8 Economics

The determination of costs and especially the assessment of benefits of KM and KMS is still in its infancy. Many authors have contributed to the description and explanation of the substantial differences between standard economic theory and information economics. Examples are negligible marginal costs or network effects (e.g., Gersbach 1991, Hirshleifer/Riley 1992, Lehner et al. 1995, 179). Our understanding of the economics of knowledge or competence is even more "primitive" than our understanding of information economics (Teece 1998a, 291).

Basically, there are the following alternatives to assess benefits of the application of KMS[612]:

Qualitative assessment. This approach involves the subjective valuations of individuals which can be participants, the project manager or individuals not involved in the process, individuals with a technical or a business background etc. Regularly, in case of subjective assessment, senior management, the project manager or a sample of participants assess the KM initiative in general or the application of KMS in particular.

Quantitative assessment. Quantitative techniques are based on precisely defined variables which can be repeatedly measured rendering consistent results.

Semi-quantitative assessment. In this case a person or, more commonly, a group of individuals, assesses the KM initiative or the application of KMS on the basis of a structured evaluation process. Semi-quantitative techniques basically convert the subjective judgements of the evaluating team on a large set of items (variables) into several measures using statistical methods, such as factor analysis. Thus, the result is a small set of interesting factors which have quasi-quantitative characteristics (usually the measures use an ordinal scale from 1-5 or 1-7).

In many cases, organizations will apply a combination of these alternatives using quantitative measures where possible and enriching the results with semi-quantitative and qualitative measures. Organizations apply the whole repertoire of data collection as can be found in the literature: questionnaire, interviews with participants and selected special roles, such as knowledge brokers or subject matter specialists and—last but not least—measures that can be automatically collected by the KMS, such as access statistics.

Box B-9 shows a case study of a software house that has used KMS for quite a while. The case study is meant to illustrate the state of practice as can be found in many organizations and should also show the challenges for the development of a model to measure the success of KMS.

612. See Hauschildt 1993, 317ff, see also section 5.2.1 - "Strategic goals" on page 114.

Assessing success of knowledge management systems at sd&m AG

The system house software design & management AG (sd&m AG) is based in Munich (Germany) and develops individual software for business information systems and is strongly oriented towards innovation with no specialization to technologies and industry sectors. The number of employees has grown at a yearly rate of occasionally more than 50% to 800 in the year 2000. Due to the substantial pace of growth, the executives identified weaknesses in the identification of knowledge within the organization, the transfer of knowledge between projects as well as in training and education.

sd&m implemented a KMS as part of a corporate KM strategy. The KMS consists of the Intranet-based system KWEB which is supported by a separate organizational unit called "technology management" with a number of so-called knowledge brokers. KWEB contains among other components

- a skill management system (a data base of the competencies of employees, voluntarily built up by the employees themselves),
- contributions of knowledge brokers about relevant knowledge areas (e.g., reports, studies, FAQs),
- descriptions of actual and completed projects,
- a data base of lessons learned from projects,
- personal homepages of the employees,
- a search engine about the complete corporate Intranet as well as several external (on-line) data bases and information services (e.g., Reuters).

The development of KWEB required an investment of five person years of developer time. Apart from one person year of developer time for annual maintenance, currently seven knowledge brokers are responsible for the maintenance of contents and the support of participants.

Success of the KM activities at sd&m is assessed with regular questionnaires on employee satisfaction a part of which deals with the satisfaction of participants with the KM services and the KMS. Success is thus basically measured in terms of improved user satisfaction. Apart from this questionnaire, success stories highlight advantages generated for sd&m's customers or reductions of the weaknesses as mentioned above. KMS use is measured generally with the help of rough numbers of accesses and the number of participants who provide information about their competencies in the skill management system.

BOX B-9. **Case study: Success of KMS at sd&m AG**

In the following, the state of the literature on economics of the application of KMS will be reviewed. An existing model will be extended to include factors and variables measuring benefits from the application of KMS. Beforehand, section 8.1 will take a closer look at the costs of the application of KMS and ways to finance such efforts. Section 8.2 will then briefly review some important existing concepts

to measure intellectual assets in an organization in a top-down approach which basically reference the resource-based view of the organization[613]. These approaches are all broadly defined and can be used to assess the benefits of a KM initiative in general. The next sections will specifically focus on the support of these initiatives by information and communication systems. First, selected models to evaluate the benefits of information systems (IS) are reviewed and the DeLone/ McLean model of IS success is discussed in detail (section 8.3). The DeLone/ McLean model is selected as the basis for the model to evaluate the benefits of KMS presented in section 8.4. This section also discusses the application of the most interesting factors according to the distinction between integrative and interactive KMS as presented in section 7.6.1 - "Knowledge Tools" on page 361.

8.1 Expenses and funding

Determining costs of the implementation and operation of an IS in general and a KMS in particular is not a trivial task. In many cases, the development of a KMS is part of a major investment in new information and communication infrastructure in the organization, e.g., the development or upgrade of an organization's Intranet, Groupware platform, an organization-wide management information system, data warehousing and business intelligence systems, document management system, office management system etc. and a combination of these efforts. As a consequence, investments into KMS regularly fulfill other business goals as well and thus are difficult to assess or even estimate.

Because of these difficulties, the investigation will be limited to the most important types of expenditures for KM initiatives. Two major cost drivers can be determined:

- the expenses taken for development and installation of KMS including non-salary costs attributed to knowledge management and
- the salaries of employees who are assigned specific KM responsibility.

8.1.1 Expenses for knowledge management

The following categories of expenses for KM initiatives can be distinguished:

Hardware. In most cases, KMS will build on an already existing ICT infrastructure. State of the art is a high penetration of networked PCs and departmental or work group file server, data base, resource (e.g., printers, scanners, special hardware), application and Web servers running client-server and Web applications. Dedicated KM suites or organization-specific KMS usually will require one or in larger projects multiple specific *KMS servers* which are used as e.g., *document server, video server, listserver* or *data base server.* The hardware requirements of specialized KMS software are substantial[614]. This is especially true if the more advanced functions such as profiling of participants, semantic text analysis and

613. See section 5.1.1 - "From market-based to knowledge-based view" on page 94.

multi-format and multi-source search functions are to be used. The increased amount of documents and stored communications (e.g., in newsgroups) requires additional *storage capacity.* The establishment of advanced communication channels, such as video conferencing or even audio conferencing, require a modern *LAN network infrastructure* (>= 100 MBit) and, if multiple locations and/or organization-external participants have to be integrated, a *connection to the Internet* that allows for substantial bandwidth. Where a constant participation of mobile employees has to be considered, substantial investments in *mobile technology* (mobile devices, such as cellular phones, palms, laptops, wireless LANs etc.) are required.

Software. There are a large number of vendors that offer *comprehensive KMS solutions* which integrate a bundle of basic functions required to support KM. There is also an abundant market supply with specific *KM tools* which provide added functionality for specific problems. However, both, KMS and tools need *significant customizing* and according to an official of one KMS vendor, it takes 6-9 months to customize an organization-wide KMS solution. Many organizations consequently build their *own solutions* which usually are based on already existing software solutions, such as document management systems, workflow management systems, Intranet solutions and communication systems (see also part C).

Training and education. Needless to say that participants have to be trained to use the new systems although it seems that in many organizations employees are supposed to be computer-literate in the sense that they learn to use new (e.g., office) systems on their own with only minor support.

Literature, conferences, participation in benchmarking groups, consulting. The first step in a KM initiative is usually that "knowledge about KM" has to flow into the organization. Thus, the KM budget is spent on literature, (expensive) reports, the funding of (university) research programs to develop KM concepts, travelling and fees for the participation of members of the organization in KM-related conferences and benchmarking groups and on professional services companies that bring in their knowledge about how to set up a KM initiative.

Organization of KM events. Last but not least, the KM initiative has to be announced and explained to the members of the organization. Many organizations have organized KM events where all the employees interested in the topic could present their ideas, discuss and network (e.g., Siemens, DaimlerChrysler).

In addition to these one-time investments, the following categories for recurring costs can be distinguished:

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614. The author experimented with a Hyperwave Information Server 5.5 and Hyperwave Information Portal 1.0 on a Sun Sparc station with Solaris 2.7. The hardware proved to be insufficient to handle not even the light traffic of one work group with response times for simple accesses to documents in the region of 15-30 seconds.

Software. In this case the category comprises maintenance of organization-specific KM software and regular upgrades of software bought on the market.

Knowledge management overhead. Overhead is calculated for the coordination of the KM initiative.

KMS administration. In a time of increasing danger from hacker attacks, it is important that the assets contained in the organizational knowledge bases are protected from unwanted access and that the communication infrastructure is secure and works reliably.

8.1.2 Expenses for knowledge management staff

Many organizations have assigned special roles for KM staff or even installed separate organizational units. The salaries for these employees form a second important source of expenses for KM. However, there might also be a number of employees who are only partly responsible for KM tasks besides their "normal" work roles. As a consequence, the seemingly easy-to-answer question about the number of employees assigned to KM might be difficult to judge. This is all the more true, the more an organization relies on the more informal, interactive KM instruments, such as communities and expert networks where it is hard to say how much time employees spend on the participation within these groups and networks. However, the estimated number of employees who are formally assigned to KM gives a first rough estimate about what an organization is willing to spend on KM.

8.1.3 Funding

The financing of KM initiatives is in no way different from the financing of other service functions. Basically, there are the following four alternative ways of funding:

1. **Fixed budget**: a separate budget for the KM initiative,
2. **Internal accounting**: allocates costs to functional departments, e.g., considers to what extent each organizational unit shares in the benefits of the KM initiative, participates in communities, accesses KMS or uses specific KM services,
3. **Internal "selling" of KM services**: or judging the functional departments' willingness to pay for KM services,
4. **External "selling" of KM services and products**: e.g., through licenses, consulting or access to KMS.

8.2 Benefits of knowledge management initiatives

In this section, first the intellectual capital approach is presented which provides measures to assess the benefits of KM initiatives (section 8.2.1). Section 8.2.2 discusses an approach to develop knowledge balance sheets and measure knowledge transformations brought about by the application of KM instruments.

8.2.1 Intellectual capital approach

One of the most prevalent questions in the knowledge management area widely discussed in literature and practice is how to determine the value created and the benefits gained by the application of such efforts (e.g., Stuart 1996, 2). Considering the fact that there is still considerable disagreement about what exactly knowledge is or knowledge resources are which have to be managed[615] it is difficult to assess what the results of the application of such a concept would be and especially what the differences to not applying this concept would be. Apart from the traditional measures for firm performance[616], several approaches to this problem can be distinguished, e.g., human resource accounting, the balanced scorecard or the intellectual capital approach (Bontis et al. 1999).

The Intellectual Capital (IC) approach is a general, holistic perspective to the intangible assets—the intellectual capital or knowledge capital—of a company (Sveiby 1987, 1998). The fundament is based on the observation that the market value of a company[617] is usually higher than its monetary and non-monetary assets. The intellectual capital comprises the immaterial values which have been created by intellectual activities (Wiig 1997, 400). Examples for intellectual capital are (Wiig 1997, 1997a, Stewart 1997, for case studies see also Sveiby 1998, 254ff, Chase 1997b, 89ff): human capital, structural capital, customer capital, organizational capital, process capital, innovation capital (intellectual property, intangible assets, see Figure B-77).

