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ABSTRACT

Organizations are shaped based on a number of implicit and explicit assumptions. Usually, these assumptions are made by the founder of a company. Management of Information Technology (IT) is shaped in much the same way. It is based on several assumptions how to carry out information systems development, maintenance, information services, and how to plan for and control all these activities. Based on such assumptions, the authors identify four different approaches or paradigms to management of IT. A model is presented to position organizations in detail according to these paradigms. Potential ways of using the model are presented. Based on results of three types of empirical research, two ways of using the model are discussed in detail: the development of a necessary vision on the management of IT, and the identification of critical issues for the management of IT. The empirical results and the discussion of vision and critical issues lead to two major conclusions. First, there seemed to be no single goal to which IT organizations grow, i.e. all paradigms for managing IT were visible in practice. Second, although all paradigms were visible in practice, one paradigm, the paradigm of management control, dominated, despite the fact that for a lot of organizations this paradigm may not be the most obvious to rely upon.

Ja mach' nur einen Plan!
Sei nur ein grosses Licht!
Und mach' dann noch'nen Zweiten Plan,
Geh'n tun sie beide nicht
Bertold Brecht, Die Dreigroschenoper
(Hofstede, 1978)

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INTRODUCTION

Organizations are shaped according to different assumptions. These assumptions address issues such as how to perform certain tasks, how communication between people should take place, and what is expected of people. They often stem from the birth of the organizations. In the early years of a company, the founder has a significant impact on how the organization is shaped (Schein, 1985), and it is in this way the organization, e.g. its culture, is created. In combination with structural elements, as described by for example Mintzberg (Mintzberg, 1979, 1983a) and Likert (Likert, 1967), several 'overall pictures emerge that describe an organization.

Such pictures are descriptions at a macro-level, the level of the organization and its environment. At a micro-level such descriptions exist as well, also in IS literature (Lyytinen, 1978). Hirschheim (Hirschheim and Klein, 1989) examines four different approaches to information systems development. He discusses how different systems development assumptions become manifest in practice. These assumptions are then grouped into four approaches to information systems development: functionalism, radical structuralism, neohumanism, and social relativism.

Descriptions at a micro and macro level may be called paradigms. But the examples of paradigms at a macro-level and at a micro-level are two extremes. Paradigms are also likely to exist at a meso-level of analysis. This level represents the level of group or department. So far, however, few attempts have been made to describe IT departments in terms of paradigms. Markus (Markus, 1983) and Kling (Kling, 1980; Kling and Iacono, 1984) discuss social and political aspects of information systems development and implementation, but these discussions are better described by perspectives or metaphors than by paradigms. Markus favours the political perspective, Kling the social perspective of the web models.

In this article, we do not focus on the best perspective or metaphor that describes IT issues. Instead, we try to identify several paradigms for IT organizations, and show that in some contexts one paradigm is better than

another. First, in section 2 several perspectives or metaphors are discussed that are commonly used in information systems research. Next, these metaphors are combined into a model that identifies four different paradigms for IT organizations (section 3). The model is defined in detail in section 4, to allow for empirical research. In section 5, three types of empirical research are discussed that elaborate the model: a survey research and two different types of case study research. Based on the empirical research two possible ways of applying the model in practice are discussed (section 6): the development of a necessary vision on the management of IT, and the identification of critical issues for the management of IT. Section 7 summarizes the findings and discusses the major conclusions from the research.

CURRENT METAPHORS FOR IT MANAGEMENT

As Walsham describes (Walsham, 1991) the organization theory is not a homogeneous area of study. There are several strands of thought and ideas. Morgan (Morgan, 1986) uses the concept of metaphor to describe this. According to Morgan, the use of metaphor implies a way of thinking and a way of seeing that pervade how we understand our world generally. So, although a metaphor is much more than 'a device for embellishing discourse', it is different from a paradigm in one important aspect. A metaphor has the characteristic of a perspective, so it is assumed that different metaphors exist at the same time to describe the same phenomenon. In contrast, a paradigm holds assumptions about the object of study, which leaves this paradigm as the only possible paradigm to look at an object at a given time.

Although the use of paradigms is very limited (Lyytinen, 1987) several metaphors or perspectives have been used in IS literature. Much of the literature relies on the metaphor of organizations as machines (Walsham, 1991). This is not too surprising, and two reasons for the use of this perspective are obvious. First of all, in the early years of use of IT, the management of IT was often part of the finance or administrative department of a company. These departments were and still are often guided by the philosophy of management accounting (Johnson and Kaplan 1987; Hofstede 1978). The control systems for management accounting were based on principles of cybernetics. In the cybernetic view, a management control process in its most simplified form is similar to a technical control process. Hofstede gives the example of the control of a room by a thermostat. A second reason for the use of a machine perspective for IT management is the technical background of most IS practitioners and managers. The technical background often reflects itself in the way of controlling and managing the IT activities.

So both the area of IT management and the area of finance and accounting rely on the philosophy of management control. Thus, they base their policies on the metaphor of organization as machines. But the management control philosophy is not regarded as obvious any more. In accounting as well as in IS and organization literature new metaphors tend to emerge. Johnson and Kaplan (Johnson and Kaplan, 1987) and Hofstede (1978) argue that the management accounting philosophy has lost its relevance. According to Johnson, this philosophy was based on the relatively stable environment of the steel and textile mills of the nineteenth century. Not surprisingly, he argues that then environmental assumptions of today do not match assumptions of the past century. Hofstede arrives at the same conclusion. However, he describes the issue in a more careful way by distinguishing between several types of management processes. He argues that the cybernetic philosophy is based on several basic assumptions, e.g. actual accomplishment can be measured. These assumptions subject this management philosophy to severe limitations, since in most organizations these assumptions will not hold. Hofstede arrives at two alternative philosophies. A distinction is made between routine industrial-type processes, for which a homeostatic approach seems more suitable, and non-routine, non-industrial-type processes, for which a political paradigm is recommended.

In IS literature the focus has been on the metaphors of organizations as machines and organisms for quite some time. However, the interest in other aspects as politics and social issues is growing, as can be concluded by publications of various authors (Markus, 1983; Kling, 1980; Kling and Scacchi, 1982; Kling and Iacono, 1984; Kiesler, 1986; Lyytinen, 1987; Hirschheim and Klein, 1989; Davenport, 1989; DeLisi, 1990; Beath, 1991; Joshi, 1991; Knights et. al., 1992; Coombs et. al., 1992). All these authors argue that social and political issues are just as important as the cybernetic perspective. But despite these publications, as Walsham concludes, the cultural and political perspectives are still under-represented in information systems research.

PARADIGMS FOR IT MANAGEMENT

The former section discussed several philosophies or metaphors on management of IT: the management accounting philosophy, which stems from cybernetics and the metaphors of organizations as machines, organization development, political perspectives and social perspectives. Dealing with perspectives means dealing with issues that are not orthogonal. Consequently, several perspectives will usually be valid at the same

