Exploring the issues in knowledge management

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A B S T R A C T

As organizations face a multitude of challenges, they have to cope with ever increasing dynamics and complexity. Even though the individual reactions of organizations may be totally different, a very common trend in all reactions is some form of decentralization. This decentralization is aimed at creating a nourishing environment for creativity. Creativity and autonomy have become strategic prerequisites for an organization. Information and knowledge structures have to be developed and maintained in order to sustain this decentralized mode of operation, thus giving rise to information and knowledge management. Focussing on knowledge management, four different forms of knowledge can be distinguished, each with its own traits and each requiring different forms of knowledge management and supporting knowledge systems. This is illustrated by providing three case descriptions, applying the concepts in a practical setting. In exploring the issues in knowledge management we investigate the ways in which organizations can influence and control the deployment of knowledge.

Exploring the Issues in Knowledge Management

1. Introduction

Over the years, organizations have seen a shift in the necessary capabilities for survival in the competitive world. The performance criteria have ranged, broadly, from efficiency in the sixties, quality in the seventies, flexibility in the eighties, to creativity in the nineties. The pyramidal nature of these criteria adds to the complexity of strategic management. Efficiency, quality, and flexibility are all, in some degree, prerequisite for business success. However, as these characteristics become less exclusive, creativity is the battleground for competitive firms. An important reason for the emerging call for creativity is the increasing individualistic nature of society: people wanting to be independent and self-sufficient. These people expect suppliers to be able to meet their individual needs. This attitude encompasses the whole spectrum from consumer goods to the service industry. As a response, organizations have taken a variety of measures. The common denominator of such measures is *knowledge management*.

In order to be creative in the marketplace, organizations have to nurture their creative skills. This involves the identification of necessary and strategic knowledge within the organization, taking measures to retain and expand this knowledge, and finding optimal ways of utilizing the knowledge. By taking a closer look into the goals, objectives, and possible instruments of knowledge management, we explore the issues to be tackled in a successful implementation and diffusion of these ideas.

This paper is organized as follows. First we explore in section 2 the grounds of knowledge management: changing organizations. We also discuss some typical

ways in which organizations react to these changes. Section 3 deals with data, information and knowledge and the related subjects data management, information management and knowledge management. The focus will be on the latter. In section 4 we present three short case descriptions, in order to clarify the language of knowledge management in practical terms. Finally, we make some concluding remarks in section 5.

2. Changing organizations and reactions

Most modern organizations have to cope with new or intensified challenges in their environment (Hammer & Champy, 1993):

- increased customer influence
- intensified competition
- shortened product life cycles
- continuous and accelerated technological change.

These challenges have created new levels of dynamics and complexity, both in profit and not-for-profit organizations, the difference being the time it takes for an organization to be held accountable for not responding to the challenges. The application of information technology can provide a competitive edge, increase customer service, or create a flexible production environment (Porter & Millar, 1985). Substitute products are just one example of competitive application of information technology. Electronic encyclopedias are offered alongside the traditional bound versions, the advantage being the ease with which electronic encyclopedias can be kept up to date and the variety of ways in which they can be offered on the market. To the publisher it is of vital importance to carry out a continuous assessment of the technological changes to be made to the product and to the production processes. These changes, apart from the knowledge content of the encyclopedia, are necessary to keep the competition from getting ahead too far.

Information technology also has a globalizing effect on the economy. For

example, flowers which were once grown and sold locally, are now being grown in Israel, sold on the flower market in Holland, and delivered to a flower shop on Fifth Avenue. This has mainly been the effect of the introduction of affordable air cargo services. In the near future, the flowers themselves will never see the place where they are sold, nor will the (wholesale) buyers have to be in the physical vicinity of either flowers or market when they buy them. Inspection and transaction are performed through high speed network facilities, connecting producers and distributors directly. Basically, the strong ties between transaction, time, and place have been lessened. As a consequence, modern organizations are faced with a tremendous number of opportunities. Different organizational and technical structures are necessary to realize new possibilities (new markets and products) through the use of information technology. The core competence of the entrepreneur is the capability to choose from the abundance of opportunities (Rinnooy Kan, 1994).

Organizations, when confronted with the challenges mentioned above, may react in variety of ways (see e.g. Paauwe, 1994). Among them are:

- changes to the organizational structure, such as reduction of the number of management levels, introduction of profit centers, outsourcing of support functions;
- changes to the functional structure, by means of increasing task span, authority, and responsibility;
- changes to the process structure, also known as business process redesign (BPR) and strategic quality management.