Some organizations, the best known probably being Skandia (see Skandia Navigator below) have extended their reports on firm performance to include non-financial indicators, indicators of intellectual capital. Some authors have even suggest to further extend this approach to balance the organizations' intellectual capital books by including "intangible liabilities" which basically denote the opposite of intangible assets such as (Harvey/Lusch 1999, 88): poor product/service quality, poor reputation, inadequate R&D, lack of patents/copyrights, lack of strategic alliances, potential product liability suits from harmed customers or high employee turnover.

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. In spite of this and the lack of an exact definition of "intellectual capital" the approach is used widely (Ulrich 1998, 16). Examples for concrete instruments to measure the IC of organizations are:

- the Intangible Assets Monitor (Sveiby 1998, 207ff),
- the Intellectual Capital Navigator (Stewart 1997, 243ff),
- the Skandia Navigator (Skyrme/Amidon 1997, Probst et al. 1998, 327ff),

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615. See section 4.2 - "Knowledge" on page 60.
616. For example ROA, ROE or EVA, see also section 8.4.8 - "Impact on the organization" on page 426.
617. The market value of a company is usually determined by the capitalization (value of the shares on the stock market) of a company.

- the Balanced Scorecard (Kaplan/Norton 1996, 1997, Horváth/Kaufmann 1998, Mooray et al. 1999, Dimmeler/Sauer 2000),
- measuring the knower which assesses the meaning of knowledge elements to people with the help of attributes such as context, framing/problem representation, configural effects (Gestalt), temporal context and network externalities (Glazer 1998, 178ff),
- as well as single measures assessing the intangible assets, such as Tobin's q (North et al. 1998, 160f), the IC-index (Roos et al. 1997, cited after Heisig et al. 2001b, 71f) and the Calculated Intangible Value (Stewart 1997, 226ff).

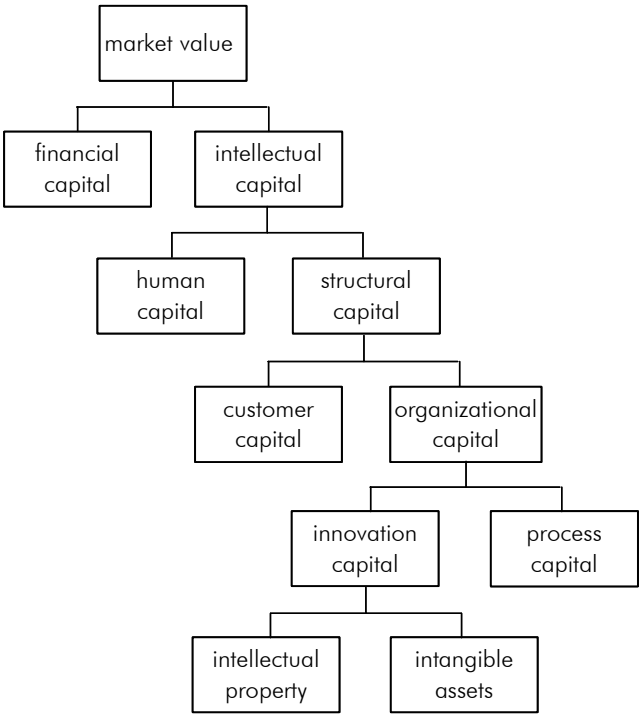

FIGURE B-77. Model of the intellectual capital[618]

8.2.2 Measuring knowledge transformations

Figure B-78 shows a comprehensive framework for the measurement of knowledge and knowledge transformation[619]. Particularly the dynamics, the changes in

618. Source: Wiig 1997, 401.
619. See North et al. 1998, 164; see also Wiig 1999, 161 who developed a similar model and Levett/Guenov 2000 who proposed a set of metrics for KM analysis.

an organizational knowledge base, matter most for a subsequent KM initiative (Amelingmeyer 2000, 176ff).

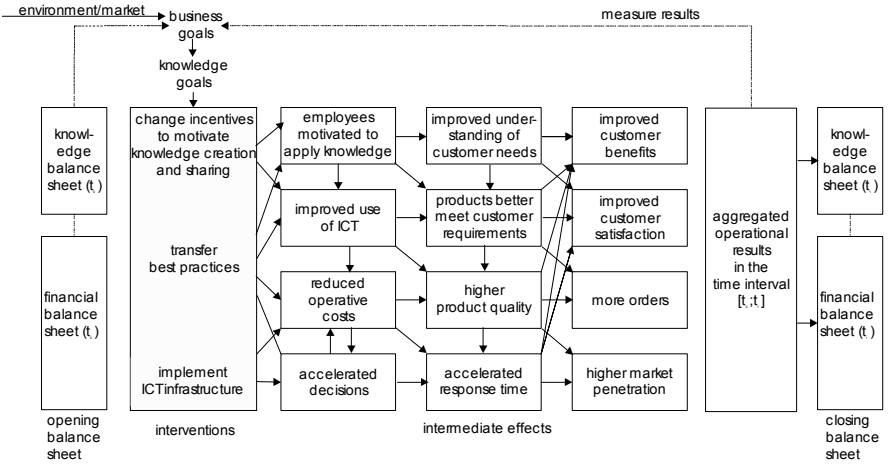

FIGURE B-78. Framework to measure knowledge and knowledge transformations[620]

The existing approaches to measure an organization's intangible assets in general and the success of KM initiatives in particular as briefly reviewed above lack operationalization. Probst et al. simply suggest to measure system use of e.g., an Intranet as part of the operative assessment of knowledge goals (Probst et al. 1998, 336). Other than that, success or failure of a KMS in these frameworks is only assessed at a highly aggregate level, e.g., with respect to measures such as turnover per employee or the share of investments in ICT infrastructure as compared to the organization's total value added, the fluctuation of experts or the share of customers that improve the organization's competencies (also Sveiby 1998, 263). These are all measures that are influenced by the use of KMS, but also by a large number of other interventions into an organization's way of handling knowledge and environmental changes as well.

Thus, the frameworks have to be detailed in order to provide an instrument which can be applied to the assessment of the success of KMS. As KMS are a special group of information systems, the literature dealing with measuring success of information systems provides a good starting point for the development of a more detailed framework to assess the success of KMS.

8.3 Information systems success

This section reviews the literature on IS success measurement (section 8.3.1). On the basis of this literature review, the DeLone/McLean (1992) model for IS success

620. Source: North et al. 1998, 164.

measurement is selected and discussed (section 8.3.2). Finally, some critics and extensions to this model are reviewed (section 8.3.3). The DeLone/McLean model will be used as the basis for the model to measure success of KMS which will be presented in section 8.4

8.3.1 A multi-faceted construct

Success of an information system (IS) cannot be measured directly, but has to be assessed using a number of measures which are relevant for success. Since the 70s, many authors have developed approaches to assess the success of an IS. They suggested a host of variables, indicators and measures. Examples are:

- *user (information) satisfaction*[621] or *system acceptance*[622],
- *user engagement*[623], *user participation*[624] or *user involvement*[625],
- *(perceived) information quality*[626] or *system quality*[627],
- *perceived service quality*: user satisfaction with the information services function (SERVQUAL)[628],
- *usage of IS*[629], *usage to support specific tasks*[630],
- *task-technology fit*[631],
- *success of specialized IS*: impact on individual, group or organizational performance, such as decision support systems[632], group (decision) support systems and group communication support systems[633], office systems[634], creativity support systems[635], computer-mediated communication[636] or end-user computing[637].

The measures as suggested in the literature cover all three levels of measurement—subjective assessment, semi-quantitative assessment as well as quantitative

621. Zmud 1979, Bailey/Pearson 1983, Baroudi/Orlikowski 1988, Doll/Torkzadeh 1988.
622. Ives/Olson 1984.
623. Hwang/Thorn 1999.
624. Kim/Lee 1986.
625. Zmud 1979, Ives/Olson 1984.
626. Bailey/Pearson 1983, Ives et al. 1983, King/Epstein 1983, Miller/Doyle 1987, Blili et al. 1998.
627. Ives/Olson 1984.
628. Kettinger/Lee 1994, Pitt et al. 1995, Nelson/Cooprider 1996. Many authors refer to an instrument called SERVQUAL originally developed to measure consumer's perceptions of service quality, see Parasuraman et al. 1988, see also Kettinger/Lee 1994, 745 for an overview of studies using the SERVQUAL instrument.
629. Zmud 1979, Hiltz/Turoff 1981, Srinivasan 1985, Kim/Lee 1986, Straub et al. 1995, Gelderman 1998.
630. Doll/Torkzadeh 1998.
631. Goodhue/Thompson 1995.
632. Sanders/Courtney 1985.
633. DeSanctis/Gallupe 1987, Kraemer/Pinsonneault 1990, Dennis 1996, Chun/Park 1998.
634. Millman/Hartwick 1987.
635. Massetti 1996.
636. Kettinger/Grover 1997, Kock 1998.
637. Blili et al. 1998; an early generalized review of MIS success can also be found in Zmud 1979.

assessment. There are far more variables assessing the perceived quality or usefulness of IS than there are "objective" criteria. If one can assume transferability of the results found in strategic management to IS, it seems, however, that perceptual assessments of IS performance provided by knowledgeable managers have a high level of convergence with objective IS performance measures (Venkatraman/ Ramanujam 1987).

In wide parts of the MIS literature, the system-use construct has been considered as a dependent variable, a success measure (Doll/Torkzadeh 1998, 173). More usage has always been considered desirable. This simple construct provides only a crude measure, though, as it makes no statement about for example the quality of the information retrieved, the perceived usefulness for the individual's work processes and the relation between these perceptions and efficiency on the organizational level. Thus, what is needed is a well-defined dependent variable for IS success (DeLone/McLean 1992, 61).

DeLone and McLean went to the trouble of a comprehensive analysis of all the different streams of research about IS success and proposed an integrated model for information system success (DeLone/McLean 1992). This model is one of the most cited and empirically tested frameworks of IS success[638], in spite of many respecifications and extensions mostly in its original form, probably due to the fact that it is comparably well-defined, theoretically founded and yet simple and easily tailored to specific situations.

In the following, the theoretical foundation of the model is briefly reviewed. According to Shannon and Weaver's well-known mathematical theory of communication (Shannon/Weaver 1949), the output of a communication system can be measured at three different levels: the technical level, the semantic level and the level of effectiveness[639] (see Figure B-79).

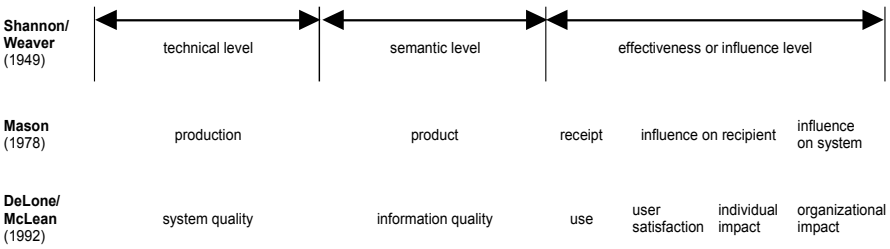

FIGURE B-79. Categories of IS success[640]

638. E.g., Seddon 1997, Ballantine et al. 1998, Garrity/Sanders 1998b, Myers et al. 1998, Wixom/Watson 2001.
639. This distinction resembles the also well-known semiotic levels syntactics, semantics and pragmatics often used to distinguish between data, information and knowledge (Lehner et al. 1995, 222ff, see also section 4.1.2 - "From data to knowledge management" on page 39).
640. Source: DeLone/McLean 1992, 62.