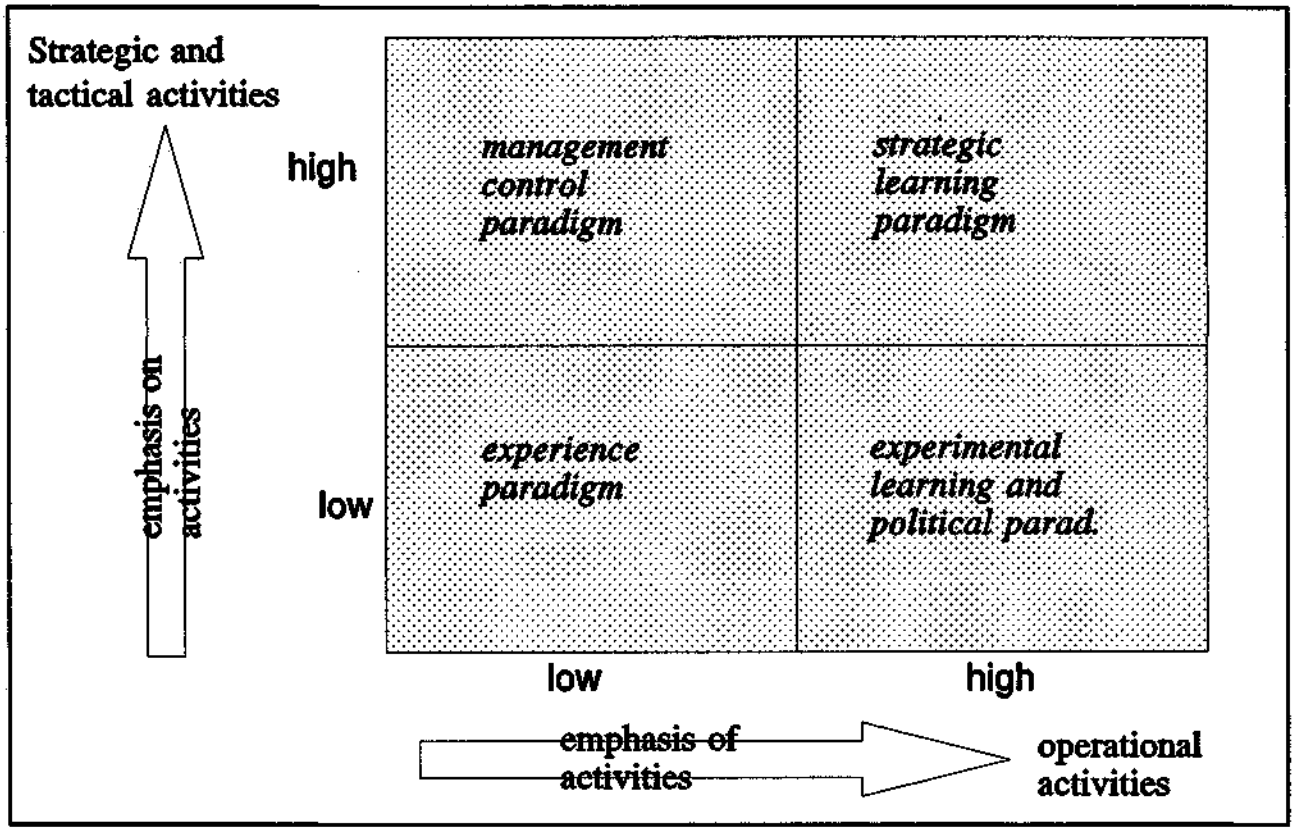

Figure 1. Four paradigms for managing IT

time. In this paper we will not focus on metaphors but on paradigms. Because paradigms hold 'meta-theoretical assumptions about the nature of the subject of study' (Burrell and Morgan, 1979), no two paradigms can hold at the same time. The concept of control can be used to make a distinction between several paradigms. With respect to control systems, Anthony identifies activities at a strategic level, tactical level and operational level (Anthony, 1964, 1972, 1975). Strategic activities address long term aspects, e.g. developing a strategy for IT. The tactical level represents activities at a shorter time frame, such as planning for various activities. The operational level holds most of the IT activities, i.e. short term activities as developing information systems, maintenance, project management, and services. The distinction between strategic, tactical and operational activities allows us to identify four different paradigms for IT management.

Figure 1 shows strategic, tactical and operational activities along two dimensions. The horizontal dimension represents the emphasis on operational activities performed. The vertical dimension represents the emphasis on the set of strategic and tactical activities. Strategic and tactical aspects were taken together to contrast management aspects to the more technical aspects of the operational activities.

Based on these two dimensions, four different paradigms are identified: experience, management control, experimental learning and political, and strategic learning. The reason for choosing the concept of control system to identify paradigms is threefold. First, the concept contains both elements of structure and of action, thus allowing for the application of structuration theory (Giddens, 1984) to elaborate the paradigms. Second, impact of IT on organizations is often described in terms of control (e.g., Orlikowski, 1992). And third, the concept of control allows for a proper distinction between traditional paradigms - the management control philosophy - and new types of paradigms. A discussion of the paradigms based on structuration theory is out of the scope of this paper. Instead, we will use several concepts that partly cover the three dimensions of duality of structure. These concepts are the concepts of control process or system, organizational structure, and culture. Before defining each of the paradigms, a short discussion of the three concepts will be given.

The control process is the 'process by which management assures that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives' (Anthony and Vancil, 1972). When talking about control, what usually is meant is the control process or control system. So, the discussion

paradigm concept	experience paradigm	management control	experimental learning and politics	strategic learning
control process	incomplete process	cybernetic process	political process	homeostatic process
dominating internal structure	machine bureaucracy, simple structure	machine bureaucracy	machine or professional bureaucracy	professional bureaucracy
dominating political and power structure	closed system, instrument	closed system, instrument	political arena	meritocracy
cultural characteristics	pragmatic, result oriented	task oriented, process oriented, tight control, normative	result oriented, often closed, loose control	tight control in several ways, pragmatic

Table 1. Characteristics of the four paradigms of managing IT

of the sepsis of Hofstede and Johnson was sepsis about the *process* of control, not about control itself. Management accountants have often relied on processes with a negative feedback loop, on cybernetic models. But, as discussed above, there are various alternatives: Hofstede presents a political and a homeostatic model, Peters and Watermann a flexible control process.

The structuration theory of Giddens refers to structures as social structures, which can be broken down into structures of signification, structures of domination and structures of legitimation. Instead of using social structures, we will use structures in the way Henry Mintzberg defines them: as representations of internal and external environment (Mintzberg, 1979, 1983a), and as representations of power and political systems (Mintzberg, 1983b).

The culture definition of Edgar Schein may used to describe each of the paradigms. He defines culture as "a pattern of basic assumptions that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems" (Schein, 1985, p.9). The basic assumptions are in fact the lowest level of culture. At higher levels are beliefs, and at the top level expressions of culture as the building and the furniture. As Schein argues, it is very difficult to arrive at the basic assumptions of a culture. Therefore, we will describe paradigms in terms of several characteristics of culture which are defined by Sanders and Neuijen (1987). Based on research in the Netherlands and in Denmark, they identify seven dimensions or characteristics of culture: process oriented/result oriented, people oriented/task oriented, committed to organization/professional, open/closed, tight control/loose control, and pragmatic/normative. These dimensions are not necessarily orthogonal or mutually exclusive, but the research of Sanders and Neuijen showed that these dimensions made the best possible distinction between different cultures.

Table 1 describes the four different paradigms based on the concepts of control, structure and culture. The paradigm of experience represents few emphasis on strategic, tactical, and operational activities. Because the low level of emphasis on activities, practitioners have to rely on their expertise. Consequently, it will be very difficult to implement a proper control system for management; usually this system will be incomplete. In order to measure performance, the culture of the IT department will be result oriented and pragmatic. Structure may be a simple structure or a machine bureaucracy, because the environment is viewed as dynamic but not necessarily complex (Mintzberg, 1979, 1983a).

IT organizations that rely on the paradigm of management control are relatively sophisticated in strategic and tactical activities, but not in operational activities. Thus, experts pay a lot of attention to formulating a strategy for IT, but few attention to developing and maintaining information systems. Because of the focus on planning, the culture of the IT organization will be task and process oriented, tightly controlled and normative. The organization will rely on a cybernetic model of control, on a management control system. Due to this mechanized view of the world, the structure is likely to be a machine bureaucracy, although theory states that such a structure is only valid for routine industrial-type processes (Mintzberg, 1979, 1983a, Cusumano, 1991). So, the type of technology or environment is not necessarily a determinant of the structure of an organization, because the organization may have the wrong perception of the type of technology or environment.

