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Management's Knowledge of Information Technology

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Abstract

Information Technology (IT) has always been the playground of technical specialists. In this paper we argue no changes in this respect, but rather that the management of an organisation becomes aware of what the technical specialists are actually doing. This cannot be achieved by teaching tomorrow's managers a few of the technical skills. We see the role of IT in management education as threefold. First, management education in general has to focus on information and knowledge and their influence on management capabilities and possibilities. Building upon this general background, advanced courses should cover the challenges of IT and the opportunities and problems on a general management level. Second, a specialisation within management education could be the information analyst, who can participate in the analysis and design of business processes and their supporting information systems. The actual construction of these systems is best left to software engineers. Third, another kind of specialisation within management should be the functional specialist with in-depth informational knowledge. In this area one can position experts in financial or logistic systems. In an attempt to capture the future course of information and knowledge education, the developing field of knowledge management is introduced briefly. Finally, the consequences of our analysis for management education are discussed.

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1 INTRODUCTION

Three kinds of knowledge and skills are traditionally represented in information systems development projects: domain knowledge, analysis skills and construction skills. Higher education in The Netherlands has mirrored these skills in their curricula. However, in 1994 a committee visited many schools and suggested a number of strategic choices for the schools (Mulder et al., 1994). It became apparent that separate analysis skills are no longer as important, as the tools for construction come closer and closer to the information analysis level. Moreover, with the pervasiveness of IT in virtually every domain of modern (business) life, domain specialists should be trained to do their own analysis, whereas information specialists might specialise in certain domain applications or domain-specific tools. This strategy reduces the number of different roles to two and eliminates the intermediary (boundary-spanner) as a cause of noise and misinterpretation. Special attention should be paid to the information technology specialisation within the management school. Depending on the kind of management the school is aiming at, the IT content of the curricula should differ.

This paper studies the different kinds of knowledge that management needs to obtain in order to take full advantage of information technology within their (future) business setting. To this end we first discuss different issues of management and try to define some of the basics of information and information technology (paragraph 2). The third paragraph links the two in terms of the educational perspectives for three different forms of IT in management education. Finally, paragraph 4 discusses the relatively new field of knowledge management.

2 CONCEPTS

In order to study the role of IT in management education, one has to be clear about the definition of key concepts within IT and within management. This section covers a variety of concepts ranging from data, information and knowledge to management control and decision support systems. It also serves as a concise description of the issues that are, in our view, fundamental to the teaching of IT in a management programme.

2.1 Management

Management has many different interpretations. A fairly strict and mechanistic view can be found as early as Fayol (1916). He describes the management process as consisting of the following subactivities: to plan, to organise, to coordinate, to command, and to control. However, this 'industrial' view of management often leads to rigid bureaucracies. In his research on organisational flexibility, Volberda (1992) describes theories of innovation and entrepreneurship. Management within such an 'entrepreneurial' context can best be described as: dreaming, laughing, and risk-taking, which shows a rather interesting coincidence with Simon's division between intelligence, design, and choice (1965).

In order to somewhat limit the scope of relevant concepts, it is helpful to confine the notion of management to that part where information technology may play a useful part. Taking into account the industrial and entrepreneurial views described above, management in such a restricted sense can be characterised as:

- the act of exerting control over a process within an organisation, based on information about the environment, the process itself and the entities taking part in the process;
- the act of designing (a process within) an organisation and the mechanisms to control it, based upon the perceived needs of the customer and the customer's customers.

The two characterisations match two differing trends in the information systems field: business alignment and strategic impact of information technology (Stegwee and Van Waes, 1990). The former is closely related to the traditional teachings in MIS, DSS, whereas the latter is represented by newer approaches, such as BPR, SISP and information policy. It also can be described as internal control versus entrepreneurial flamboyancy.