The *technical level* measures the accuracy and efficiency of the communication system that transports the information, the *semantic level* measures to what extent the information can convey the intended meaning and the *level of effectiveness* measures the effect of the information on the receiver.

Mason extended the effectiveness level to include a hierarchy of events taking place at the receiving end. After receiving the information, it influences the recipient and also leads to a change in system performance (Mason 1978, 227). DeLone/McLean build on this idea of a series of events on the receiving end of information, but changed the concepts substantially to fit to the analysis of complex organizational systems.

8.3.2 The DeLone/McLean model

The resulting model of the measurement of IS success is used to classify the abundant variables described in a large number of empirical studies and comprises the following six components (see Figure B-80, DeLone/McLean 1992, 64ff):

System quality. Measures of system quality describe the system itself and comprise criteria such as reliability, response time, resource utilization or system flexibility. The criteria reflect a more engineering-oriented performance evaluation of the system.

Information quality. This category measures the output of the information system, e.g., in the form of reports or search results, such as relevance, accuracy, timeliness, reliability, completeness, informativeness. Most of the criteria used in this component are assessed as perceived by the users, thus this component has a close relationship to user satisfaction and many of the criteria in fact were developed as part of instruments measuring user satisfaction (e.g., the multi-item instrument developed by Bailey/Pearson 1983).

Use. Variables describing the use of IS are among the most frequently applied success measures reported in the MIS literature. Use comprises both, objective criteria such as login times, number of IS functions used as well as perceived measures of use. Even though use seems to be easy to quantify and an objective measure (DeLone/McLean 1992, 68), the construct is not well understood (Goodhue/Thompson 1995, 218) and there are several issues to be considered, e.g.: voluntary versus mandatory use, direct versus chauffeured use, single versus recurring use, intended/appropriate versus unintended use or general use of pre-defined reports versus specific use with personally-initiated requests for information. Moreover, the fit between task and technology characteristics as well as individual characteristics of the person influence the attitude towards utilization, namely the expected consequences of using the system (Goodhue/Thompson 1995, 217).

User satisfaction. User satisfaction is, together with system use, the most widely applied measure of IS success. The popularity is probably supported by the existence of a widely used 39-item instrument developed by Bailey/Pearson (1983), that

allows for comparisons to other studies and by the fact that data is easily obtained when compared to other measures. User satisfaction—and also the use—are always related to user attitudes towards computer systems which consequently have to be measured as well.

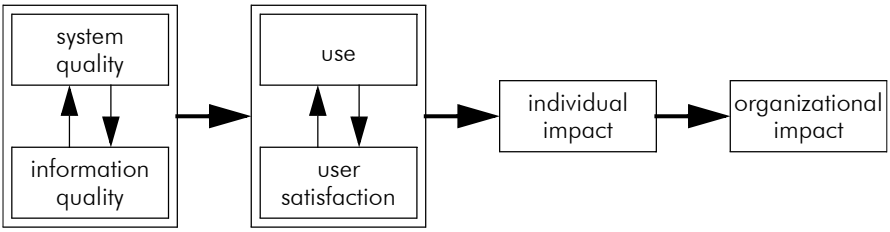

FIGURE B-80. Information system success model[641]

Individual impact. This component is closely related to the performance of an individual, although in the chain of events also encompasses preceding events and thus more than actual performance, e.g., a better understanding of a decision or a better decision productivity. It comprises measures describing to what extent the use of an IS has changed the behavior of individuals. Most of the measures have been developed and applied in controlled laboratory experiments. Examples for measures are decision-making productivity, average time to make a decision, the number of alternatives considered, the confidence in the decision, increased user productivity or willingness to pay for certain IS outputs.

Organizational impact. This component assesses the impact of the use of an IS on the level of the organization (e.g., a strategic business unit, a factory or the entire organization). The challenge for measures on the organizational level is to isolate the effect of the IS from other effects which influence organizational performance, a problem which caused many researchers to avoid this last question even though IS practitioners' interest in the topic is high (DeLone/McLean 1992, 74). Measures used are usually performance indicators, such as overall productivity, organizational effectiveness, and financial measures such as return on investment, return on assets, market share, stock prices[642]. The measures applied for the evaluation of intangible assets (intellectual capital) as described above also fall in this category[643]. They promise variables that are closer to the central goals of the application of KMS, namely the improvement of an organization's way of handling knowledge and thus will be integrated into the model to measure success of KMS.

The success of IS therefore can be assessed by a multitude of measures. It is suggested that one should apply a weighed set of variables from several, if not all

641. After: DeLone/McLean 1992, 87.
642. See also section 8.4.8 - "Impact on the organization" on page 426.
643. See e.g., Sveiby 1998; see also DeCarolis/Deeds 1999 who analyze the impact of knowledge stocks and flows on firm performance.

of the six categories outlined, so that success is a multi-dimensional construct with six interdependent categories. Doll and Torkzadeh also develop a multidimensional construct to measure system-use which they call the system-to-value chain: causal factors -> beliefs -> attitude -> behavior -> social & economic impact. Thus, they argue, one can avoid the shortcomings of a one-dimensional construct.

Figure B-80 also shows that the six categories are interrelated and describe a process view of IS success, a series of constructs which include temporal and causal influences in determining success (DeLone/McLean 1992, 83ff). The first level—system quality and the quality of the system's outputs—are interrelated and jointly and independently affect the second level—use and user satisfaction—which are interrelated as well. Use and user satisfaction directly influence the individual impact which in turn leads to impacts on the organizational level.

8.3.3 Critique and extensions

The clear structuring of the measures and especially the interrelationships hypothesized in DeLone/McLean's model have been subject to repeated criticism. Examples are (Li 1997, Seddon 1997, Ballantine et al. 1998, Garrity/Sanders 1998b, Myers et al. 1998):

Dependent variables. It is unclear which of the categories and especially the variables within the categories are dependent variables in the sense that they describe IS success and independent variables in the sense that they are precedents that influence IS success. This question can only be resolved with respect to a specific application of the model.

Nature of relationships. The nature of the interrelationships between the categories is left open: on the one hand, the model can be seen as a variance model explaining that the measures depend on each other and thus variance in one category causes variance in a dependent category, on the other hand, it can be seen as a process model which explains "events" that trigger each other. Each event in the chain is necessary, but not sufficient for the outcomes to be produced (see especially Seddon 1997 who analyzes this argument in great detail).

Contribution to overall success. It remains unclear to what extent the individual variables in the categories contribute to the overall success of the application of an information system. Also, it is unclear how individual variables influence or depend on each other.

Missing feedback links. As opposed to Mason's (1978) approach, the DeLone/McLean model does not include any feedback loops which could lead to a different use of the system or even change the system itself or its contents. Also, as others have shown, user involvement in the design process of IS impacts system use and user information satisfaction significantly (e.g., Baroudi et al. 1986) and thus has to be accounted for.

Missing consideration of environment. The model is limited to the most direct influences of the application of an IS and thus neglects environmental variables. The environment has to be measured or at least controlled in order to render results of IS success comparable. Examples are: the organization's strategy, the organizational structure, the tasks which are supported by the IS, the fit between tasks and IS as well as the human aspect, e.g., the quality of services provided by IS or IT personnel or departments or individual characteristics of the users.

Organizational impact. This category almost exclusively comprises financial measures which are inappropriate to assess the influence of the application of IS. In the case of KMS, these measures can be extended to cover variables assessing the organization's intellectual capital which are closer related to KMS success than the general financial criteria[644]. Additionally, with the advent of group support systems and the emphasis on work groups, teams and communities, it is suggested to include another construct in between individual and organizational impact: *workgroup impact* (Myers et al. 1998).

Several authors have extended the original DeLone/McLean model (e.g., Pitt et al. 1995, Li 1997, Myers et al. 1998), re-specified parts of the interrelationships (e.g., Seddon 1997) or even presented alternative models that follow an entirely different logic (e.g., Ballantine et al. 1998). Ballantine et al.'s 3-D model of IS success can be taken as a surrogate for several attempts to re-specify the DeLone/McLean model.

Figure B-81 shows this model. IS success in this model is divided into three consecutive levels: the *technically realized system*, the *used information system* and the *effective information system*. The results that are obtained are "filtered" on their way up through the levels. There are three filters: the *implementation filter*, the *integration filter* and the *environmental filter*. Feedback is conceptualized with the help of a *learning cycle* that encompasses all the levels of the model.

Even a short glance to the 3-D model reveals its substantially increased complexity when compared to the original DeLone/McLean model. The same is true for other attempts to re-specify the original model (e.g., Seddon 1997).

The model allows for a much more comprehensive analysis of independent factors influencing IS success and takes into account most of the critique directed at the original DeLone/McLean model. However, it seems questionable whether constructs like a fit between strategy, style, structure, status and culture has any empirical relevance. It is doubtful that enough data can be obtained to populate all the levels and filters in the model and even if it would be possible, it might be an inefficient way to assess an IS's success. Even though the levels seem to clearly differentiate between dependent variables (results of the levels) and independent variables (influencing variables on the levels), to cite a cliché: "the devil is still in the detail". Individual variables depend on each other, even between the levels and

644. See section 8.2.1 - "Intellectual capital approach" on page 400.

contrary to the relationships depicted in the model. Ballantine et al. do not provide measures for constructs as complex as learning cycle, project management, culture or movements of competitors. Even though the model represents a brave attempt to respond to a great part of the critique against the DeLone/McLean model, it still lacks operationalization and raises more new question than it answers.