The political and experimental learning paradigm is characteristic for organizations that emphasize the operational activities as compared to the strategic and tactical activities. Few emphasis is laid on the formulation of a strategy of IT, but developing and maintaining information systems is highly sophisticated. So, on the one hand state-of-the-art technology is used to arrive at a sophisticated level of systems development, but on the other hand the formulation of a strategy for IT is rather ad hoc. There are several explanations for this paradox.

For example, IT might be critical for survival of the organization, but the external environment is too dynamic to develop a strategy for use of IT. The best the organization can do is always to use the state-of-the-art technology and rely on the ad hoc formulation of a strategy (for example, Informatieplanning in de praktijk, 1992). Another explanation may be that the IT organization is very political, which reduces the relevance of plans and strategies. Regardless of the explanation for the paradox, the control process for the IT organization will be political: since no detailed plans and strategies exist, control will be result oriented. Due to the political nature of the IT organization, the organization is also likely to be more or less closed, and control will be more loose than tight.

The fourth paradigm, that of strategic learning, is characterized by a high level of emphasis on all activities, i.e. strategic, tactical and operational activities. Since we are dealing with non-routine, non-industrial type processes (Cusumano, 1991), the control process will be a homeostatic one (Hofstede, 1978), based on a learning system. Strategies are not necessarily planned, and can emerge from various places in the organization. The organization is self regulating, homeostatic. Consequently, the emphasis will be on working in teams, and few hierarchical levels will exist (Hofstede, 1978), and the structure of the organization is likely to be a professional bureaucracy (Mintzberg, 1979, 1983a) and a meritocracy (Mintzberg 1983b). The culture will be characterized by relatively tight control, but this tightness is not due to formal planning, but to the pragmatism that exists.

A DETAILED IT MANAGEMENT MODEL - POSITIONING THE IT ORGANIZATION

The four paradigms may be used to define a detailed model of management of IT. There already exist models that describe the aspects of strategy, tactics, and operations of the IT function. We will rely on these existing models to arrive at a detailed model of management of IT.

With respect to operational activities, the most commonly used model is the Capability Maturity Model of the Software Engineering Institute (Humphrey, 1988, 1989; Humphrey and Sweet, 1987; Weber et. al., 1991; Paulk et. al. 1991). Although the model has some drawbacks (Bollonger and McGowan, 1991), the advantage of the model is that it almost explicitly focuses on operational activities. Strategic aspects of IT are not discussed, and tactical aspects of IT only in the latter phases that the model describes. By excluding the tactical aspects of the model, we arrive at a model for the operational dimension of managing IT. An IT organization can move from an ad hoc systems development process, called *Initial*, to a flexible process, called *Flexible*, where new technology or other improvements are incorporated in the existing process. For a detailed description, see Paulk (Paulk et al., 1991), and Weber (Weber et. al., 1991).

With respect to strategic and tactical aspects of managing IT, the Nolan model (see Nolan, 1973, 1979, 1987; Gibson and Nolan, 1974) is the most widely used. Other models describing strategic issues are the models of Greiner (Greiner, 1972) that emerged from management literature, and the model of Stegwee (Stegwee et. al., 1990). We will rely on the Information Systems Management Architecture (Van Schaik, 1985). This framework describes IT activities at operational, tactical, and strategic level, and relates these activities to the Nolan model. The description of the strategic and tactical activities can be used to define the strategic and tactical aspects of the IT function (see Van Schaik, 1985 for a detailed description of the phases). An organization can move from an ad hoc strategic and tactical process, called *Initial*, to a thorough process of strategic and tactical activities, called *Strategic planning*. Figure 2 shows the resulting model.

By explicitly defining the dimensions of operational activities and of strategic and tactical activities, what results is a detailed model of managing IT that allows us to position an organization according to one of the four paradigms (see Appendix A). The intention is not to favour one paradigm above the other. Although the learning organization paradigm may be sound, it should not be regarded as a panacea.

For some organizations it is sufficient to have a moderately sophisticated IT organization. It may be a simple benefit/cost consideration to rely on less sophisticated control. Strategic use of IT may not be one of the objectives. What can be said is that *if* strategic use of IT is critical for survival of the IT organization, then the learning organization paradigm is the most favourable paradigm. But even in these situation the organization may argue that the environment is too complex to use a sophisticated planning mechanism.

The consequence of this line of reasoning is that the model is *not* a deterministic model. Thus, IT organizations do not necessarily grow from a experience paradigm to a learning paradigm. In contrast to deterministic models as the models of Nolan (1973, 1979), the Software Engineering Institute (Humphrey, 1988, 1989) and Greiner (Greiner, 1972) there is not single growth path, nor is there any 'mature' phase, or may new phases be added (as by Keuning and Eppink, 1986, Nolan, 1987). An organization can not pay more attention to strategy formulation than 'strategic planning',

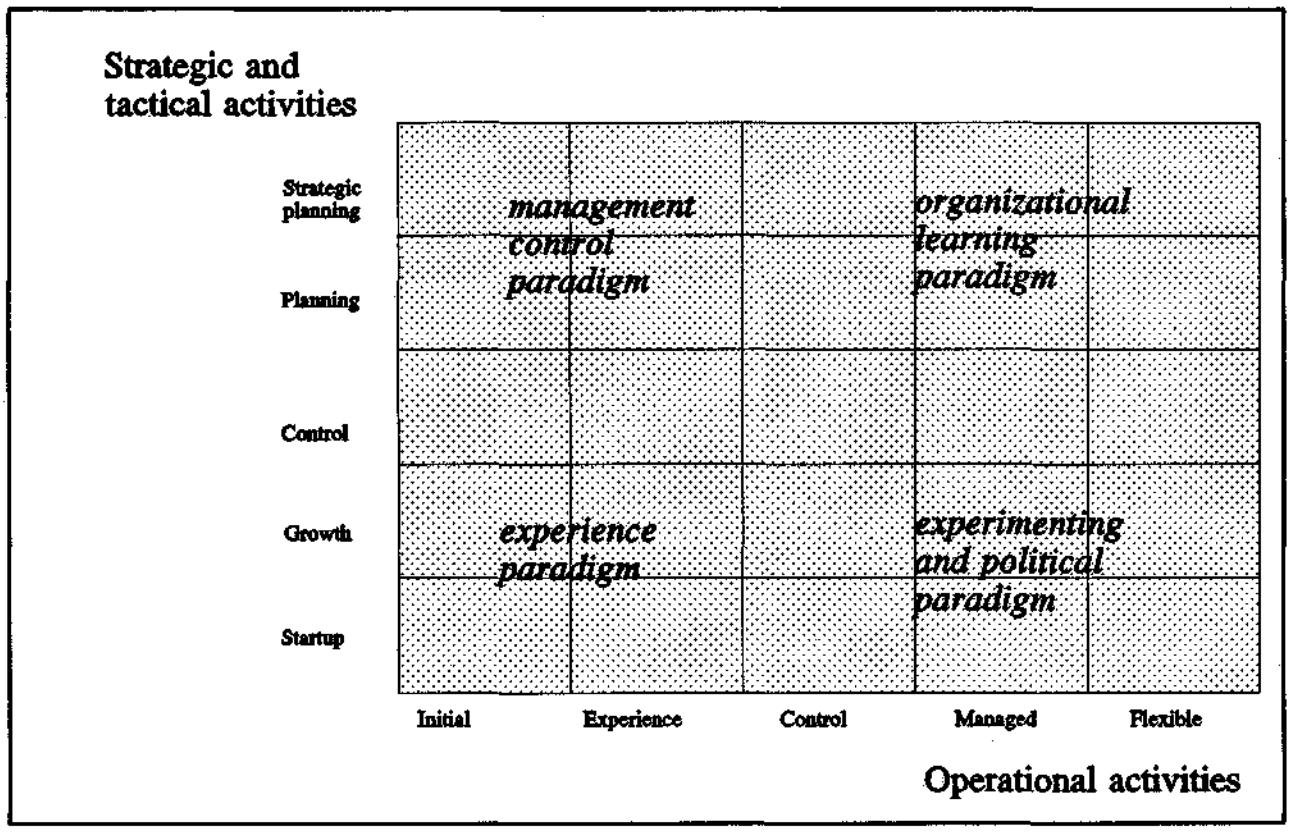

Figure 2. A detailed model for managing IT

nor can it be more flexible than 'flexible'. Characteristics of the various phases may change due to new insights in technology or organizations, but no new phases have to be added.