The common denominator of these changes is the increased authority and autonomy of the individual employee. A certain kind of decentralization is contained in all three different reactions. The primary aim of this decentralization is to move vital decision making processes to lower levels in the organization (De Leeuw, 1982). Creativity within the organization and responsiveness to customer needs are boosted by creating the proper environment for relatively autonomous teams and individuals. Although numerous examples can be found in the literature (Trist & Bamford, 1951; Galbraith 1973; De Sitter, 1989; Van

Eijnatten, 1994), the consequences they have for the information and knowledge structures within the organization are often neglected. We will further discuss these issues in section 4 after the introduction of the proper terminology for information and knowledge management in the following section.

3. Knowledge and knowledge management

3.1 Data, information and knowledge

Much has been said and written about the distinction between data, information and knowledge. Clear-cut distinctions are hard to make. In this paragraph we present our descriptions of the terms, combined with the related issues of data, information, and knowledge management.

In our view, data represents certain characteristics of (groups of) objects or events in the real world. Data are literally "given". Data can range from a social security number to the combined statistics of the norwegian economy. Data can become information when it serves a meaningful purpose in a certain setting, in general a decision process. Information is a means of reducing uncertainty (Galbraith, 1973): the CEO is uncertain of her company's competitive performance in the last quarter as long as she hasn't seen the reports over this last quarter. However, information can only reduce uncertainty if it adds something to the knowledge of the recipient of the information. We define knowledge in a pragmatic way. "Knowledge is understanding plus ability to transform it into actions (skill), which yields performance." (Nooteboom, 1995). When people receive information, they interpret and evaluate this information in a (decision) model they have of the real world and, consequently, they take actions (or not).

Knowledge can be divided in declarative knowledge ("knowing that") and

procedural knowledge ("knowing how"). We give a simple example in order to explain the difference. Experienced warehouse employees often know the exact location of certain auto parts of a specified make and model. The ability to reproduce these locations is declarative knowledge. The actual handling of the part and the processing of the accompanying paperwork requires a certain routine or procedure. Hence, the latter is termed procedural knowledge. Together, declarative and procedural knowledge are important foundations for organizational control.

A third kind of knowledge to be distinguished, apart from declarative and procedural knowledge, is what we call background knowledge ("knowing why"). This knowledge is required when new procedural knowledge is drawn up and when lines of reasoning have to be explained. Why are certain transactions carried out in a specific order? Why is one procedure better than another? Answers to these questions reflect directly on the efficiency and effectiveness of an organization. Comparative advantages can be gained by the organization that finds better answers.

Data, information, and knowledge in combination are essential to organizations. As data and information are carriers of knowledge, it seems appropriate to regard knowledge as a major production factor (Zeleny, 1989; Boersma, 1995) for organizations. The availability of data and information does not necessarily alter the organization’s behavior or competitiveness. The knowledge needed to interpret the information and to act upon it is the key to organizational success. For this reason, it has to be managed.

3.2 Knowledge management

In order to manage knowledge as a resource for an organization, one needs to understand the characteristics of knowledge and have at one’s disposal a number of instruments to actually influence the deployment of knowledge throughout the

organization. To this end, we distinguish between four forms of knowledge (Van der Zwaan & Boersma, 1993):

- human knowledge, where knowledge is contained in the heads of the members of the organization;
- mechanized knowledge, where the knowledge necessary to carry out a specific task has been incorporated in the hardware of a machine. We classify embedded systems as mechanized knowledge;
- documented knowledge, where knowledge has been stored in the form of archives, books, documents, ledgers, instructions, charts, design-specifications, etcetera; and
- automated knowledge, where knowledge has been stored electronically and can be accessed by computer programs that support specific tasks.

Instruments to influence the deployment of knowledge throughout the organization differ, depending on the form of knowledge to be managed.

Human knowledge encompasses the knowledge that is available through education, training, observation, experience and (implicit) reasoning. Human knowledge in organizations consists of the knowledge required to accomplish various operational tasks. In addition, it also includes managerial knowledge required to formulate policy, to carry out planning, and to exert control. A part of this knowledge is explicit and can be passed on to other people. Another part is tacit knowledge, which is often personal or group specific. It is difficult to objectify and externalize tacit knowledge, i.e. to translate it into terms of the other three forms of knowledge.

Mechanized knowledge is usually aimed at the accomplishment of a specific task. As the knowledge is embedded within a machine, it is almost impossible to access, transfer, or alter mechanized knowledge. It basically is just there and performs its function in the daily operations of the organization.