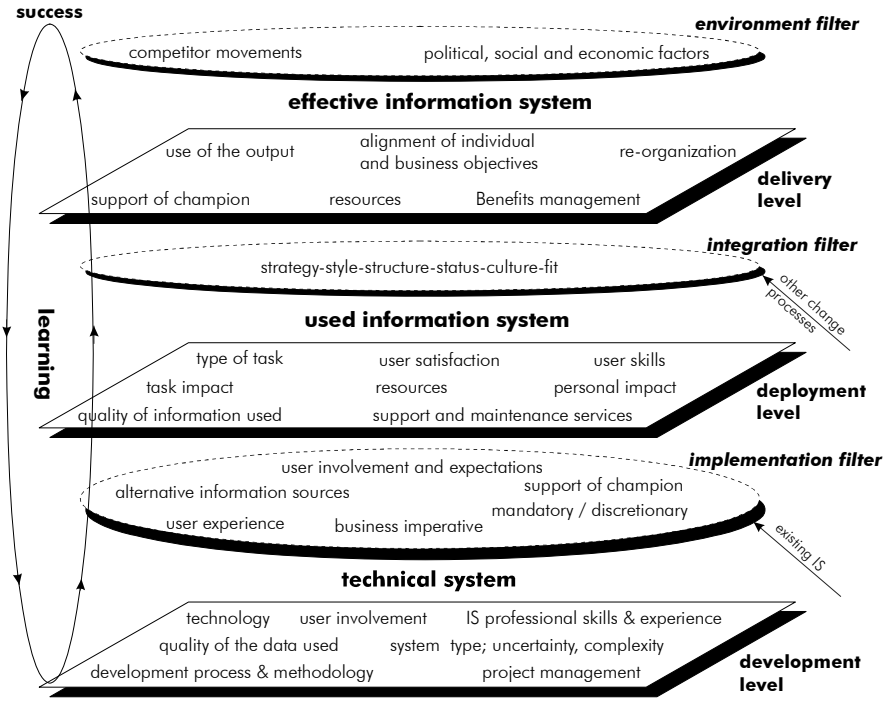

FIGURE B-81. The 3-D model of information systems success[645]

Thus, despite the critique, the DeLone/McLean model—especially in a slightly modified and extended version—still seems a pragmatic basis for empirical investigations because of its simplicity and understandability, the focus on a handful of relevant and relatively clearly structured categories which makes it applicable in practice. In order to apply the model to the measurement of success of KMS, it has to be extended, though.

645. Source: Ballantine et al. 1998, 54.

8.4 Success of knowledge management systems

Figure B-82 shows the model for measuring success of KMS. The model consists of three consecutive levels which correspond to the three levels identified by Ballantine et al. (1998) in their 3-D model[646].

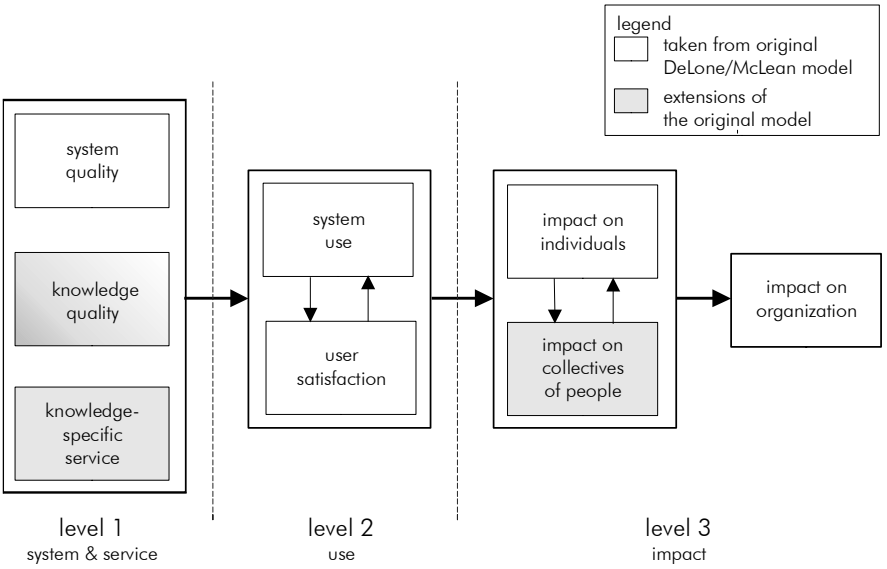

FIGURE B-82. Model of knowledge management systems success[647]

The first level deals with criteria describing the system itself, the quality of the presentation of knowledge as well as the knowledge-specific service, the development level. The second level comprises the usage and the user's satisfaction, the deployment level. The third and last level finally contains criteria to evaluate the impact of the system's use, the delivery level. The white boxes in Figure B-82 show those categories that were taken over from the original DeLone/McLean model. The grey boxes show the categories that were either extended or added to the original model. In the following, the extensions and additions will be discussed.

Knowledge quality. As mentioned earlier[648], KMS differ from IS with respect to the context of knowledge. One example is the documentation of links to other knowledge elements, to experts, users and communities. Thus, the original category "information quality" was extended to include *knowledge quality.*

646. See section 8.3.3 - "Critique and extensions" on page 407.
647. The figure is based on: DeLone/McLean1992, 87, see also Maier/Hädrich 2001, 6 for a previous version.
648. See chapter 7 - "Systems" on page 273.

Moreover, *communication* is of central importance for the sharing of knowledge between individuals and also in collectives (e.g., teams, work groups, communities). Communication is the defining phenomenon for a memory of groups or organizations: a *transactive memory system* (Wegner 1986, 191). KMS can play the role of a context-rich medium supporting the communication within transactive memory systems. *Information and knowledge quality* was therefore extended to include *communication quality.* Due to the fact that information and communication are considered two sides of the same coin and for reasons of simplicity, the category was simply termed *knowledge quality.* Additionally, the category *system use* was extended to include measures for the assessment of the frequency and extension of communication and measures concerning the impact of KMS on the communicative behavior of teams and communities were also added on the impact level in the category *impact on collectives*.

Knowledge-specific service. Several authors have suggested that service quality is an important factor determining success of ICT in organizations (e.g., Bailey/Pearson 1983, Ferguson/Zawacki 1993, Kettinger/Lee 1994, Pitt et al. 1995, Li 1997). This category is based on the analogy to the customer perspective of organizations which leads to an alternative design of organizations in terms of business processes the goal of which is to improve customer service throughout the organization. Accordingly, the IS/IT function or organizational unit in an organization is viewed as providing IS service for the rest of the organization. Many instruments suggested to measure IS service quality are based on Parasuraman et al.'s (1988) instrument originally developed for the retail industry called SERVQUAL. Service quality measures for example reliability, responsiveness, competence, accessibility, courtesy, credibility of IS personnel. Thus, it is not surprising that several authors have suggested to include service quality into the DeLone/McLean framework (e.g., Li 1997, Myers et al. 1998).

The category *knowledge-specific service*, however, targets a different service unit. Many organizations have established specific roles to support the handling of knowledge in an organization, especially search and retrieval, transfer and dissemination as well as the publication of knowledge, e.g., *knowledge brokers* or knowledge stewards, but also *subject matter specialists*[649]. If designed accordingly, these roles can substantially increase the usefulness of KMS. Thus, knowledge-specific service assesses to what extent specific roles exist that support the participants of KMS in using the organization's knowledge base.

Impact on collectives of people. As discussed[650], collectives of people represent the most important organizational unit for jointly developing, evaluating, sharing and applying knowledge. Apart from traditional work groups, project and virtual teams, it is communities which are in the central focus of many KM initiatives.

649. See section 6.1.2 - "Knowledge management roles" on page 162.
650. See section 6.1.3 - "Groups, teams and communities" on page 177.

Thus, a model for assessing success of KMS has to consider the impact of these systems on the handling of knowledge in social groups, especially communities.

As a consequence, the model consists of eight categories as depicted in Figure B-82. Many more influences on the success of KMS are thinkable as already briefly sketched out[651]. Apart from individual characteristics of the participants, it is in general the *goals*, the *organizational design*, the *organizational culture*, the organization's *business environment* and the *KM instruments* applied in the organization's KM initiative that influence the impact of supporting KMS[652].

Thus, a complete and consistent assessment of a KM initiative or an organization's way of handling knowledge has to take into account a lot more effects which impact success. Many authors have suggested corresponding approaches which all lack operationalization due to the massive amount of variables that would have to be included[653]. The model is restricted to the most direct influences of the use of KMS and thus neglects many of these additional influences. It is seen as a first step towards the operationalization of the approaches to assess the success of KM initiatives in general and should provide a foundation for the systems support part of these initiatives.

The following sections will step by step discuss the eight categories of the model of KMS success. Selected measures will be described for each of the categories. Each measure can be assessed by a number of variables or indicators which are described in detail in the literature. A prior version of the list of measures was co-developed by the author (Maier/Hädrich 2001[654]). 133 measures were selected based on an extensive literature research[655] and another 105 measures were added with the help of the literature on KM and KMS as well as the results of the empirical study (especially the interviews) as described in part C. In the following, a subset of these measures will be discussed which seems to be most critical for KMS success.

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651. See section 8.3.3 - "Critique and extensions" on page 407.
652. See also the research model used as the basis for the empirical study in part C which encompasses all these influences.
653. See also section 8.2 - "Benefits of knowledge management initiatives" on page 399.
654. A comprehensive overview of variables and links to the corresponding literature where these variables and their operationalization with the help of instruments to measure the variables have been defined and empirically validated can be found in Hädrich 2000.
655. The literature research was based on the extensive literature review documented by DeLone/McLean for the literature up until 1992. The journals *Management Information Systems Quarterly*, *Decision Sciences*, *Information Systems Research*, *Information & Management*, *Communications of the ACM*, *Management Science* and the journal *Wirtschaftsinformatik* were searched for recent additions. The variables were mostly applied to Management Information Systems, MIS, decision support systems, DSS, group support systems, GSS, group decision support systems, GDSS and communication systems, such as email or voice mail. The selection of measures was based on two criteria: (a) *citation*: the variables were repeatedly applied in a cumulative manner and (b) *empirical validation*: they were empirically tested in field studies. These two criteria should support the applicability of the resulting measures in practice.

8.4.1 System quality

This category comprises variables which assess the processing system itself, in this case a KMS. The measures reflecting system quality of IS are generally technical, performance-oriented, engineering criteria (DeLone/McLean 1992, 64). As the focus is on one specific class of systems, measures can be added which specifically assess the quality of KMS functions. Table B-22 gives an overview of the most important measures for an assessment of integrative KMS, measures for interactive KMS and of measures which can be applied to assess both types of KMS.

TABLE B-22. Measures for system quality

integrative KMS	interactive KMS	both
• efficiency of support for the publication of knowledge • orientation/quality of visualizing context and structure • quality of the presentation of search results • quality of the design of feedback about contents • integration of knowledge sources • quality of the support for dynamics of contents • quality of search engine	• quality of communication media • design and number of communication channels • perceived social presence • ease of feedback • quality of the support for community-workspaces • quality of search for experts	• response time • ease of use • complexity • flexibility • reliability • availability/accessibility • quality of documentation • quality of integration of functions • resource utilization • support for multiple languages

Integrative KMS have to basically provide functions for the publication, search, retrieval and maintenance of knowledge elements in knowledge repositories. The measure *orientation/quality of visualizing context and structure* shows a close link to the category information, knowledge and communication quality. The KMS has to provide functions to support participants' *navigation* in the knowledge elements (e.g., mindmaps, hyperbolic browser[656]) and the *restriction* of the abundance of knowledge elements to a portion that is relevant for the participant in order to avoid information overload (e.g., oriented on the business process or the topic in or on which the participant works). The latter effect is closely coupled to role models of different types of users which should be supported by the KMS. The measure *integration of knowledge sources* assesses to what extent the KMS spans knowledge sources with different architecture or formats (e.g., internal documents on file servers, Lotus Notes data bases, the organization's Intranet, the WWW or external on-line data bases) and supports the user in accessing all these systems (e.g., registration, authentication, translation of search terms and logics). The measure *quality of the support for dynamics of contents* assesses to what extent the

656. See 7.3.3 - "Integrating architectures for KMS" on page 311.

KMS helps for example participants to find new documents, authors to update their knowledge elements, information subscriptions that notify participants about new or updated knowledge elements within their area of interest. There are a number of measures to assess the *quality of a search engine* or an information retrieval system respectively which basically relate the number of documents found that are deemed relevant to the number of documents that were not found, found and irrelevant or not found and irrelevant (referred to as the *Cranfield model* of information retrieval evaluation, see Harter/Hert 1997, 8f and 27ff for a discussion of the evaluation of Internet search engines and extensions of this traditional model).