The model that we defined provides an organization with a description of its current IT organization. Although such a 'sketch' of the organization can provide the IT manager with a useful insight into his business, such a description should merely be regarded as a starting point for further analysis. There are a number of different ways of using the model. First, the model can be used as a tool for developing an overall vision on the use of IT in an organization, i.e. for deciding on the future profile of the IT organization, and the ways to attain this profile. Second, the model can be used to identify problem areas in the current IT organization, and how to overcome these problem areas. Third, the model can be used as a guide for implementing new Information Technology into the organization. Fourth, the model can be used to manage specific areas of the IT function, for example the information infrastructure.

In this paper we will focus on the first two possible uses of the model: defining a vision on IT, and identifying problem areas or critical issues in the management of IT. In the following section, we will describe empirical results from three research projects, that help us to clarify different visions on IT and problem areas in IT. In the next section, we will use the results of these projects to flesh out these issues.

AN EMPIRICAL INVESTIGATION BASED ON THE IT MANAGEMENT MODEL

As is discussed in section 4, the model, which we will call the IT management model, can be used in a number of different ways. In this paper we will focus on two possible ways of using the model: to develop a vision on the use of IT, and to identify problem areas in the current IT organization. We will describe empirical results from three research projects, and use this results in the next section define methods for defining a vision and identifying problem areas. For each of the three research projects, we will discuss (1). the positioning of organizations in the framework, (2). characteristics of the organization in terms of culture, structure and control, and (3). strengths and weaknesses of IT organizations based on the positioning and the characteristics.

Table 2 gives a short outline of the three projects. The research projects were also focused on another use of the IT management model, i.e. the implementation of IT on the organization. CASE-technology was chosen as specific type of IT. Descriptions of the research from the perspective of CASE-technology can be found in Fi-

characteristic project	type of research	site of research	overall objective	additional objectives
REVIVAL (Organizational aspects of CASE-technology and reverse engineering)	detailed case-study, action research	banking and insurance organization in the Netherlands	identify critical factors for success of implementing CASE and reverse engineering	elaboration of the detailed IT management model, define an impact analysis approach
PICO (Practical Inquiry to CASE in Organizations)	survey research	the Netherlands (1800 companies, response 280)	investigate implementation process and use of CASE from organizational and methodical perspective	positioning of organizations in the IT management model, characteristics of each of the phases
OIC (Organizational Implementation of CASE-technology)	in-depth interviews	20 companies in the Netherlands, several interviews per company	investigate the implementation of CASE from organizational perspective	detailed positioning of companies in the IT management model, use of the model to describe the process of implementation of CASE

Table 2. Description of the research with respect to the IT management model

scher (Fischer and Doodeman, 1992; Fischer et. al., 1993) and Kusters (Kusters et. al., 1992).

The case study research

The case study research was carried out as part of a larger project at a large banking and insurance company. The objective was to identify several critical management issues when implementing reverse engineering and CASE-technology. A secondary objective was to elaborate the IT management concept, and develop and test an approach to impact analysis based on the model.

Thus, the case study was not only evaluative research or a scientific experiment, but also a type of action research (Buitendijk and Van Waes, 1990, Susman, 1978, 1983). Consequently, principle goal was not only a practical result, not only a scientific research, but a combination. Action research is particularly appropriate for the following types of problems (Buitendijk and Van Waes, 1990, Benbasat, 1983, 1987, Straub, 1989):

- initial and exploratory research.
- sticky, multi-variable problems in which less a priori knowledge exists of what the variables of interest are, how they are related, and measured.
- practice-based problems.
- problems in an environment in with a high rate of change.

The list of research problems shows that action research may be a useful approach to elaborate and test a model that is developed. A description of the methodology of the case-study can be found in Fischer (Fischer, 1992b).

Positioning an IT organization in the IT management model is not always straightforward. It may be particularly difficult when dealing with large organizations. Large organizations, such as banking and insurance companies, may have different departments that develop information systems, e.g. one for each business unit. These companies also may have different departments for planning. In addition, part or most of the activities of the IT function may be decentralized. To overcome these difficulties, a new concept has to be defined, that of *relevant context*. It allows boundaries to be placed around the subject of study. The relevant context may be defined in various ways. For example, it can be defined as that part of the IT organization that performs the activities of the information systems life cycle subject to investigation. So, for every information system the relevant departments can be identified that contributed to the life cycle of that system. The set of all these departments may be defined as the relevant context. This definition has the drawback that is does not allow for political aspects and social aspects across various departments that perform the same activities. From this point of view, it is better to rely on the theory of web models of Kling (Kling and Scacchi, 1982). Drawing from this theory, it is possible to identify appropriate boundaries around IT activities and systems. Web models make explicit the connections between the focal information system and the social, historical and political contexts in which the information system is developed and used. Populations, equipment, spatial and temporal elements are included within an analysis when these elements either constrain actors involved in specific IT systems or are taken into account by actors in decision processes.

Based on the concept of relevant context, the positioning showed the IT organization in the Experience phase of operational activities, and in the Control phase of strategic and tactical activities. However, careful