Management control

The management control paradigm can be abstracted by using the CO-TS model as depicted in figure 1. The manager is often seen as the CO (Controlling Organ) and the process that (s)he manages as the TS (Target System). Actually, this model can be applied to almost any situation in which some form of control or direction is exercised, which makes it an interesting model from an information systems point of view. In order to know whether action is appropriate, the manager needs to know the current state of the target system. The combination of the current state of the target system and information about state of the environment may lead to the decision that action is necessary. This decision is based on a model of the target system's behaviour within its environment. If the model predicts that the target system will not remain 'on course' on its own, action is needed. Which action is needed can be determined by taking into account the effects different means of control have on (the model of) the target system. The means of control itself may consist of certain information being sent to the target system.

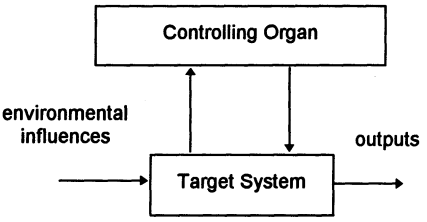

Figure 1 A standard CO-TS model after De Leeuw (1988).

Process innovation

The process innovation approach often takes Porter's Value Chain model as a starting point (Porter, 1985; Porter and Millar, 1985). The value chain model can be used to arrive

at a set of loosely coupled activities within the context of adding value (Porter calls these activities 'value activities'). Based upon a distinction between different value activities within the primary activities, one has a threefold task in terms of process innovation and competitive strategy:

1. IT can be used to redesign the value activity itself in order to deliver better performance in terms of quality, efficiency or flexibility;
2. the coordination between different value activities within the value chain can be improved by using IT, in order to achieve a better overall business performance;
3. the competitive scope of the firm can be altered through the use of IT in certain key parts of the value activities in relation to the entire value system.

Support activities are necessary to provide the primary activities with the necessary resources: technological, financial, human, and information resources. The proper deployment of IT within support activities is required to deliver the appropriate resources in optimal coordination and at minimal cost. In the present context we will only mention the possibilities of incorporating information technology within the product itself.

2.2 Information Technology

From the description of management given above, we can now provide some specific definitions used throughout this paper. *Data* are literally "givens". Data itself is a mere representation of information, independent of its originator or recipient, which may be stored, manipulated or communicated. In order to interpret data correctly, some form of understanding is needed between originator and recipient of the data, which is also reflected in the representation. This is sometimes referred to as *meta data*. The meta data can also be perceived as part of the knowledge necessary to interpret the data. *Information*, in our view, consists of data which convey something useful in a certain setting, in general a decision process to the recipient of that data. In order for information to actually convey something useful to its recipient, the recipient needs a certain amount of knowledge to process that information. "*Knowledge* is understanding plus ability to transform it into actions (skill), which yields performance." (Nooteboom, 1996). 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 into two categories: factual or declarative knowledge ('know what') and procedural knowledge ('know how'). A necessary addition to these categories is the notion of background or meta knowledge ('know why').

Different kinds of definitions are used to describe information technology. Breukel (1996) discerns technological and knowledge definitions. Knowledge definitions view IT as the skills necessary to further develop the information systems support for an organisation. We prefer the technological definition, as it clearly makes a distinction between the technology itself and its deployment within an organisation. *Information technology* (IT) is used as a comprehensive term for:

- hardware, software, and services
- relating to the processing, storage, and communication of data

- using primarily opto-electronic means.

In the context of this paper, information technology is regarded as a given, outside the boundaries of the organisation, to be applied by the organisation in order to support its operations. An application of information technology usually gives rise to an *information system* (IS), that is a concrete system that consists of four components:

- the organisational component, consisting of people and procedures;
- the technical component, consisting of hardware and systems software;
- the software component, consisting of application programs; and
- the data component.

All (formally acknowledged) information systems within an organisation together form the *information systems support* for the organisation. The thing that makes the concept of information systems support an interesting one is the fact that there are bound to be replications of parts of the components of an information system within the organisation. The same data will be stored in more than one place, or data about the same entities are stored in several systems. Trying to grasp the complexity of information systems support within an organisation is a challenge.