Quality of **interactive KMS** is assessed with the help of the measure *quality of the communication media*, e.g., reliability, exactness and clarity of the medium as well as design and number of communication channels. Additionally, *social presence* theory can be applied to assess whether the communication medium is able to convey a trustful, personal, warm, sociable, sensitive atmosphere (Short et al. 1976, 64ff, Kettinger/Grover 1997, Karahanna/Straub 1999). *Ease of feedback* aims at the KMS's support of spontaneous answers which are often crucial for the close interaction necessary for sharing knowledge (Kettinger/Grover 1997). There is an analogous measure in the area of integrative KMS which reflects the option to easily give feedback to contents of a knowledge repository.

There are a number of measures that can be applied to the assessment of **both types of KMS**. Most of these measures were already suggested for general IS, such as *response time*, *ease of use* which assesses e.g., the number of errors regularly made, perceived *complexity of the system* etc., *reliability* and *accessibility*, e.g., of communication media or of integrated external knowledge sources. *Support for multiple languages* is of increasing importance in organizations where there might be one or even more than one organization-wide language, but there might still be abundant knowledge elements and communication in often multiple local languages as well.

8.4.2 Knowledge quality

This category describes the quality of the contents and/or the output of KMS rather than the quality of the system performance and the functions provided. It covers the knowledge stored, distributed and presented by the KMS (e.g., search results, experts found for a given topic) as well as the communication that is mediated by the KMS. The original measures for IS success are assessed from the perspective of the user, thus it is not surprising that many of the variables were developed and applied in instruments to measure user satisfaction (e.g., Bailey/Pearson 1983). Table B-23 shows the most important measures for this category.

The quality of the information and knowledge provided by **integrative KMS** assesses the quality of knowledge elements, the *structuring*, *linking* and the *meta-knowledge* of knowledge elements as well as *participants' confidence* in the knowledge presented. It is also important that the *context* of knowledge elements in the system corresponds to the context held by the members of the organization. As an example the context realized in the KMS might be a concrete business process, a

project, an important research topic or an area of competence and this context must reflect the mental models of the participants. In a concrete evaluation, one could study for example to what extent participants think that the context can provide a productive limitation of search results. *Completeness or sufficiency of the knowledge base* can be assessed e.g., using participants' perceptions or comparing the quantity of the documents and links contained with a reference system (e.g., the KMS of a benchmark leader, detailed with respect to e.g., topics).

TABLE B-23. Measures for knowledge quality

integrative KMS	interactive KMS	both
• quality of the content of knowledge elements • quality of context correspondence • quality of knowledge structure and linking • quality of meta-knowledge • confidence in knowledge elements • completeness/sufficiency of knowledge base	• quality of expert profiles and skills directories • structure of newsgroups and discussion lists • quality of contents of community-services/community work spaces • timeliness of answers • confidence in communicated knowledge	• understandability (e.g., of knowledge elements, expert profiles or skills directories) • reliability of contents • currency • accuracy • conciseness • relevance • quality of format • quality of relevance valuations

The assessment of **interactive KMS** is a challenging task as contents of communication are difficult to evaluate. Moreover, there are legal barriers in several countries, e.g., the Austrian or German data privacy law (e.g., Höller et al. 1998, 289ff). However, *expert profiles* and *skills directories* can be assessed as well as *work spaces* to support communities and the *structure of* platforms for multilateral communication, such as *newsgroups* or *discussion lists*. These instruments are believed to provide means for preparing or initiating communication between knowledge seekers and knowledge providers. One important measure might be the perceived *timeliness of answers* of participants in general and experts in particular which reflects an important part of the organization's routines and culture. In analogy to *confidence in knowledge elements* within the integrative KMS, the measure *confidence in communicated knowledge* generally assesses trust in knowledge sharing. KMS can help to provide trust by making the competencies of a knowledge provider visible to the knowledge seekers.

Both types of KMS can be assessed using general measures of information quality, such as *understandability*, *currency*, *accuracy*, *conciseness*, *relevance*, the *quality of the format*. Whereas these measures are used to assess documented knowledge in the case of integrative KMS, they can be applied to expert profiles, skills directories and—in part—also to messages transported by the KMS. An example for the latter is the quality of format that measures to what extent the KMS

helps the participants to structure their responses, automatically link them or suggest links with relevant knowledge elements, such as a glossary or similar cases etc. The *quality of the valuations of relevance* could be oriented towards certain types of users, e.g., novices versus experts, general versus specific knowledge, abstract/scientific versus narrative knowledge[657].

8.4.3 Knowledge-specific services

The measures in this category assess the success of the knowledge-related services in an organization which are produced by specialized employees in the roles of e.g., knowledge brokers or subject matter specialists with support of the KMS. The service should support the participants in handling knowledge with the help of the KMS. The literature provides a number of criteria for the evaluation of IS services[658]. The criteria have to be adapted to knowledge-specific services. Table B-24 presents a number of measures to assess knowledge-specific services.

TABLE B-24. Measures for knowledge-specific services

integrative KMS	interactive KMS	both
• quality of support of knowledge publication • quality of refining/ repackaging knowledge • quality of support of knowledge search • quality of distribution of knowledge elements • quality of maintenance of knowledge base (e.g., archiving/ deletion of obsolete knowledge elements, maintenance of knowledge structure)	• quality of communication support (e.g., help with selection and use of communication channels) • quality of support for communities (e.g., moderation and structuring of discussion lists, cross-postings) • quality of support for the development of expert profiles and skills directories	• transparency of services • reliability of services • responsiveness/promptness • availability of personnel • assurance (credibility, competence, courtesy of personnel, communication, security) • empathy (understanding/knowing KMS participants) • ability to motivate participants • quality of training and education • one-on-one consultations or helpline • appropriation support • integration of knowledge-specific services into KMS • error recovery (time to correct errors in KMS) • time required for new developments/changes to KMS

657. See also the types of knowledge distinguished in section 4.2 - “Knowledge” on page 60.
658. See e.g., Ferguson/Zawacki 1993, Pitt et al. 1995, Myers et al. 1998, 105f, Guimaraes et al. 1999; see Parasuraman et al. 1985 and 1988 for the SERVQUAL instrument; see also

In the case of **integrative KMS**, the quality of services to support *publication*, *refinement*, *distribution* and *search of knowledge elements* could be assessed as well as the *maintenance of the knowledge base*. In many organizations, subject matter specialists are involved in the publication process for example (a) to identify participants who could potentially publish knowledge interesting for a larger group of knowledge seekers, (b) to support authors to document, structure and link their knowledge, (c) to assess and improve the quality of documents and (d) to notify potentially interested knowledge seekers of the new documents. Knowledge brokers play an important role to improve the efficiency of participants who search the KMS for knowledge. Last but not least, a knowledge base requires continuos attention in order not to loose focus, to adapt the structure to cover new topics and to remove knowledge elements that are not needed anymore.

In the case of **interactive KMS**, the quality of knowledge-specific services to *support the communication* between knowledge seekers and knowledge providers can be assessed, e.g., helping to develop expert profiles and skills directories, initiating communication, demonstrate and help to select communication media and help with using new communication media (e.g., video conferencing). So-called community managers are responsible for the moderation and structuring of discussion lists and newsgroups, cross-posting of contents interesting for other communities and the like.

A number of more general measures (adapted from the SERVQUAL instrument and its extensions, see above) can be applied for **both types of KMS**, e.g., *reliability*, *responsiveness*, *transparency*, *availability* and *understanding* of specialized employees providing knowledge services, *consultations* or a *helpline*. *Assurance* means that the specialized employees providing knowledge services manage to instill trust and confidence of participants in their services. It is also important that specialized employees *motivate participants* to actively use the KMS, publish knowledge elements, engage in discussions, ask and answer questions and the like. As the installation of KMS often requires a substantial change in the ICT infrastructure, the quality of the training to use the KMS provided for the participants is an important factor determining success of the KMS's use. More generally, the KMS service should *support appropriation*, e.g., through guidance, facilitation, norms and policies as well as specific training so that KMS are used appropriately (Dennis et al. 2001, 173). One example is the moderation of communities, newsgroups or discussion data bases.

Also, knowledge-specific services should be as much *integrated into the KMS* as possible, e.g., the moderation of communities, but also the support of knowledge publication or search should be mediated by the KMS. Last but not least, the knowledge-specific service is responsible for *correcting errors*, for *new developments* and for *processing change requests* to the KMS.

8.4.4 System use

System use is probably the most frequently assessed category both in conceptual models as well as empirical studies measuring IS success[659]. System use comprises

many measures which, at least theoretically, can be easily quantified and automatically recorded with the help of a system monitoring. However, there has been an intensive debate about whether the use of a system is a good indicator for success (for counter-arguments see e.g., Doll/Torkzadeh 1998, 172f, Gelderman 1998, 12ff). System use is a necessary determinant for IS success, but not a sufficient one. The system use construct might at best help to identify the most unsuccessful systems. However, quantitative data about the frequency and duration of system usage without further detailing the extent, intensity and the tasks for which the system was used carry little value and the results are subject to misinterpretation (Gelderman 1998, 12f).

Thus, the measures assessing system use have to be detailed for the use of KMS (see Table B-25). Generally, KMS can be used actively (e.g., publishing, contributing to discussions, answering, valuing, commenting) and passively (e.g., searching, reading discussions). The ratio between participants actively and passively using KMS is an important criterion for a KMS successfully stimulating interaction and, as a consequence, knowledge sharing between participants.

An assessment of the use of **integrative KMS** could evaluate the *frequency*, *regularity*, *duration*, *intensity* and the *extent* of the *direct* and *chauffeured use* of specific KMS functions and knowledge-specific services for the *publication*, *distribution*, *access of* and *feedback to knowledge elements*. The measure *use in support of horizontal integration* describes to what extent the KMS are used to coordinate activities or knowledge sharing within the work groups, teams or communities. The *use in support of vertical integration* comprises to what extent KMS are used along the hierarchy and thus for coordination and knowledge sharing with superiors/subordinates (Doll/Torkzadeh 1998). One important group of measures assesses the dynamics of an organizational knowledge base, to what extent KMS are used and the knowledge-specific services contribute to *actuality, refinement and repackaging of knowledge elements*.