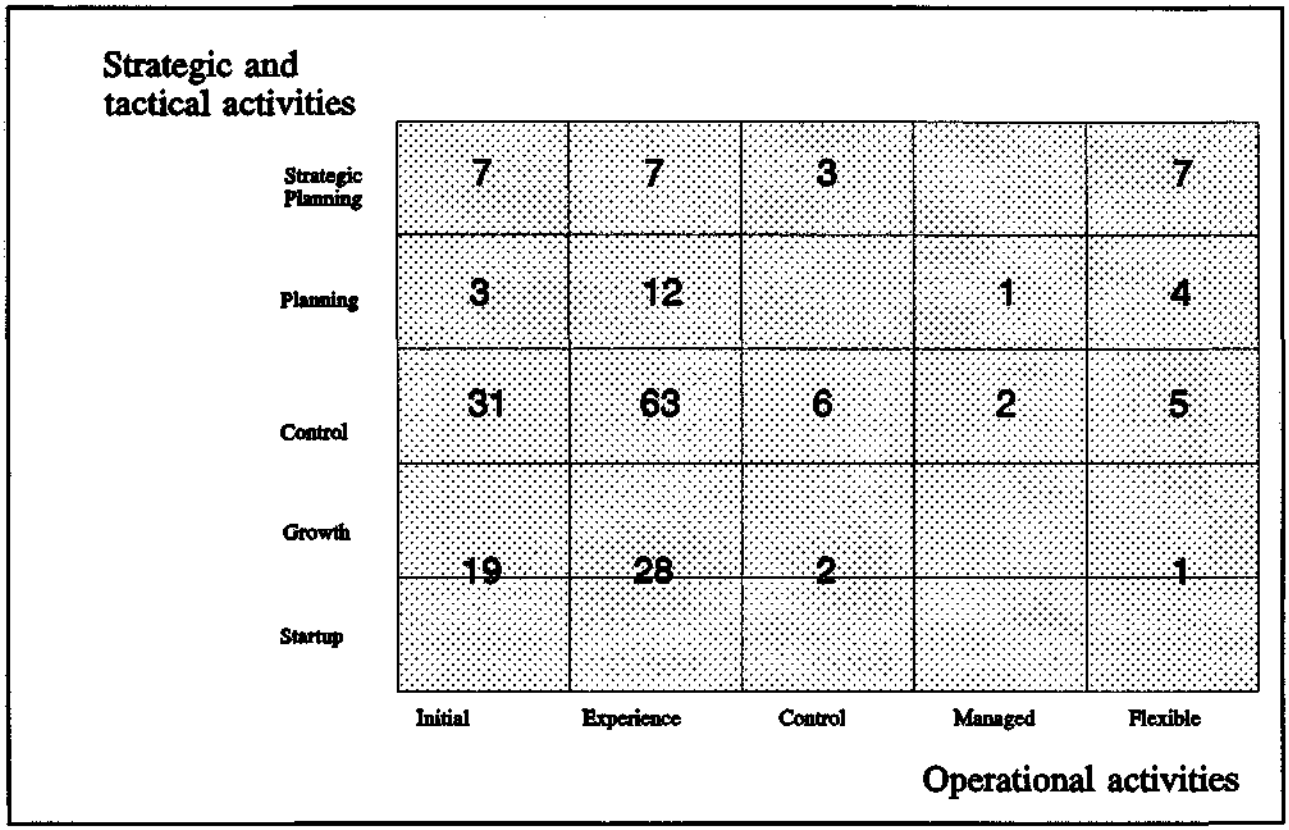

Figure 3. A detailed positioning of IT management

analysis also revealed that although there was only one *actual* positioning of the IT organization, different departments *perceived* the actual positioning to be different. Apparently various departments had different levels of ambition with respect to the use of IT, or different visions on the use of IT.

A similar difference occurred between departments withrespect to characteristics of culture. Departments differed on the cultural dimensions open/closed and pragmatic/normative. The process of control was the same for all departments, as was the structure of the departments: the process of control was a cybernetic process, and the structure of the organization was accordingly, i.e. machine bureaucracy.

The discussion of the positioning and characteristics of the organization already revealed some of the weaknesses in the current IT organization. The most important one is the lack of a coherent vision on use of IT. Different groups in the IT organization had different visions on coping with IT, and as long as this difference remains it will be difficult to manage the IT organization as a whole. The difference may probably stem from the difference in culture of the various departments that was identified, and culture could be used as a starting point to overcome the problem area of vision. The positioning also revealed other, more detailed problem areas, such as the mismatch between strategy formulation and actual accomplishment of operational activities, and the focus on use of new technologies when using current technology is not really controlled.

Strengths the organization, which may also be strengths for other organization with the same positioning, were the rigidity in planning, both for information systems and for architecture and infrastructure. This rigidity resulted in a low risk strategy and a relatively static internal organization, but this did not prove to be problematic because the strategic focus of the organization was not on its internal, primary, process.

Survey research

The advantage of survey research is that it allows for a large sample of organizations, thus offering possibilities of generalization of research findings. However, the data will of course be of less detail than in studies with a smaller sample, as for example case study research or interview research. Moreover, survey research is usually less suitable to test cultural characteristics (Schein, 1985) and issues of structure and control. Therefore, the focus of this study was more on positioning organizations, characteristics of use of IT technology, and implementation of this technology.

Figure 3 gives an overview of the positioning in the IT management model. A simplified version of the questionnaire to arrive at a positioning of the IT organization, developed for the case-study, was used. This simplification allowed no distinction between the first two phases of the strategic and tactical dimension. For a detailed description of the methodology of this study, we refer to Kusters (Kusters et. al., 1992). From the positioning it can be concluded that most organizations rely on the management accounting paradigm. Most organizations plan for IT with of horizon of 1 to 3 year, and are in the Experience phase of the operational dimension. There are almost no organizations that rely on an experimenting paradigm, at least not on the strongest version of this paradigm.

The positioning allowed us to identify several characteristics of organizations for each paradigm. Due to the type of research, i.e. survey research, it was difficult to assess any cultural characteristics. The use of the framework of Sanders and Neuijen proved however to be an advantage above the methodology described by Schein (Schein, 1985). It allowed several aspect of IT management to be interpreted in terms of dimensions of culture. For example, tightness of control, represented by the number of developers that used specific tools, increased with an increase in operational and strategic activities. This confirms the aspect of 'tight control' that is characteristic for the management control paradigm and the strategic learning paradigm. Introduction of new technologies also tended to be more rigid for organizations relying on the management control paradigm. Thus, the focus was more on the process of implementation of IT than on the result of implementation.

An examination of the characteristics of structure showed that a lot of companies still had difficulty to attain a proper level of control of strategic and tactical activities. The organizations that did achieve a considerable level of control of these activities usually were the large companies. A similar conclusion could be made for the emphasis on control of the operational activities.

Statistical analysis was also carried out to determine the correlations between strategic activities, operational activities and characteristics of diffusion of new IT, CASE-technology, in the IT organization. This allowed us to identify several strengths and weaknesses of the four paradigms from the perspective of use of IT. Not surprisingly, the assessment of current needs seemed to be more convenient when the IT organization operates at a more sophisticated level of strategic and tactical activities, i.e. the 'rigidity' of this assessment will be higher when an organization relies on a management control paradigm or strategic learning paradigm. But assessing the current needs of the IT organization is different from actually implementing technology. The study showed that attention paid to implementation of technology, in this survey CASE-technology, was not very different among organizations relying on different paradigms. The rigidity in planning seems to be counterbalanced by the process orientation these organizations have as characteristic.

Interview research

In the interview research key figures at 18 companies in the Netherlands were interviewed on aspects of IT management and the introduction process of Information Technology, again CASE-technology. A structured questionnaire was used for the interviews (see Appendix A), in order to identify the positioning in the IT management model, the structure of the IT organization, its culture, its internal environment, its external environment, history, traditions and the implementation process of CASE-technology. The questionnaire was based on several exploratory interviews and on works of various authors (Bouldin, 1989; Mintzberg, 1979, 1983a, 1983b; Burke, 1982, 1987; Sanders and Neuijen, 1987; Paulk et. al., 1991; McClure, 1989; Zaltman, 1977). The research methodology of this study is described by Fischer and Doodeman (Fischer and Doodeman, 1992). Part of the methodology was to select a representative sample of organizations in The Netherlands.

Figure 4 shows the detailed positioning of the IT organizations studied, and the relation of the positioning to the internal structure of the IT organization. Individual cases are represented by white balls. Note that the positioning is similar to the positioning of the survey research.

The positioning allowed for a detailed identification of the dimensions of culture, and of structural properties. It showed that most IT organizations were either machine bureaucracy - those relying on experience and management control - or professional bureaucracy - those relying on strategic learning and experimentation. IT organizations that relied on experimentation could best be characterized as political systems within a machine bureaucracy. Analysis of cultural characteristics showed that nearly all IT organizations were characterized by professionalism, as contrasted to committed to the organization. This professional orientation seems to be characteristics for IT professionals.

There was more difference between organizations along the other cultural dimensions. Organizations relying on management control tended to be more task oriented, and more process oriented than other companies. Organizations relying on experimentation or on management control had a more closed culture than the other organizations.