3 MANAGEMENT EDUCATION

Following the introduction of concepts and terminology, we will now discuss the role of information technology and information technology education in different fields of management. For obvious reasons we do not consider personal productivity tools, such as word processing or spreadsheets, as part of information technology education but rather as part of the training of necessary general skills. These kinds of courses, however important from a skills point of view, are as much part of information technology education as cooking is of a physics or chemistry curriculum.

In this paper we will be using a distinction among three kinds of management functions. *General management* takes a fairly strategic outward view of the organisation and looks for opportunities to improve on market performance and technological sophistication. General management initiates and promotes innovations and sets priorities for major investments. *Information management* tries to match the technological opportunities with the required information systems support, necessary to accommodate the innovations and improvements initiated by general management. As such it has a direct responsibility both to general management and to functional management. This responsibility ranges from strategic decision making to day-to-day operations of information systems. *Functional management* takes care of tactical and operational management in such a way that it implements and carries out the innovations and improvements mentioned before, while maintaining a proper level of performance for day-to-day operations.

3.1 General management

In the strict technological sense, given above, general management does not have to know anything about information technology. What general management should know, however, are the possible impacts this technology may have on:

- the competitive relations in the marketplace,
- the primary activities of the organisation,
- the efficiency and effectiveness of all value activities, and
- the flexibility of the organisation.

General management can integrate these IT-related issues within their common frames of reference. For example, the advantage of electronic cash-registers in combination with customer credit cards becomes apparent when this data is made available for market analysis and sales forecasting. Another major area to look into is value-added services through information technology.

Basically, two kinds of IT education are available for general management:

- learning to identify strategic, external and internal, opportunities for IT deployment; valuable concepts in this area are, among many others, strategic impact analysis (Applegate et al., 1996), value chain analysis (Porter and Millar, 1985), and process innovation (Davenport, 1993).
- learning to incorporate IT policy formulation within a strategic planning framework; key areas to be covered are information systems strategic planning (e.g. Earl, 1989, Stegwee and Van Waes, 1990) and information policy formulation (Boersma & Stegwee, 1994, Davenport et al., 1989).

Other areas of interest, as quoted by senior management, are performance analysis of an enterprise's information systems. Information economics tries to give substance to such analyses (see e.g. Parker et al., 1989), but usually senior management looks at comparative studies within their industry (Applegate et al., 1996). As such, these comparative studies are no different for IT expenditures than for other functional areas of the enterprise.

3.2 Information management

Information specialists with a management background have to be able to manage the information function within an organisation. This entails, broadly, two distinct areas:

- integrative information management, which tries to map out information systems areas and communication patterns throughout the organisation, and
- operational information management, which tries to develop, implement, and maintain concrete information systems.

The first area is comparable to financial, logistic, or quality control functions within an organisation. Virtually all departments within an organisation contribute to and are part of the information bases and information systems of the organisation. The information management function needs to take an integrative view of information systems support for the organisation, trying to work out ways in which communication between different departments or with the customer can be optimised from an organisational, rather than

departmental, point of view. The second area, on the other hand, is much more like facilities management; making sure that information technology works for the organisation. Different skills are necessary for both areas. In both cases students need to have a thorough knowledge of architectural principles in information technology on the one hand, and a deep understanding of business and management practices on the other. With respect to the IT area, the basics of major components of the IT infrastructure should be taught, such as networks, database management systems, systems development methods, CASE tools, etc. Systems design and programming, however, is best left to computer science majors.

For a more integrative information management approach, considerable emphasis should be given to information planning methods (e.g. Stegwee & Van Waes, 1990), project portfolio management (e.g. Parker et al., 1989), and information policy formulation (e.g. Boersma & Stegwee, 1994). More advanced students may venture into the realm of business process redesign (e.g. Hammer and Champy, 1993).