Documented knowledge is usually not necessary for the day-to-day operations of an organization. It should, however, be available and easily accessible, because

the organization has to be able to probe it's 'memory'. Audits and lawsuits are bound to rely upon documented knowledge, but also may research and development initiatives. The need to access documented knowledge is often hard to anticipate, but documented knowledge should always be available for offhand retrieval.

Automated knowledge is found in information, expert, or knowledge-based systems. These systems contain information and sometimes knowledge necessary to carry out tasks like diagnosis, design, therapy, and planning. Often they are designed as decision support systems, assisting the human operator of the system in taking the appropriate decision within a specified domain.
Together the four forms of knowledge form a triangle, depicted in figure 1. In this figure is human knowledge the center of gravity.

Knowledge management encompasses three different functions with respect to the four forms of knowledge:

- asset management; a taxonomy and measurement of available knowledge, distribution of knowledge, and knowledge retention;
- access management; accessibility of knowledge, valuation of available knowledge, and evaluation of knowledge deployment;
- accruement management; acquisition of desired knowledge, and development of new knowledge

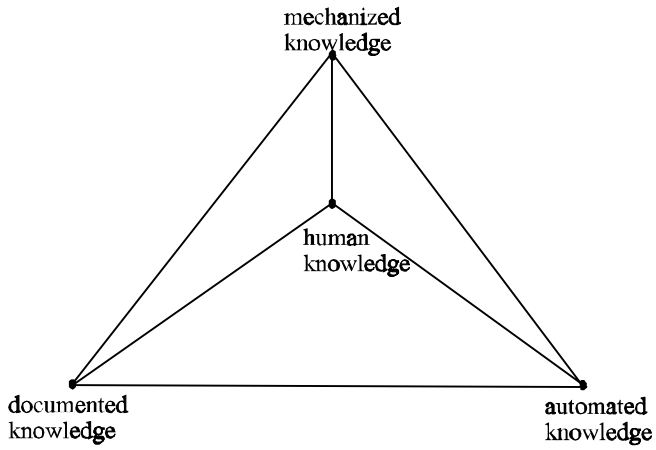

Figure 1 Connection between the four forms of knowledge

The basic instruments for knowledge management are tightly linked to these functions:

- asset management is carried out through knowledge mapping and knowledge representation;
- access management is aimed at improving the accessibility and deployment of knowledge, by means of analysis of knowledge intensive tasks and transformation of knowledge into forms more applicable to support these tasks (e.g. transformation of human knowledge into automated knowledge);
- accruement management takes place through an array of measures, ranging from hiring new personnel, instruction and training, to research and development, and the diffusion of knowledge within the organization.

Now that we have discussed the forms of knowledge that have to be managed, the elements of knowledge management, and the basic instruments available for knowledge management, the purpose of our research has been clarified. In summary, we argue that alterations in the behavior of the individuals in an organization are the effect of changes in the (tacit) knowledge of these individuals. Explicit attention should be paid to the presence, accessibility, and increase

of knowledge in order to influence the further development of the organization and its members. In the remainder of this paper we will discuss a series of cases and we will try to identify the different forms of knowledge and the mechanisms available to manage that knowledge in each one of these cases.

4. Three cases of knowledge management

The real-life case descriptions in the following three paragraphs serve to illustrate different applications of knowledge management. In each one of the cases different forms, functions, and instruments of knowledge management are discussed. Although all these aspects can probably be found in each single case description, the different cases represent a broader exploration of the issues.

4.1 Management of human knowledge

An international firm, with offices in several countries and a total of 40,000 employees, has some 500 key positions. It is essential for the organization that vacancies for these positions are filled by competent persons, preferably from inside the organization. At corporate headquarters, a small group of personnel advisors has the responsibility for the continuity of the 500 key positions. To this end they need an information system that not only contains standard data like name, age, position, and marital status, but can also render information on qualifications, courses completed, previous positions, and evaluations. The reason for such an information system should be obvious. The personnel advisors have to be able to assess the organization's capability to fill future vacancies with competent personnel. They need to know whether there is a gap between supply and demand and, if so, whether this gap can be bridged by means of training and coaching of promising internal candidates. Furthermore it is important to provide fitting career opportunities to outstanding employees, in order to retain their

knowledge for the company.

It is not easy for the average company to obtain such information, neither on an individual nor on an aggregate level. Even though computers have been in use for over 40 years, hardly any automated personnel information system will be able to provide the information needed. Current systems record certain parameters, like sex, date of birth, date of employment, function level, and sometimes even completed education and training. However, these systems lack the capability to chart the knowledge available to the organization. The systems may be sufficient in an operational sense, they are inadequate to manage human knowledge within an organization.