The use of **interactive KMS** can be assessed with analogous measures focusing communication and interaction between knowledge seekers and knowledge providers and in communities. Examples are the *number of emails sent, received or forwarded* which can be detailed according to the *type of usage* (e.g., in task-related, social and broadcast use of email, Kettinger/Grover 1997, 517ff), the *relationship between sender and receiver* (e.g., within work group or team, in communities, along hierarchy), with respect to the *type of message* (e.g., questions, answers, valuations, voting, scheduling meetings, announcing events, reports, new knowledge elements or links to experts), *contributions to newsgroups*, the *communication acts* that use KMS, such as video conferencing, audio conferencing, chat or instant messaging and finally the use of interactive KMS to *locate experts* or *search skills directories*. A purely quantitative assessment cannot be recommended as it is the

659. See DeLone/McLean 1992, 66; see also e.g., Zmud 1979, Hiltz/Turoff 1981, Srinivasan 1985, Kim/Lee 1986, Finholt et al. 1990, Rice/Shook 1990, Straub et al. 1995, Kettinger/Grover 1997)

(type of) contents that are communicated, the actuality and relevance of the knowledge shared, that count. The interaction in communities can be assessed with respect to the *focus* or the *range of the discussions* and knowledge exchange going on, the *evenness of contributions*, that is the distribution of activity in the community (e.g., by grouping members of the community with respect to their levels of activity).

TABLE B-25. Measures for system use

integrative KMS	interactive KMS	both
• use for knowledge publication (e.g., number/size of knowledge elements published per topic) • use for knowledge-search and retrieval (e.g., number/size of knowledge elements accessed per topic) • use for knowledge distribution (e.g., number of information subscriptions per topic) • use in support of maintaining quality of knowledge elements and structure (e.g., actuality, number of refined/repackaged knowledge elements, number of changes to knowledge structure) • use in support of horizontal/vertical integration • use in support of feedback to knowledge elements (e.g., number of comments)	• number/type of task-related, social, broadcast messages sent/received/forwarded • number/size of contributions in newsgroups, discussion lists • number/type of communication acts per communication medium (e.g., audio-/videoconferencing) • percentage of employees with profiles in skills directories • number of profiles accessed • use in support of horizontal/vertical communication or communication within communities • use in support of locating experts and skills • use in support of feedback (e.g., number/focus of responses to questions) • evenness of participation • focus/range of communication (especially in communities)	• number of users • regularity of use • intensity of use • extent of use (e.g., use of certain KMS functions or contents, levels of use) • frequency of past, intended, voluntary use • frequency of direct/chauffeured use • duration of use • use of KMS by business partners (e.g., customers, alliances, suppliers)

As already mentioned above, the more general measures such as the *number of (active and passive) users*, the *frequency*, *regularity*, *intensity*, *duration* and *extent of use* can be applied to assess **both types of KMS**. Last but not least, the *use of KMS by business partners* can be evaluated as well and the share of external versus internal users gives an indication of the openness of the KMS to organization-external users and topics.

8.4.5 User satisfaction

Similar to the category *system use*, *user satisfaction* is assessed frequently in the literature. One of the best known and most applied instruments to measure user (information) satisfaction is the one originally developed by Bailey/Pearson (1983)

and shortly after improved (shortened) by Ives et al. (1983, 789ff)[660] as well as the similar instrument developed for the area of end-user computing by Doll/Torkzadeh (1988)[661]. The instruments are quite extensive: Bailey and Pearson's instrument comprises 39 variables (Bailey/Pearson 1983, 539ff), Doll and Torkzadeh's consists of 12 variables (Doll/Torkzadeh 1988, 266ff). However, most of the variables in these instruments fall into the categories (perceived) *information* and *system quality* and *service quality* and thus were discussed in the corresponding categories[662]. In other words, these variables assess user satisfaction indirectly. In the following, those variables will be discussed which *directly* assess user satisfaction as well as a couple of variables measuring the perceived participation and control of users in the KMS's design (see Table B-26).

TABLE B-26. Measures for user satisfaction

integrative KMS	**interactive KMS**	**both**
• satisfaction with the publishing instruments & procedures • satisfaction with knowledge search functions • knowledge satisfaction: difference between knowledge elements needed and amount of knowledge elements received • satisfaction with knowledge elements presented in KMS (contents and structure)	• satisfaction with communication media • satisfaction with interactions in communities • satisfaction with functions and contents supporting the location of experts/knowledge providers	• overall satisfaction • positive attitude towards KMS • realization of expectations/ demand for redesign • perceived utility • demand for redesign • satisfaction with interface • satisfaction with knowledge-specific services • understanding of KMS • enjoyment • feeling of participation • feeling of control over KMS developments/changes

Satisfaction with **integrative KMS** can be detailed according to the main functions that are supported by the systems, namely publishing and accessing knowledge elements. Furthermore, participants can be asked for their satisfaction with the contents of the KMS as well as the knowledge structure and visualization of links. *Knowledge satisfaction* describes in analogy to information satisfaction the difference between knowledge needed and the amount (and also the quality) of knowledge elements received (e.g., Olson/Ives 1982, 51).

660. See also Zmud 1979, Ives/Olsen 1984, Baroudi et al. 1986, Baroudi/Orlikowski 1988, Li 1997, Blili et al. 1998.
661. See also its applications, e.g., in Igbaria/Tan 1997, McHaney/Cronan 1998, Downing 1999.
662. See sections 8.4.1 - "System quality" on page 413 and 8.4.3 - "Knowledge-specific services" on page 416.

In the case of **interactive KMS**, *satisfaction with communication media* assesses to what extent the communication needs of participants (bilateral as well as multilateral) are met by the KMS. Also, the *satisfaction with interactions in communities* assesses how well participants think that the existing communities serve their needs for sharing, evaluation and development of knowledge. A third group of measures within interactive KMS assesses the satisfaction with functions and contents of *expert locators* and *skills data bases*.

In addition to these specific variables, there is a large group of measures taken from the instruments to measure user satisfaction as mentioned above that can be applied to measure **both types of KMS**. Apart from the *overall satisfaction* these measures assess the involvement of the participant in design and management of the KMS (Franz/Robey 1986, 351ff), specifically whether the participants' *expectations were fulfilled*, whether the participant has a *positive attitude towards the KMS* (Winter et al. 1998), whether he or she could *participate in the design of the KMS* and *feels to control developments or changes made to the KMS*.

Furthermore, *satisfaction with knowledge-specific services* across integrative or interactive KMS can be assessed. Another group of measures targets the *usefulness of the KMS* for participants' tasks (also Franz/Robey 1986, 353f) and the *understanding of the system* and even assess whether the participant enjoys to use the KMS.

8.4.6 Impact on individuals

There is a substantial amount of literature dealing with the question of how the use of IS impacts individual behavior[663]. Most of the measures in this category assess the perceptions of individuals about the impact of the use of IS in general and KMS in particular on their behavior and performance (mostly decisions and productivity in performing a specific task). The majority of these measures have been empirically tested in laboratory situations (DeLone/McLean 1992, 74).

In those cases where "objective" measures were applied, the tasks or problems were predefined and thus the quality of the results (e.g., decisions, task performance) could be judged straightforwardly. However, it will be challenging to translate these measures into "real world complexity", especially with respect to KMS where problems—and solutions—tend to be unique and thus it will be difficult to define a "reference task" which could be used to objectively measure performance. Therefore, the evaluation will have to rely in large parts on participants' perceptions of the impact of KMS on their individual performance (see Table B-27).

In the case of **integrative KMS**, the *impact on capabilities for unaided publication of knowledge* as well as the *impact on capabilities to access knowledge elements* measure new ways to access knowledge from a variety of sources and new

663. See e.g., Millman/Hartwick 1987, Rice/Shook 1990, Massetti 1996, Kettinger/Grover 1997, Blili et al. 1998, Igbaria/Tan 1998, Lucas/Spitler 1999 and the 39 sources cited in DeLone/McLean 1992, 76ff.

ways to publish knowledge potentially relevant for other participants. Examples for measures are autonomy (e.g., access or publication possible with the help of a specialist, with the help of another participant or without any help, Blili et al. 1998, 149), the number of knowledge sources accessible, privileges for knowledge publication and distribution as well as the ease-of-use of the KMS to publish knowledge and retrieve relevant knowledge from various sources. The actual *impact on the access to knowledge* can be measured in terms of speed, e.g., time required for access or publication, amount of KMS output that has to be processed in order to get to the knowledge elements needed, number of clicks needed (there are a number of variables defined in the literature measuring both, speed of access and ease of information retrieval, e.g., Blili et al. 1998, 151). Finally, a good knowledge structure, visualization and profiling might result in a *reduced feeling of information overload* because the KMS present the right amount of information targeted at participants' information needs.

TABLE B-27. Measures for individual impact

integrative KMS	interactive KMS	both
• impact on participants' capabilities to publish knowledge elements • impact on participants' capabilities to access knowledge elements • impact on actual access(es) to knowledge elements • impact on feeling of "information overload"	• impact on individuals' communication capabilities • impact on communication behavior (e.g., response time for emails, use of alternative communication channels) • impact on locating knowledge producers/appliers/experts	• impact on creativity (e.g., number, novelty and value of ideas) • impact on personal productivity (time savings) • impact on decision making (e.g., time, confidence, number of alternatives) • impact on autonomy • impact on awareness of importance of systematic handling of knowledge • willingness to pay for KMS use

Interactive KMS impact participants' *communication capabilities* e.g., by adding communication channels or by pre-formatting and supporting electronic conversation. These new capabilities might influence the actual *communication behavior* which can be measured e.g., by the response time for emails, the number of alternative (new) communication channels used, the perceived appropriateness of communication channels for predefined communication aims. Finally, the support of interactive KMS in *locating knowledge producers, experts or other knowledge appliers* to exchange know-how is assessed using measures such as the amount of time required to locate an expert in a given topic or to answer a specific question or the number of knowledge appliers with a similar background and/or application context found in a certain amount of time.

For **both types of KMS**, the impact on specific aspects of the way individuals handle knowledge can be studied. The *impact on creativity* and thus the creation of

knowledge can be assessed e.g., as a perception (peer estimation) or as the number and the perception of novelty and value of ideas generated (Massetti 1996, 87). The influence on task completion and on decisions were the two most studied of all the measures applied in empirical studies to assess the impact of IS on individual behavior (DeLone/McLean 1992, 76ff). The *impact on personal productivity* can be assessed using e.g., the time required to complete a (predefined) task or the improvement in personal productivity for specific tasks (e.g., the staffing of a new project).

There are a number of variables measuring the *impact on decision making*, e.g., the time to make a decision, the confidence of the individual in the decision, the speed, extent and quality of decision analysis (e.g., the number of alternatives generated and/or considered, the accuracy of interpretations), the quality of the decision (e.g., accuracy of forecasts) or, generally, the perception of the individual that the use of the KMS has led to changed or new decisions. The use of KMS might also influence (perceived) functional *autonomy* of a position (e.g., Blili et al. 1998, 151).

One of the more subtle influences of KMS might be a change in participants' *awareness of the importance of a systematic handling of knowledge* (e.g., avoiding unnecessary double developments or the "not invented here" syndrome, importance of trust in and help for other departments/work groups or speed up distribution and realization of ideas). Last but not least, participants might be asked what they would be *willing to spend* for their participation in communities, for the use of the expert locator, skills data bases or knowledge repositories in general or for individual KMS outputs in particular (e.g., search results, reports).