3.3 Functional management

Students with a specialisation within functional management need to be taught the essentials of human information processing and the necessity of information for organisational coordination and control. Such knowledge enables functional management to design and improve business practice within their functional realm. For example, a marketing and sales director has to be able to identify knowledge bases and information flows relating to the acquisition of an order. This entails the construction of a customer profile, or even the profile of the customer's customers. In the latter case, the relationship becomes more of a partnership and networks of smaller organisations together form virtual organisations. Eventually, the marketing and sales director must be able to grasp the information flows and knowledge bases required for optimal performance of such a network.

Meanwhile, the same director must also be able to judge the impact of IT application within the functional department itself. An analysis along the lines of the CO-TS model, discussed in paragraph 2, can render opportunities to implement information systems for improved performance and control. Within a functional area, several examples can be found of more or less standard functional information systems. It is very helpful for the student to work with, for example a marketing and sales system or a production management system. It explains the structure of business processes and creates a basis for discussion of information flows and requisite knowledge to work with such a system. Organisational implications of the adoption of a particular system are a very welcome subject for discussion. Process improvement through information technology application becomes the more specialised task of students within this field.

4 KNOWLEDGE MANAGEMENT

In order to manage knowledge as a resource for an organisation, 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 organisation. To this end, we distinguish among four forms of knowledge (Van der Zwaan & Boersma, 1993):

- human knowledge, where knowledge is contained in the heads of the members of the organisation;
- mechanised 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 mechanised 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 organisation differ, depending on the form of knowledge to be managed. Together, the four forms of knowledge form a triangle, depicted in figure 2. In this figure is human knowledge the center of gravity.

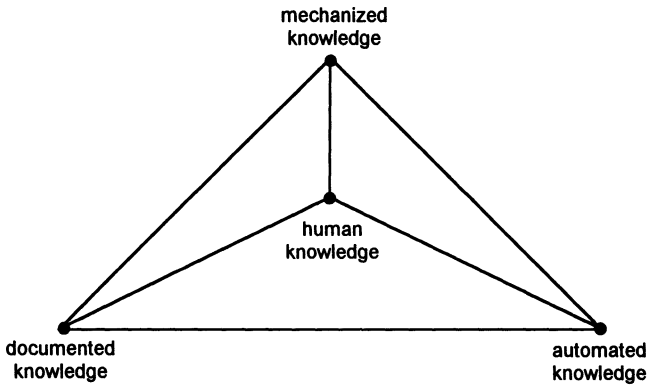

Figure 2 Connection between the four forms of knowledge

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

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 organisation.

Information technology may support either of the above instruments of knowledge management, giving rise to various forms of knowledge based systems such as expert systems, knowledge based decision support systems, and knowledge information systems.

5 A MAJOR CHALLENGE

Information Technology for general and functional management should not be taught from a technological viewpoint, but rather from the application of information technology within a certain business environment. It is not the technology itself that's interesting, it's the consequences and implications that should be the turf of general and functional management. To this end, general management may learn from case studies of market failures and successes related to the (im)proper use of information technology. Also, they should be taught how to incorporate information policy formulation within their strategic decision making processes. Functional management benefits most from studying actual applications of information technology within their field. Software selection and implementation issues in an organisational context are much more valuable to functional management than the principles of structured systems analysis and design. Information management may start from an information technology background or from a business education background. The former is more suited to the operational side of information management, whereas the business student with an information technology specialisation should be taught to think in terms of architectures, planning methodologies, and the management of project portfolios.

Only students of Information Management are served well by the common literature in information systems. Most books on Management Information Systems, and the like, lack the necessary degree of integration between business process, process design, process control, and the information systems necessary to support these processes. Almost all books cover the traditional areas of hardware and systems development methodologies. A systems development methodology should be the concern of the information management specialist, whereas the process development methodology should be taught to the functional specialist.

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Robert Stegwee holds a master's degree in computer science and a doctorate in management and organisation. Currently he is a senior consultant for IT in health care at Moret Ernst & Young, Management Consultants. In addition he is assistant professor of Information Management with the Faculty of Management and Organisation at the University of Groningen. He has been active in the development of courses in 'Information and Organisation' and 'Management and Organisation of Information Systems Support'.