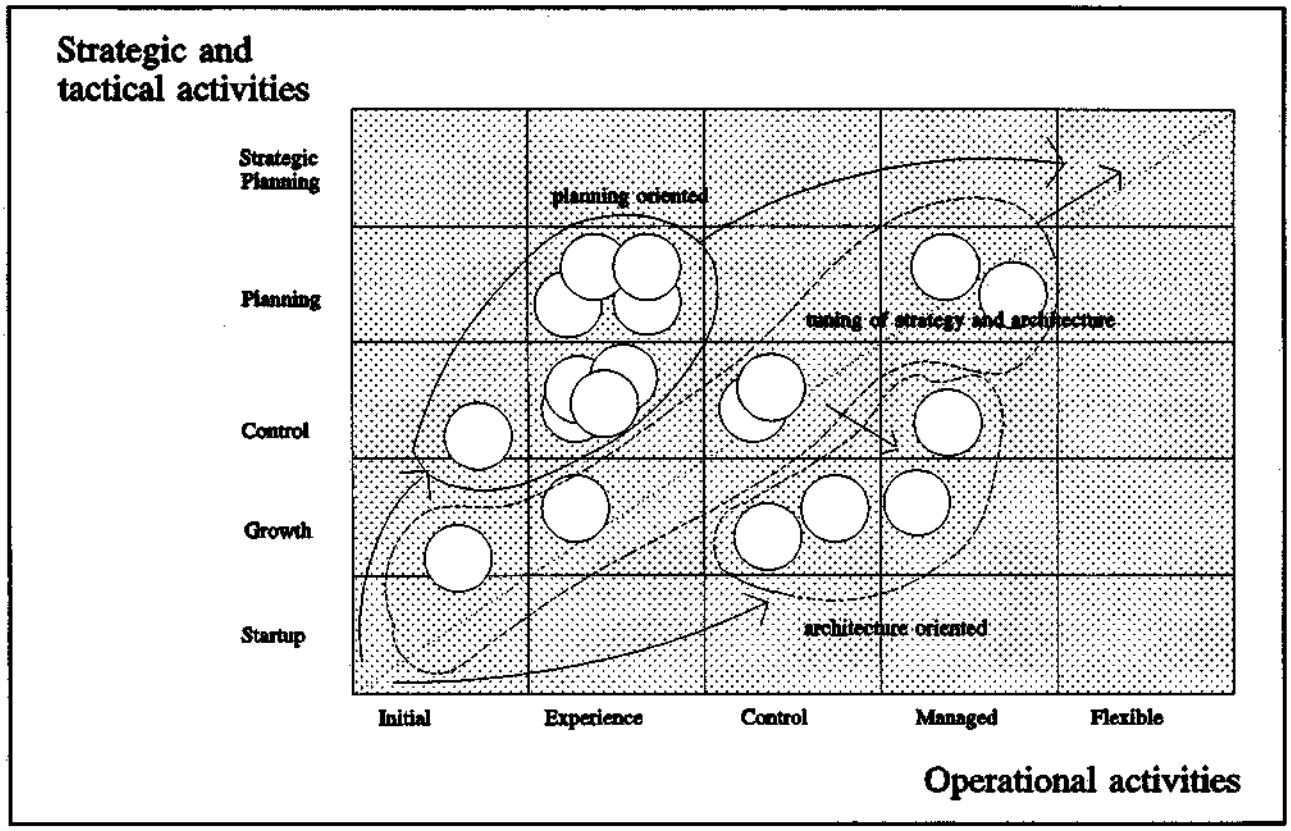

Figure 4. Qualitative clustering of the organizations subject of study

With respect to the control process, it is possible to identify three clusters of organizations, which more or less conform the paradigms. The clusters are shown in figure 4 and defined as *planning oriented*, *tuned*, and *architecture oriented*. Planning oriented companies are characterized by tight control and formalization, i.e. a cybernetic philosophy at the management level. These companies do not only pay a lot of attention to strategy formulation, but view the IT strategy as the starting point for all activities. Usually the IT strategy is tuned to the business strategy. The information infrastructure - which we define as a generic and permanent, basic facility for information processing, storage and transport (Truijens et. al., 1990) - is viewed as a derivation of the IT strategy. On the other hand, architecture oriented companies use the information architecture as basis for their IT activities. The information architecture is regarded as a given resource for a long period of time, and IT strategy should adapt to it. The result of this approach is that starting projects is not just (strategic) planning for the proper future environment. It tends to be more political, i.e. given the available resources, select a project that has a high change of being realized. Finally, tuned companies do not favour either strategy of architecture. They pay equal or little attention, which results in an incomplete control process, or to each of them resulting in a more homeostatic, self-regulating control process.

An analysis of strengths and weaknesses of the various paradigms revealed that each of the paradigms did seem to have its strengths and weaknesses, and that organizations do not necessarily move towards a strategic learning paradigm. One large organization that participated in the research even changed is future goal from strategic learning to experimentation. "Our external environment is becoming to dynamic and complex to allow for any rigidity in planning," according one of the key figures in an IT organization. Although the strategic learning paradigm has the strengths of being rigorous in planning, having a focus on strategic use of IT, and aiming at a learning organization, the research showed that it is an expensive option, and is not without any risks of failure, because the IT organization deliberately chooses to by innovative. The management control paradigm does not have the high cost and high risk of the strategic learning paradigm, but also does not have the strategic value and learning characteristics of that paradigm; although the management control paradigm suggests a planning orientation, and consequently, an orientation towards strategy, the study showed that organizations relying on this paradigm did not aim for strategic use of IT. The experimentation paradigm does not need the rigidity that the strategic learning paradigm needs, but implies far more risks, and only seems to imply learning principles at operational level, i.e. not at top level. The paradigm that remains is the experi-

ence paradigm. The interviews showed that this is a low cost and low risk option, that did not require rigidity, but may be costly in the long run - due to lack of proper planning for infrastructure - and is definitely not strategic.

IMPLICATIONS FOR MANAGEMENT OF IT

In the former section we discussed three research projects that were used to verify and elaborate the IT management model. The model can be used in various ways, and the results of the research can be used to flesh out the different ways in which the model is used. In this section, we will use the discussion of the research results of the former section to flesh out two possible ways of using the model: the identification of a proper vision on management of IT, and the identification of problem areas for managing the current IT organization.

As the case-study showed, the identification of a proper vision on IT - choosing a paradigm that guides management of IT - is one of the most important elements of proper management of IT. When a coherent vision on IT does not exist in an IT organization, each department will develop its own vision, resulting in a suboptimal situation, or failures and successes of projects may be addressed to the wrong reasons. It is important to realize that there is not single best vision, as the discussion in section 5 showed. Every vision has its strengths and weaknesses, and an organization should select the vision with the maximum amount of strengths and minimum amount of weaknesses, given the issues it regards as important. For example, if low risk is regarded as an important issue for an IT organization, it may decide to rely on management control instead of on strategic learning or experimentation. The fact that the positioning is low risk may outweigh the lack of strategic potential in that situation. Management should be aware of the drawbacks of the paradigm it relies on. For example, when an organization relies on experimentation it should realize that failures with using new technology are not necessary bad, but a natural phenomenon as part of that paradigm. Based on the research results, five issues can be used to describe that strengths and weaknesses of each paradigm: costs of IT, rigidity in planning, strategic value, risk, and potential for organizational learning. Figure 5 shows for each paradigm the value of these issues.

Figure 5 can be used as a part for identification of a proper vision on IT. Such an identification consists of six steps. Before deciding on a paradigm for managing IT, management should first decide whether IT should be used strategically or not. A framework that makes it possible to decide on strategic potential of IT in an organization is the framework of Porter and Millar (Porter and Millar, 1985). They describe organizations along two dimensions: the information intensity of the primary process, and the information content of the endproduct. When either of these is high, an organization might use IT strategically. Whether it does use IT strategically in practice the organization has to decide among itself. The stability of the environment seems to be an important determinant for this. For example, the information intensity of the primary process of oil-companies is high, but in reality the strategic use of the primary process is low, whereas for airlines, it is very high. The six phases for identification of a proper vision on IT area:

- position the organization according the framework of Porter and Millar.
- decide on strategic use of IT in the primary process.
- decide on strategic use of IT for endproducts.
- the two former decisions limit the scope of possible paradigm to rely on. Decide on one of the paradigms as the proper paradigm for the *future* IT organization.
- position the *current* IT organization at a global level, in the IT management model.
- based on figure 5, identify the strengths and weaknesses of the current and future organization, and sketch the migration path towards the future organization, in terms of changes in cultural, structural, and control characteristics.