Knowledge management contributes to solving the above problem in at least three ways. First, the basic perspective on organizations changes drastically. Organizations are no longer viewed as machines which carry out information processing tasks, but rather as containers of knowledge with a mission to retain existing knowledge and create new knowledge. The key to successful organizations is the utilization of new technology in order to create new products that provide competitive advantage in the marketplace. Creative entrepreneurship has, as early as Schumpeter (1934), been equated with the discovery of new combinations (’neue kombinationen’). Intelligent firms strive for new combinations of technological knowledge, market knowledge, strategic knowledge and organizational knowledge.

The second contribution of knowledge management lies in the accessibility of personal knowledge. The question should no longer be: "Which persons are available?", but rather: "Which knowledge is available?". By means of knowledge acquisition techniques (Reitman Olson & Rueter, 1987; Welbank, 1983), tacit knowledge can be transformed into explicit knowledge. Tacit knowledge consists of (technical) expertise, but also includes lines of reasoning and procedures used by researchers to acquire or create new knowledge (Nonaka, 1991). The description in the following paragraph is a good example of the trans-

formation of tacit knowledge in explicit knowledge, stored in the form of a computer-based knowledge system.

Finally, knowledge management induces the development of a knowledge expert and information system (KEIS). Such a system records the knowledge and expert resources throughout an organization and provides tools to match these records. As one manager said: "At least now we know which knowledge is available and where to find it".

4.2 The distribution of unique knowledge

A second example of knowledge management is found in a medium sized company that makes fiberglass products. The company can be characterized as a knowledge intensive firm. Tasks at various levels require the availability of fairly specialized knowledge. The company's clients use fiberglass as an ingredient in the manufacturing processes for a large variety of products, such as textiles and reinforced plastics. The processing of fiberglass in other products is often complex. Several problems can occur that reduce the quality of the final product. The reasons behind these problems are often hard to establish. The analysis of such problems is a knowledge intensive task that has mainly been delegated to one person within the company. This person is considered the expert problem solver with respect to fiberglass components. Plans for establishing a branch in another country, combined with the expert's wish for early retirement, presented a major challenge. The company had to think of ways to both retain and distribute the knowledge necessary to analyze fiberglass problems. Even though the knowledge had for a large part been documented, its structure prohibited easy access for others.

It was the expert's own initiative to engage in the development of computer-based support in the form of a knowledge system. The development of knowledge systems consists of a number of phases (Boersma, 1992):

- definition of the knowledge domain;
- knowledge acquisition, by means of document research as well as interviews with the experts;
- knowledge representation by means of a suitable computer program;
- construction of a prototype;
- tailoring the knowledge system to meet specific user requirements;
- programming the system;
- system implementation.

Without going into further detail, the construction of a prototype is proof of the feasibility to transfer the human knowledge of the expert into the automated knowledge of the computer program. The expert can use the computer program in support of the specified tasks or, as in the case described here, the computer program can be used by others in the company to distribute and to share the previously unique knowledge of the expert. The expert finds the system a pleasant reminder and the others find the system helpful in answering questions they would otherwise have asked the expert.

4.3 Integration of distributed knowledge

Planning the admission of patients for (planned) surgery and consequent care in a hospital is another example of a knowledge intensive task. Basic planning rules take into account the availability of an operating theater and a bed for the patient in the appropriate ward. More advanced planning rules also take into account the work load the patient generates for the nursing staff. Other factors, like budgeting, availability of implants, intensive care capacity, and vacancies in nursing homes for subsequent treatment must also be taken into account. The latter belongs to the category of transmural requirements: what will happen to the patient when he or she can leave the hospital. For the moment, let us focus on the operating theater, nursing staff, and transmural requirements, as patient characteristics highly influence the capacity needed in these three areas. Estab-

lishing proper estimates requires specialized knowledge. To complicate matters, the required knowledge in this case is of a distributed nature.

The medical doctor knows the medical consequences of surgery and also has a means to estimate the time required for the surgery based on a patient's characteristics. The time needed to properly administer the anesthetics also depends on the condition of the patient. However, the surgeon is no expert in this field, hence this knowledge has to be provided by a second person. Patient care profiles can be used to chart the attention to be given by the nurses on a day-to-day basis. They also provide an indication of the expected length of stay. The amount of care needed and the actual length of stay depend on patient characteristics such as disabilities, age, and mental condition. Experienced nurses can reliably establish a patient's care profile. The patient's expected condition upon discharge, combined with the possibilities of home care, determines the necessity of transmural care. In order to assess the transmural requirements, extensive knowledge is needed about the possibilities of home care. The abilities and availability of private or community nurses and the local general practitioner are a prime determinant in this area. Community care coordinators are appointed to take care of these problems.