8.4.7 Impact on collectives of people

Participants work in social groups or collectives, such as work groups, project or virtual teams and more recently in communities. Although there is increasing interest in the implementation of communities in organizations, there is still a lack of reports on the impacts of KMS on this new organizational instrument to support knowledge development, and especially knowledge valuation and distribution (e.g., Ferrán-Urdaneta 1999). However, there are a number of approaches in the literature dealing with the effects of group support systems or group decision support systems on the performance and culture of groups, teams or more generally collectives of people[664]. Group performance can be assessed with the same measures as applied for individuals, e.g., impact on creativity, productivity, decision making, autonomy as well as satisfaction[665]. Generally, these measures should be positively influenced if the ICT systems (no matter whether GSS or KMS) fit the tasks of the group or community and if the group uses the technologies appropriately which

664. For an overview see e.g., DeSanctis/Gallupe 1987, Kraemer/Pinsonneault 1990, Dennis 1996, Chun/Park 1998, also Reagan/Rohrbaugh 1990, Kamel/Davison 1998, Kwok/Khalifa 1998, Shirani et al. 1998, Gibson 1999, Huang et al. 1999, Dennis et al. 2001.
665. See section 8.4.6 - "Impact on individuals" on page 421.

can be supported e.g., through guidance, facilitation, restrictiveness or appropriation training (Dennis et al. 2001, 172ff).

However, one has to be careful in the application of measures developed to assess group performance for communities. This is especially true for variables measuring the impact of IS on the group's productivity or decision making. As opposed to teams or work groups, communities lack a common task and regularly do not decide as a collective (e.g., Ferrán-Urdaneta 1999). Also, the knowledge developed and distributed in communities might or might not be aligned with the organization's goals making it even more difficult to conclude from a positive impact on communities to a positive organizational impact. Table B-28 gives an overview of the most important measures in this category.

In the case of **integrative KMS**, groups and communities might have a positive influence on the *contextualization of knowledge elements*. Groups or communities with their similar interpretation, background and shared history ease the interpretation of knowledge elements developed within and for the group or community. The positive effects of shared context for interpretation and sharing of knowledge are not restricted to integrative KMS. Sharing knowledge within a community also aids to build *confidence in the knowledge elements* (e.g., Ferrán-Urdaneta 1999).

TABLE B-28. Measures for impact on collectives of people

integrative KMS	interactive KMS	both
• impact on contextualization of knowledge elements • impact on confidence in knowledge elements	• improved quality of communication in groups/communities • impact on interactions in communities (knowledge creation and sharing) • confidence in communication • activity (active participation of members in communities) • thoroughness of (virtual) meetings	• impact on group/team productivity • impact on group/team decision making • impact on members' attitudes towards the group/team/community • impact on group/team autonomy • impact on group/team/community consent • impact on group/team/community creativity • impact on social structures • impact on integration of members of collectives (e.g., communities) • impact on valuations of knowledge in communities

The use of **interactive KMS** can have a positive impact on the *quality of communication* (e.g., Finholt et al. 1990, Kock 1998) which could be measured e.g., as the perceptions of members of a community whether contributions to discussion lists and newsgroups have improved because of the use of a KMS. The *impact on knowledge creation and sharing* measures e.g., the number, novelty and value of ideas developed in communities or groups (Massetti 1996), the speed of distribution of ideas, the response time for questions to be answered in newsgroups, espe-

cially in communities, but also the type of knowledge created or shared, e.g., social knowledge. As with integrative KMS, communities and groups might have a positive impact on *confidence in communication*, e.g., contributions to discussions, answers or lessons learned. It is closely related to the rate of *activity* of members' participation in the communities, e.g., measured by the percentage of members that regularly contribute to discussions or the number of knowledge transactions performed in the community (e.g., requests, revisions, publications and references, Adams/Freeman 2000, 42f). Interactive KMS can also be applied to support virtual or electronic meetings, e.g., using multi-point audio- or video conferencing or chat. The effectiveness of these meetings can be measured in terms of *thoroughness and focus of the discussions* as well as the *quality of the moderation* in the meetings[666].

The measures listed in the column for **both types of KMS** are probably more influenced by the interactive KMS then by the integrative KMS as most of them rather build on direct interaction between group members. In many cases collectives of people will use both, integrative and interactive KMS together in order to support their (individual or group) tasks so that it seemed appropriate to move the general measures taken from GSS research to be applicable for both KMS. *Consensus* in collectives of people can be measured e.g., by the total number of positions members were away from the most agreed-upon policy (see e.g., Shirani et al. 1998, 235, Huang et al. 1999 and the literature cited there) or in this case the most agreed-upon knowledge element. In analogy to the impact on decision making on the individual level[667], *group decision making* might be affected by KMS resulting in e.g., a deeper analysis of the decision problem, the generation of more and/or better alternatives or ideas, more active involvement of group members, a better understanding or comprehension by and more interaction between the members of the group, positively or negatively affect confidence in and satisfaction with the decision (e.g., Chun/Park 1998, Kwok/Khalifa 1998, Dennis et al. 1999).

The use of KMS can also have effects on the *attitudes of members towards the group or community* which can be measured e.g., by assessing the satisfaction with the group or the willingness to work with the group or participate in the community (e.g., Kraemer/Pinsonneault 1990, 378) The *impact on social structures* in groups comprises phenomena such as group cohesion, collectivism, personal and cultural tensions, removing of communication barriers, group pressure, normative, social and intellectual influences, domination of discussions, perceived status differences of members or the degree of anonymity (also Kamel/Davison 1998, Gibson 1999, Huang et al. 1999, Karahanna/Straub 1999, 242). Additionally, KMS use might have an impact on the size of communities, the attitudes towards membership and on the process of *integrating (new) members in the community.*

666. See also section 8.4.3 - "Knowledge-specific services" on page 416.
667. See section 8.4.6 - "Impact on individuals" on page 421.

8.4.8 Impact on the organization

As opposed to the large number of approaches in the literature analyzing the individual impact of IS and the influences on the group level, the organizational impact has not received equally high attention in the literature[668]. This is due to the significant challenges that are required for the isolation of organizational impacts due to the use of an IS from the abundance of other factors that influence organizational performance[669].

As a consequence, most of the studies assessed the impact of overall IS or IT investments on firm performance instead of the performance implications of an individual IS. Overall IS or IT investments were measured in terms of e.g., total IS budget, also as a share of other variables, such as total sales; the number or share of IS employees or details about what the budget is spent on. Examples for performance indicators used are

- *sales performance*, e.g., total sales or market share,
- *financial firm performance*, e.g., operating costs; economic value added (EVA), divided by sales, general and administrative expenses; return on assets (ROA); return on capital employed (ROCE), return on equity (ROE); return on investment (ROI); return on sales revenue (ROS) or share prices and
- *indirect or intermediate performance indicators*, e.g., labor productivity or asset turnover.

Additionally, there are studies that suggest to use the subjective perceptions of the (strategic) benefits achieved by an IS or IS project (see e.g., Mirani/Lederer 1998 who asked IS professionals to estimate the benefits of their projects). The effects on cost and benefits on the organizational or strategic level are very high on the agenda of CKOs and CIOs and every practitioner interviewed as part of the empirical study described in part C was concerned with some form of cost/benefit analysis to justify expenses and demonstrate explicit value creation or cost savings stemming from the use of a KMS.

The effects of KMS use on the organizational level are difficult to measure, apart from some crude measures such as time and money savings for avoided travelling, saved costs for the access of external on-line data bases or participants' perceptions of the quality of KMS and its impact on business performance. One promising direction might be the intellectual capital approach which at least concentrates on knowledge-related organizational performance. Thus, effects can be easier attributed to KMS use than in the case of the general financial indicators. Table B-29 presents a set of measures to assess the organizational impact of KMS.

Business partners, especially customers, might have to pay for accessing **integrative KMS** and thus generate *additional profits*. Several professional services

668. See DeLone/McLean 1992, 74 and Prattipati/Mensah 1997, Mirani/Lederer 1998 and the literature cited in these articles, also Nelson/Cooprider 1996, Rai et al. 1996, Kettinger/Grover 1997, Hoopes/Postrel 1999, Li/Ye 1999.
669. See e.g., Lincoln 1986, 26 for a good example; see also section 8.3.3 - "Critique and extensions" on page 407.

companies have already started to charge their customers for accessing their knowledge repositories. The use of knowledge maps and knowledge structures as well as the authentication of knowledge documents might improve the *visibility of knowledge structures* and—together with the counterpart on the side of interactive KMS, the *visibility of knowledge networks*—support the identification of experts which in turn is the basis for greater flexibility and generally for the (strategic) management of knowledge resources in the organization[670]. KMS that integrate various knowledge sources might help to *reduce costs for the access of organization-external knowledge services*, e.g., on-line data bases, knowledge repositories of business partners, news services, benchmarking and competence centers.

TABLE B-29. Measures for organizational impact

integrative KMS	interactive KMS	both
• additional profits through selling access to the KMS • impact on visibility of knowledge structures • impact on costs of access to organization-external knowledge services	• impact on communication on an aggregated level • impact on visibility of knowledge networks • savings on travelling	• efficiency of the KMS • impact on financial/sales performance/ competitive advantage • impact on innovations • impact on products and services • impact on business relations • impact on the amount/quality of training and education • impact on building of social networks • reduction of fluctuation • impact on willingness to share knowledge • effectiveness of environmental scanning

Interactive KMS can help to *improve communication* on an aggregated level, e.g., between strategic business units, across countries and cultures or between departments with varying professional background (e.g., engineering versus business background). Interactive KMS improve visibility of knowledge networks, e.g., through analysis of contributions within and across communities. Also, a newly recruited employee or an employee moving within the organization onto another job might quickly take over the (official) knowledge networks of the new position, thus reducing time for settling in a new position. Cost reductions are also possible through *avoiding travel expenses* with the help of interactive KMS (e.g., video conferencing, electronic access to expert and community know-how from any place).

Generally, for **both types of KMS** the economics can be assessed in terms of perceived efficiency of the KMS (e.g., Kettinger/Grover 1997). As discussed above, performance indicators such as *impact on innovations, relations to business partners, products and services* and especially *financial or sales performance* are

670. See section 5.1.1 - “From market-based to knowledge-based view” on page 94.

indirect and determined by a large set of variables which can hardly be assessed or controlled empirically.

Three more effects of KMS use directly target the organization's employees. *Impact on the amount and quality of training and education* should in turn effect the employees' competencies and can be assessed with the help of employee-oriented measures from the field of HRM (e.g., Drumm 2000). Some organizations interviewed, especially the professional services companies, specifically targeted newly recruited employees. KMS could help to accelerate the *building of social networks*, coaching and mentoring as well as an improved training on the job because of the access to a wealth of knowledge and information about experts and peers. If organizations manage to use KMS to support the development of unique networks of competencies, they might also help to *reduce fluctuation* as employees cannot transfer these networks into other organizations.

KM initiatives and the use of KMS also aim at increasing participants' *willingness to share knowledge*, a dimension of organizational culture[671]. *Effectiveness of environmental scanning* describes how rapidly and how accurate an organization identifies problems or opportunities in its relevant environment (Huber 1990, 62f).