As shown, associated with every paradigm are strengths and weaknesses. But the discussion in the former section revealed that management of IT also may face several problem areas or critical issues, not specific to on type of paradigm. For example, an organization may want to rely on experimentation, but its culture and structure are not appropriate for this type of paradigm. A professional bureaucracy with political elements is the obvious organizational structure, and the culture of the IT organization should at least be result-oriented. When management is not aware of the appropriate structure and culture for the paradigm it relies on, it might never be possible to attain real experimentation. A similar problem area may exist for organizations relying on other paradigms. A five step approach can be used to identify critical areas for managing IT. Each step reveals potential problems in different types of areas:

- identify a vision on IT (the approach discussed earlier). This reveals a possible *diffusion of visions among departments*.
- position the current IT organization in detail. This step reveals *IT activities to which no proper attention is paid*. For example, the case-study showed that a mismatch occurred between planning and developing systems, or to

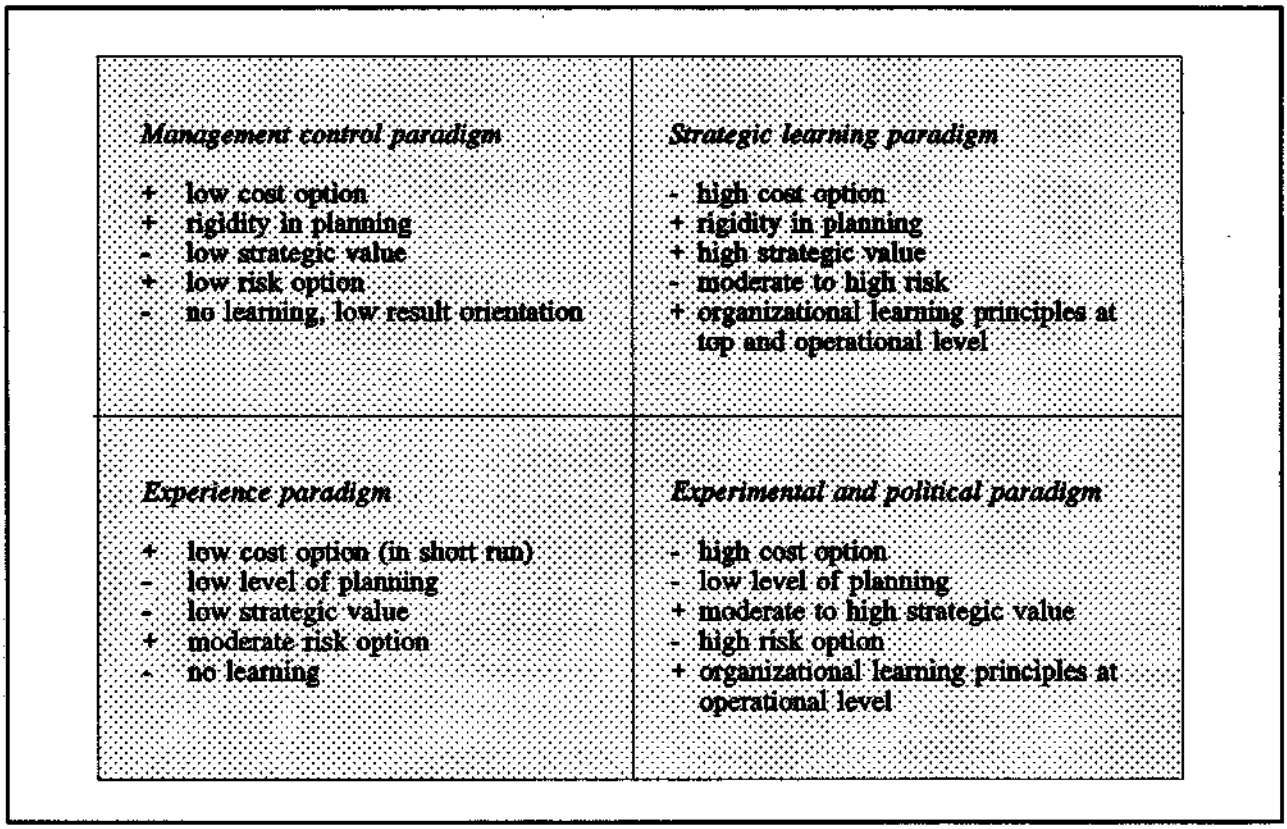

Figure 5. Strengths and weaknesses of each of the four paradigms

much focus on implementing new technologies.

- compare the (ideal) cultural, structural, and control characteristics of the current paradigm the IT organization relies on, and compare it to the real cultural, structural, and control characteristics. This reveals any *mismatch between organizational characteristics and the vision the IT organization relies on*.
- identify the activities that should be part of the future IT organization, i.e. activities belonging to the future paradigm chosen, and compare it to the activities belonging to the current paradigm. This reveals *new emerging activities for the IT organization*.
- identify the strengths and weaknesses of the current paradigm and check whether management is aware of these issues. This reveals any *lack of awareness of the vision the IT organization relies on*.

PARADIGMS FOR MANAGING IT - CONCLUSIONS

Based on several perspectives and philosophies in IS and accounting literature, four different paradigms to management of IT were identified: experience, experimental learning, management control, and strategic learning. The paradigms are expressions of structure as well as of action (the duality of structure, see Giddens, 1984). Based on this notion, the characteristics of the paradigms were discussed from the perspective of control, culture and structure. A model was defined to allow for a detailed positioning of an IT organization along one of the paradigms, called the IT management model. The IT management model can be used in various ways. For example, it can be used to guide the implementation of IT in organizations. In this paper, the focus was on two other possible ways to use the framework: to identify a proper vision on the management of IT, and to identify potential problem areas or critical issues in the management of IT. Three different types of research were discussed to arrive at specific guidelines: a case-study, a survey, and interview research.

The case study research resulted in the notion of *relevant organization*. The survey research allowed a representative sample of organizations in the Netherlands to be positioned along each of the four paradigms. The interview research allowed for a detailed evaluation of characteristics of organizations in the model, which did confirm the characteristics initially described in table 2. It also showed that a strategic learning organization is not always the objective of an IT organization. The environment may be too dynamic to allow for this, or the IT function is simply not

regarded as a strategic business function.

Based on the research described in this paper, two major conclusions could be made. First of all, all four paradigms were visible in practice. Especially the interview research showed that here did not seem to exist a single migration path for IT organizations, as is argued by authors as Nolan (Nolan, 1973, 1979, 1987) and Humphrey (Humphrey, 1987, 1988). Organizations tend to move in various ways, not necessarily to a common goal, i.e. a mature organization according to the model of Nolan or Humphrey. Quite a few organizations are satisfied with a moderate level of maturity, both at the operational level - a moderate level of systems development and maintenance - and at the strategic and tactical level. Second, although all four paradigms were visible in practice, one paradigm dominated: the paradigm of management control. If only organizations with few strategic intentions relied on this paradigm this would not be surprising. As was already noted, quite a few organizations want to attain a moderate level of maturity of the IT organizations. But there are a lot of organizations that rely on this paradigm and still aim for strategic advantage with IT. As long as the competitor also has a low level of maturity in IT it is possible to gain strategic advantage, but it is not always possible to rely upon the immaturity of the competitor. From a theoretical perspective (Mintzberg, 1978; Cusumano, 1991; Huppes, 1990) it can be argued that a management control paradigm is not the most obvious paradigm to rely upon when one wants to attain strategic advantages. The management control paradigm is associated with the machine bureaucracy, based on cybernetic principles, and such a structure is not characterized by a high level of innovation. Planning should not be regarded as a panacea for strategic advantage (Loyd, 1992). The quotation at the start of this paper is part of Brecht's Beggars Opera. Hofstede used it as an introduction to his article 'The Poverty of the Management Control Philosophy', but it applies as well to the control philosophy of IT management. The translation of the quotation is (Hofstede, 1978):

> *"Just try to make a plan*
> *for which you pick your brain*
> *and after that, another plan*
> *your toll will be in vain".*

The most important implication of the findings in this paper is that there is no single, ideal, way of managing IT. Consequently, a contingency approach should be used. Every IT organization has to decide for itself whether, and in what way, it wants to be strategic with IT. Based on that notion, it should decide on the vision, i.e. paradigm, on which it will rely. Each vision has its strengths and weaknesses. This vision again implies specific structural, cultural, and control characteristics for managing IT. These characteristics should be embedded into the IT organization. On embedding these characteristics in the organizations, the organization should be aware of several critical issues. The approaches discussed in this paper are means to develop a proper vision on IT and to identify the associated critical issues for managing IT.

