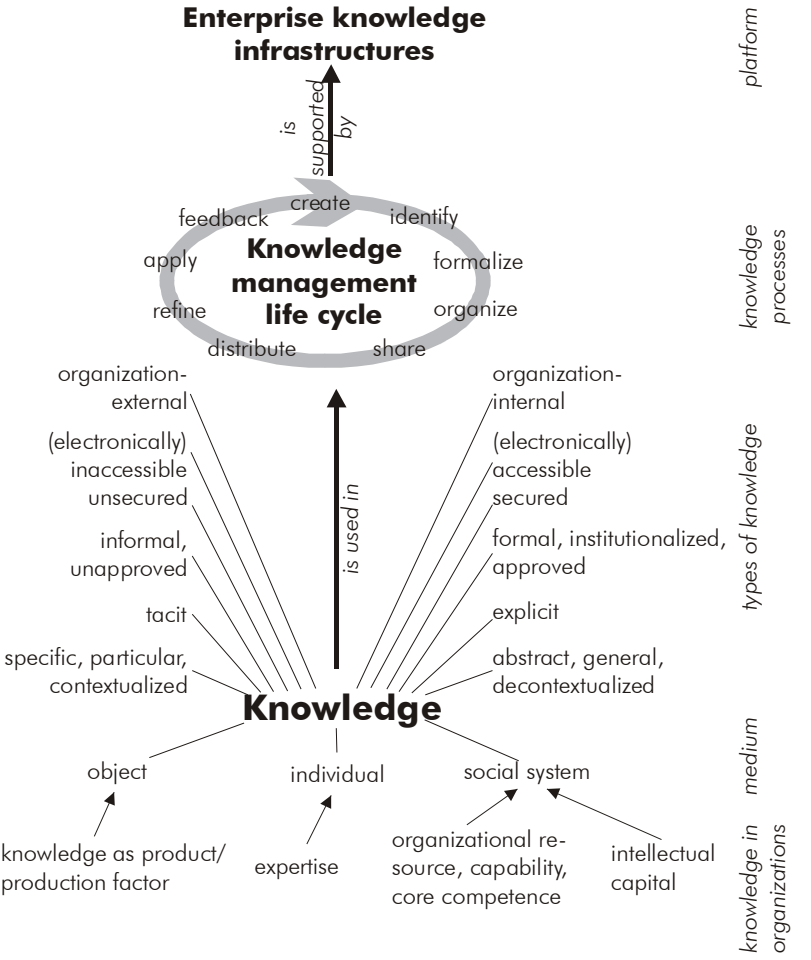

Figure 1-6. Knowledge and its application in KM