8.5 Résumé

The assessment of success or benefits of KMS is a difficult task even if the measures are restricted to the ones presented here. It requires a combination of quantitative, semi-quantitative and qualitative assessments applied in a thoroughly defined and repeatedly applied KM audit. Thus, comprehensive results about success and failure of KM initiatives and KMS cannot be expected from a survey on the basis of a questionnaire as part of the empirical study. However, some of the proposed measures are easier to assess and therefore will be included into the questionnaire. In the following, the measures used in the empirical study are described and the hypotheses are discussed which relate to the usage and economics of KMS. The following measures will be applied in the empirical study:

Size of KM initiative. The size will be assessed using two measures:
- *KM expenses*: total expenses for KM excluding salaries,
- *number of employees working for KM*: the number of KM staff or KM expenses can also be related to the number of participants giving the rate of KM support per participant.

Funding of KM initiative. The following three alternatives will be given:
- a separate budget for the KM initiative,
- internal accounting or internal "selling" of KM services,
- external "selling" of KM services e.g., through licenses, concepts.

671. For an instrument see section 6.4 - "Organizational culture" on page 221.

Rate of participation. This variable is computed as the number of employees participating in KM activities divided by the total number of employees.

Rate of KM activity. This variable is computed as the number of active participants divided by the number of employees participating in KM activities.

Access to KM-related systems. These variables are computed as the numbers of employees having access to email, WWW, advanced Internet systems, Groupware or KMS respectively divided by the total number of employees.

Frequency of KMS use. This variable measures the frequency with which particular (sets of) functions of KMS are used.

Intensity of KMS use and KM services use. Respondents will have to estimate to what extent their KMS and KM services are used per month. A list of six functions and services will be presented covering knowledge publication, distribution, search and retrieval, communication and KM service. In order to relate these figures to the size of the KM initiative, the following ratios will be used:

$$s_1 = \frac{i(u)}{p} \qquad s_2 = \frac{i(u)}{ap}$$

legend:

$s_{1,2}$	*success measures*
$i(u)$	*intensity of usage*
p	*number of participants*
ap	*number of active participants/authors;*

General support of business goals. A single question will be used to assess to what extent respondents think that business goals are supported by their KM initiative.

Support of particular business goals and KM goals. Two lists with ten business goals and with fourteen KM goals will be presented for which respondents again will have to indicate to what extent they feel that these goals are supported by their KM initiative. The lists were derived from previous empirical studies[672].

The following hypotheses support the analysis of the relationships between (a) the existence of and the regulation of access to KM-related systems and KM services on the *system level* and (b) the impact on individuals aggregated on the *organizational level*.

Hypothesis 21: Organizations with KMS have a higher rate of KM activity than organizations without KMS

672. Surveys and field studies: APQC 1996, Bullinger et al. 1997, 18f and 32, ILOI 1997, 15, Heisig/Vorbeck 1998, 7, Earl/Scott 1999, 31; see also section 5.2.1 - “Strategic goals” on page 114.

Many of the KMS functions aim at a stronger support of a more active role of users than is the case in basic Intranet systems. In Intranet solutions, the publication, structuring and organization of documents are often centralized. Looking at the market for KMS, the most propagated benefits of the use of KMS are that it is a lot easier to document, publish and distribute knowledge elements, to comment on documents, to locate and to communicate with knowledge providers as well as knowledge seekers, to share in an electronic discussion or to give feedback to questions or proposals of participants or experts than before. Additionally, the integration between documentation, contextualization and communication functions eases direct or indirect interactions between participants.

Hypothesis 22: The more employees have access to Groupware and/or KMS, the more they are willing to share knowledge

The implementation of Groupware tools or KMS requires that the organization focuses more on the support of groups and teams as well as the communication and collaboration between groups and teams. The higher the share of employees who can access these systems, the easier it is for these employees to exchange ideas within and between groups and teams and the more groups and teams are emphasized as the units holding documents and receiving messages rather than the individual. This heightened awareness, the increased ability to share knowledge, the higher visibility of groups and teams as well as the easing of knowledge-related tasks with respect to groups might support willingness to share knowledge.

Additionally, the following hypothesis concerning general success of the KM initiatives will be tested:

Hypothesis 23: The more rigorously knowledge management is established in an organization, the more business goals are achieved in that organization

Rigor of the systematic establishment of knowledge management will be measured according to the investment in KM per participant. There were two measures for this: firstly, the ratio *KM expenses divided by the number of participants* and secondly the *number of employees assigned to KM divided by the number of participants*. Supposed that KM instruments generally support the achievement of business goals, then the more organizations invest into that approach, the more they should benefit.

Relationships between the organizational design of a KM initiative, the use of contents and the application of KMS and the achievement of business goals will be explored along with this hypothesis. As the state of theory in this area is still in its infancy, the statistical tests will be run in the sense of exploratory research and used to generate hypotheses for subsequent studies. The following measures will be correlated to business goals:

Reporting level of the head of knowledge management. This measure is a good indicator for the attention that the organization pays to KM. The higher the attention and the closer the KM initiative to the CEO, the more probable it is that business goals can be supported with the help of this initiative.

Centralization and formalization of knowledge-related tasks. The best organizational design for a KM initiative might be a decentral assignment of responsibility because the handling of knowledge generally is a decentral activity. Similarly, communities have been proposed as an important organizational instrument for KM suggesting a rather informal approach. However, a centralized KM unit might be able to successfully coordinate KM activities. KM projects might be able to overcome important barriers to KM which are due to formal organizational structures and processes. It is uncertain whether decentral or central, formal or informal approaches should be more successful and in what cases. The interviewees believed that KM-related tasks should be decentralized as much as possible. The KM initiative should have a formal organizational design that increases visibility and trust in the approach. They suggested that a central KM unit or at least a KM project should coordinate the activities.

Rate of KM activity. One of the primary targets of KM initiatives and the use of KMS is to stimulate employees to actively contribute to the organization's knowledge flows. It is expected that a higher activation should positively influence the achievement of business goals.

Management of types of contents as part of the KMS. A systematic handling of certain types of contents in the organization's KMS might also promise improved performance on business goals. There is not enough knowledge about what types of contents might support what types of business goals yet. It is supposed, though, that a greater variety in the types of contents is an indicator for a more thorough design of the KM initiative, a more rigorous establishment of KM in that organization and thus might have a positive impact on business goals.

Use of KMS. This relationship assesses the impact of an extensive (large number of KMS functions) and intensive (high frequency of usage) implementation and use of KMS on the achievement of business goals. Even though the relationship is an extremely indirect one, its exploration should lead to hypotheses about the impact of different types of KMS or KMS functions that can be tested in subsequent studies.

This chapter discussed the challenging tasks to assess costs and especially benefits of a KM initiative in general and the success of KMS in particular. After a brief review of concepts and approaches to determine an organization's intellectual capital, a model for the assessment of success of KMS was proposed. This model was built on the popular model to measure success of IS proposed by Delone/McLean (1992). Then, a selection of the most important or most interesting success measures was discussed using the classification of KMS into integrative and interactive KMS (Zack 1999a). The measures could be used in the case study presented in the beginning of the section (sd&m AG) to assess the success of KM services and the implemented KMS in a more detailed way (Maier/Hädrich 2001). The results of

this analysis could in turn provide a basis for the improvement of KMS functions, of the role of knowledge brokers and of knowledge processes.

The assessment of success of KMS and of a KM initiative are extremely complex tasks. KMS comprise a wide variety of systems in support of KM[673]. Thus, it is not surprising that there is also a wide array of measures which could be applied to assess the success of such systems. The model for measuring success of KMS is meant to provide an organizing framework for the many variables thinkable. The selection of measures within each of the eight categories gives an overview of the variety of different approaches to assess the value of IS in the literature. The state of the art of the literature does not allow to give detailed recommendations for the selection of variables to assess a specific KMS because the interdependencies between specific variables still remain to be empirically tested. Due to the large number of variables this is a challenging task. Additionally, many of the variables that are suggested in the literature measure on an ordinal scale. They also reflect the subjective estimations and perceptions of various groups of people in different relations to the KMS, such as the knowledge manager, knowledge brokers, IS professionals, authors, participants etc. A portion of the factors describing system quality, information quality and system use can be objectively obtained, e.g., with the help of functions for system monitoring. Due to restrictive data privacy laws even these measures are far from being easily applicable[674].

The model presented here is also intended to provide a set of practicable measures that should spark ideas for the development of concepts to assess concrete KMS applications in organizations. A set of measures that covers all of the categories supposedly provides a much more solid basis for the currently unavoidable subjective assessment of the success of KMS in practice.

More generally, a model for success of KMS is confronted with the high requirements which result from a combination of measurement instruments from the natural sciences and engineering on the one hand and from the social sciences and management science on the other hand. Once again, the technology-oriented and the human-oriented side of KM have to be combined in order to obtain acceptable results. Moreover, success of KMS is influenced by many more factors than the ones considered in the model. Examples are:

- *characteristics of the participants*: Individual characteristics such as creativity, training and education or age play a role with respect to the success of KMS which cannot be clearly defined at this stage, but have to be considered when comparing results from different organizations and thus require statistical corrections (e.g., Massetti 1996).
- *communication not supported by KMS*: Interactive KMS are only one medium which supports and thus influences organizational communication processes.

673. See chapter 7 - “Systems” on page 273.
674. This is the case at least in European countries, especially in Germany, although workplace privacy has been an important US legal issue during the last decade as well and is supposed to be of even higher priority during the next years with other parts of the world pressuring the US to expand their privacy protection (e.g., Boehmer 2000, 32).

Telephone and direct personal interaction (both, formal and informal) are other examples which supposedly are also influenced by the existence of a KMS. The impact of changed communication processes on e.g., task performance is difficult to assess due to the fact that the biggest part of communication processes is not observable and also protected by data privacy law[675]. A central problem is the measurement of tacit knowledge and its sharing through socialization (Nonaka/Takeuchi 1997, 75ff).

- *organizational structure and processes*: The design of structure and processes of an organization influences the design of the KM function as well as the institutionalization of collectives of employees, their form, processes and relationships in and between e.g., work groups, project and virtual teams, networks and communities. Therefore, they also influence the success of KMS[676].
- *organizational culture*: The organizational culture and sub-cultures, such as work group, departmental, network or professional cultures within an organization are one, if not the most important factor influencing an organization's way of handling knowledge and its employees' willingness to share knowledge. Measurement of organizational culture is difficult as the actual norms and (basic) values of members of the organization can only be indirectly assessed through e.g., stories, symbols, rites, language, architecture, so-called clans or role models of supervisors[677].

An integration of all of these aspects into the model to measure success of KMS would further increase the complexity of the model. It is likely that the measurement of success would become a virtually insoluble empirical challenge. As a consequence, the number of measures that were included into the questionnaire had to be limited. Still, some interesting results are expected from the analysis of correlations between variables describing the organizational design, contents and systems of a KM initiative to the estimations of respondents about the achievement of business and KM goals that they aimed at.

675. For an overview of measures to assess communication processes see e.g., Rubin 1994.
676. See also the contingency approach in the area of GSS, e.g., Zigurs/Buckland 1998; see sections 6.1 - "Structural organization" on page 158 and 6.3 - "Process organization" on page 207.
677. See e.g., Drumm 1991, 166f; and section 6.4 - "Organizational culture" on page 221.