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APPENDIX A - POSITIONING AN IT ORGANZATION - METHOD AND CONCEPTS

The method used in the three research projects discussed is similar to the method used for the SEI Maturity Model. A detailed discussion of this method can be found in various publications (Humphrey and Sweet,1987; Paulk et. al., 1991; Weber et. al. 1991; Fischer 1992a; Fischer, Vinig et. al., 1992). A fundamental construct in the Maturity Model is the concept of key capability area. Each phase consists of several of these areas. These areas are divided into several activities, and a questionnaire is used to identify whether these activities are carried out or not. Based on the activities carried out for each phase, it can be determined which phase the organizations is in. Because every organization will be at least in the Initial and Startup phase, no key areas for these phases are defined.

Table 3 shows the key areas that were identified for the three research projects. It partly consists of the key capability areas of the Maturity model, and is extended with areas for strategic and tactical activities. Some key areas of the Maturity Model were excluded. The list of key areas is used to develop questionnaires for the three projects discussed in this article. For the survey research, a short questionnaire was used that did not allow for a distinction between the first two phases of the strategic/tactical dimension. Table 4 shows a sample questionnaire used in the interview research to position an IT organization. For each question, the corresponding key area is given between brackets.

The algorithm to position an IT organization is based on the key areas of figure 3. Each of the questions addresses an activity belonging to one of the key areas. Several key areas belong to different phases of strategic/tactical or operation activities. If most of the questions (>80 %) of the questions belonging to a specific phase are positively answered, an IT organization has at least reached this phase. For a thorough description of this algorithm, see or Fischer (Weber et. al., 1991; Fischer, 1991).

Strategic/tactical activities	Key area	Operational activities	Key area
Strategic planning	(TSA) Technology scanning (IP) Infrastructure planning	Flexible	(PCM) Process Change Mgt.* (DP) Defect prevention * (WS) Workplace simulation (TSIM) Technology simulation
Planning	(MSP) Mgt. systems planning (MSM) Mgt. Systems monitoring (AP) Architecture planning (IB) Infrastructure blueprint	Managed	(QM) Quality Mgt.* (PMA) Process measurement and analysis*

Control	(RP) Resource planning (ITSP) Service planning (LPTP) Linked planning and task performance (SIP) Strategic information planning	Control	(PR) Peer reviews* (IC) Intergroup coordination * (SPE) Software product engineering * (ISM) Integrated software management * (TP) Training program* (OPD) Organization process definition * (OPF)Organization process focus*
Growth	(ITSD) Service definition (ITSC) Service control (RC) Resource control (IPP) Information and project planning	Experience	(SCM) Software configuration mgt.* (SQA) Software quality assurance * (SSM) Software subcontract mgt.* (SPO) Software project tracking and oversight * (SPP) Software project planning * (RM) Requirements mgt.*

Table 3. Key areas (key capability areas of the Capability Maturity Model are indicated by a star)

For each of the following questions indicate whether the activity is performed in the organization, and to what extend this activity is performed.

- use of standard procedure (formal or informal) for requirements definition (RM).
- change management (formal or informal) for requirements definition (RM).
- use of standard procedure (formal or informal) for project planning (SPP).
- use of standard procedure (formal or informal) for project management, i.e. controlling project activities and status of projects (SPP).
- estimation of costs of systems development projects for *each* project, according to a standard procedure (formal or informal) (SPTO).
- estimation of time of systems development projects for *each* project, according to a standard procedure (formal or informal) (SPTO).
- estimation of size of systems development projects for *each* project, according to a standard procedure (formal or informal) (SPTO).
- identify responsibility for Software Quality Assurance (SQA).
- definition of a SQA plan on a regular basis (SQA).
- software configuration management (SCM).
- definition of a software configuration management plan on a regular basis (SCM).
- definition of an information systems plan on a regular basis (IPP).
- periodical evaluation of the systems development process (OPD).
- identifying needed actions based on this periodical evaluation (OPF).
- evaluation of new technology not yet used by the (IT) organization (SPE).
- definition of a training plan for each systems development project (TP).
- definition of a training plan for the whole IT/EDP organization (TP).
- use of a standard procedure (formal or informal) to determine the training necessary in each systems development project (TP).
- use of guidelines to adjust the standard systems development process to each individual project (ISM).
- participation of development groups with end-users and customers to identify systems requirements (IC).
- identification of intergroup issues affecting systems development projects (i.e. several groups participate in the systems development process, e.g. analysis design, coding, testing. Intergroup issues are those issues that affect several groups and have impact on their way of working) (IC).
- identifying needed actions based on these intergroup issues (IC).
- planning of management reviews on a regular basis (PR).
- definition of a standard management model or schema for the IT organization (i.e., a description of the 'SOLL' situation for the IT organization) (OPD).
- comparison of the standard management model (the 'SOLL' situation) to the existing IT organization (the 'IST' situation) on a regular basis (OPF).
- identifying needed actions based on this comparison (OPF).
- use of a standard procedure (formal or informal) for information systems planning (SIP).
- notification of project defined in information systems planning to all persons affected by these projects (SIP).
- only those projects are carried out that are defined in the information systems plan (SIP).
- participation of (representatives of) end-users in IS planning (SIP).
- quantitative measurement of process and product data about the systems development process (PMA).
- quantitative analysis of the systems development process (PMA).
- definition of software quality measures (QM).
- definition of data architectures on a regular basis (AP).
- definition of systems architectures on a regular basis (AP).
- definition of configuration architectures on a regular basis (AP).
- definition of communication (network) architectures on a regular basis (AP).
- definition of the information infrastructure (IP).
- simulation of use of new information technology (TSIM).
- planning for technological innovations (TSA).
- workplace simulation (WS).

Table 4. Sample questionnaire used in interview research to position the IT organization

APPENDIX B - FRAMEWORK FOR THE STRUCTURED INTERVIEWS

Structured interview on organizational aspects of implementation of CASE-technology

Section	Comments
1. General	In this section, several general characteristics of the organization where asked for, such as organizational scheme, number of employee, and function of the person interviewed.
2. IT facility	In this section, several characteristics where asked with respect to developing, maintaining, planning for and implementation of information systems were asked. This allowed us to assess the 'maturity' of the EDP department.
3. Organizational Characteristics	In this section several organizational characteristics of the EDP department were asked for:
3.1. Culture	• the culture of the IT organization
3.2. Structure	• the organizational structure
3.3. Internal environment	• leadership still, power characteristics
3.4. External environment	• characteristics of the external environment (passive, dominated, etc)
3.5. History, traditions	• important historical issues and traditions
3.6. Technology	• importance of technology for the company
4. Implementation of CASE-technology	specific questions regarding the way CASE was implemented, who participated in the implementation process, the type of CASE-technology, the impact on the organization, etc.

1991-1	N.M. van Dijk	On the Effect of Small Loss Probabilities in Input/Output Transmission Delay Systems
1991-2	N.M. van Dijk	Letters to the Editor: On a Simple Proof of Uniformization for Continious and Discrete-State Continious-Time Markov Chains
1991-3	N.M. van Dijk P.G. Taylor	An Error Bound for Approximating Discrete Time Servicing by a Processor Sharing Modification
1991-4	W. Henderson C.E.M. Pearce P.G. Taylor N.M. van Dijk	Insensitivity in Discrete Time Generalized Semi-Markov Processes
1991-5	N.M. van Dijk	On Error Bound Analysis for Transient Continuous-Time Markov Reward Structures
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