In order to arrive at optimal usage of the scarce resources of the hospital, the planning of patient admission has to take into account all these factors. Failure to do so can result in a number of problems: huge delays in the operating theater, with canceled operations as a result; large fluctuations in the nurses' workload, inducing discontentment, stress and sick leave; deferral of a patient's discharge, resulting in a number of patients unnecessarily occupying scarce and expensive hospital beds. The hospital described here faces all of these problems to a certain extent, as admissions planning was carried out by one person who could only take into account the capacity of the operating theater and the availability of beds in the nursing wards. In order to tackle these issues the hospital has experimented with weekly meetings for admissions planning for orthopedic surgery. These meetings are attended by a surgeon, a head nurse, a

community care coordinator, a member of the operating theater staff, and an admissions planner. Each quarter, reviews of past performance lead to suggestions for improvement.

There are two reasons for the hospital to start work on a computer based system to support admissions planning. First, the amount of valuable time spent by a number of persons on weekly or biweekly planning meetings is excessively high. Establishing the proper capacity estimates is a time consuming task and the combination of capacity estimates for the various disciplines and for the various patients into a viable admissions schedule is very tedious. Second, in a number of areas the human knowledge employed can be acquired by manipulating electronically stored data. For example, nurses keep track of their workload per patient on a daily basis. This data could well be used to construct patient care profiles, rather than to use human knowledge about patient care profiles. The same holds for operating theater time, as all surgeries are recorded in detail, including time measurements and medical details. It is expected that a computer based system will be able to suggest the necessary estimates to the experts involved, who can approve or alter them without having to interact with the other members of the planning team. In this way, the weekly meetings will be reduced to the discussion of a complete admissions schedule, which greatly lessens the time needed.

Knowledge management has taken on two forms in this hospital. First, the hospital has analyzed the knowledge intensive task of admissions planning and recognized that the knowledge necessary for optimal planning is of a distributed nature. The hospital responded by bringing the required knowledge together within one group. Confronted with the cost of this operation the hospital is now investigating ways to transform the human knowledge into automated knowledge, thus alleviating the burden of establishing estimates and enabling automated support for schedule generation.

5. Concluding remarks

In this paper we have presented three cases to explore the issues in knowledge management. Based on the knowledge triangle presented in the third paragraph, we can conclude that the three cases show a difference in focus and an increasing degree of complexity. In the large international organization, the issue was to map out the human knowledge available to the organization, in order to manage the continuity of the key positions within the organization. The impact of information technology on this kind of knowledge management is rather straightforward: an information system matching the knowledge needs of the organization with the knowledge resources it has in terms of its employees.

The second case presented the translation of human knowledge into automated knowledge. The knowledge of a human expert has been represented in a knowledge system, which supports both the expert himself and the colleagues that used to rely upon his knowledge. Apart from describing the knowledge needed, the knowledge had to be transformed into a proper representation for manipulation by a computer program. This, of course, is a more complex issue than just describing the knowledge, as was done in the first case.

The issue becomes even more complicated in the third example presented here. First, the human knowledge required to optimize the planning task at hand had to be brought together. Second, documented knowledge, in terms of historical data pertinent to the problem at hand, is transformed into electronic knowledge, such that it can be used to support the planning process. Finally, plans are being made to access the distributed human knowledge by means of a computer-based system, such as to avoid lengthy meetings with a number of valuable persons.

Knowledge management aspires to bring together different forms of knowledge together within a single framework. By taking such an integral approach, organizations can choose to take a number of measures. First and foremost, the realization that knowledge is a precious asset for an organization surfaces as a

result of knowledge management. Consequently, the organization can investigate ways to retain, distribute, and augment the knowledge within the organization. Also, it will find out what knowledge is becoming obsolete, so as to cut off funds flowing towards the development of these knowledge centers. The knowledge triangle enables management to imagine several different ways to solve problems pertaining to the deployment of knowledge. Several forms of transformation are suggested by the triangle, each of which is accompanied by a number of different instruments, ranging from effective human resources management to the development of highly sophisticated knowledge-based systems. It is our aim to further develop and integrate these instruments into a coherent set of tools to shape knowledge management within the intelligent firm.

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