



Vicious and virtuous cycles in ERP implementation: a case study of interrelations between critical success factors

H Akkermans^{1,2} and K van Helden³

¹Eindhoven University of Technology, Eindhoven, The Netherlands; ²Minase BV, Tilburg, The Netherlands; and ³A-Décom Consulting, Werkendam, The Netherlands

ERP implementations are complex undertakings. Recent research has provided us with plausible critical success factors (CSFs) for such implementations. This article describes how one list of CSFs (Somers & Nelson, 2001) was used to analyse and explain project performance in one ERP implementation in the aviation industry. In this particular case, poor project performance led to a serious project crisis but this situation was turned around into a success. The list of CSFs employed was found to be helpful and appropriate in explaining both the initial failure and the eventual success of the implementation. CSFs in this case appeared to be highly correlated, ie changes in any one of them would influence most of the others as well. The reversal in performance after the project crisis was caused by substantial changes in attitudes with most of the stakeholders involved, such as top management, project management, project champion and software vendor.

European Journal of Information Systems (2002) 11, 35–46. DOI: 10.1057/palgrave/ejis/3000418

Introduction

ERP (Enterprise Resource Planning) systems may well count as 'the most important development in the corporate use of information technology in the 1990s' (Davenport, 1998). ERP implementations are usually large, complex projects, involving large groups of people and other resources, working together under considerable time pressure and facing many unforeseen developments. Not surprisingly, many of these implementations turn out to be less successful than originally intended (Davenport, 1998; Avnet, 1999; Buckhout *et al*, 1999).

Over the past few years, a considerable amount of research has been conducted into critical success factors, or CSFs, for ERP implementations (eg Holland & Light, 1999; Sumner, 1999; Willcocks & Sykes, 2000) and IT implementations in general (Reel, 1999; Marble, 2000). Such factors typically include top management support, sound planning, end user training, vendor relations, project champions, interdepartmental collaboration and communication and the like. Now we even have available a ranked version of such a list, based upon a survey among managers of organisations that have recently gone through an ERP implementation process (Somers & Nelson, 2001). However, at present it is not yet clear how these CSFs interrelate. It seems unlikely that they all work in isolation, without one CSF also

affecting another and vice versa. At present, what we have are 'laundry lists' (Richmond, 1993) of relevant CSFs. However, for the time being, we have little theory on how these CSFs affect each other.

This article describes an exploratory research study where this particular ranked list of CSFs was used to analyse a case study of an ERP implementation. This implementation at first experienced severe difficulties but turned around remarkably after a project crisis had resulted in changes in several of the CSFs for this case. This article shows how, at least in the case studied, these CSFs affected each other in a reinforcing manner. It argues that the same reinforcing 'loops' of causal relationships that at first led to a vicious cycle, or downward spiral, of ever-degrading performance *after* the crisis led to a virtuous cycle, or upward spiral, of continuously improving implementation success (cf Senge, 1990; Sterman, 2000).

Critical success factors for ERP implementations

In a recent article by Toni Somers and Klara Nelson (Somers & Nelson, 2001), a very useful and well-grounded ranked list of CSFs for ERP implementation is presented. The 21 CSFs in this list were first compiled from a meta-study of over 110 ERP implementation cases described as well as of the general literature on IT implementation, BPR (Business Process Reengineering) and project management. This list was then rated by 52 senior managers. This group consisted mainly of CIOs

Correspondence: H Akkermans, Eindhoven University of Technology, Technology Management, PO Box 513, 5600 MD Eindhoven, The Netherlands

Email: H.A.Akkermans@tm.tue.nl

(Chief Information Officer), MIS (Management Information Systems) managers, directors, vice-presidents (VPs) or executive vice-presidents (EVPs). The companies involved were US firms that had completed their ERP implementation either last year or longer ago. Table 1 shows the resulting ranked list.

In the remainder of this article, we will focus on the top 10 CSFs, which are italicised in Table 1. The choice for precisely this number was somewhat arbitrary, but worked out well in our analyses, as will become apparent later on. Strongly influenced by the sound literature study underlying Somers' and Nelson's ranked list, we will briefly discuss each of these top CSFs. Together, they form an interesting mix of more conventional, 'hard', implementation aspects, such as clear goals and objectives and strong project management, and 'softer' aspects, such as team competence and interdepartmental communication and collaboration. Most of them would hold for IT implementation projects in general, but some are more important for ERP projects in particular.

- (1) *Top management support*. If top management is not actively backing an all-pervasive project like an ERP implementation, there is little hope for it. This is especially so in the early stages of such a project (Slevin & Pinto, 1986; Bingsi *et al.*, 1999). It is probably true for most implementations of innovations into organisations (Jarvenpaa & Ives, 1991). On the other hand, it would be unwise to suggest that top management is omnipotent in this

kind of process. Middle management and other staff are at least as important, but will play different roles (Mumford, 1983; McKersie & Walton, 1991). However, if top management permanently delegates its responsibilities to technical experts, the chances for project failure are high (Ewushi-Mensah & Przanyski, 1991).

- (2) *Project team competence*. This CSF is one of those that was originally not very high on Somers and Nelson's (2001) list but that ended up remarkably high when ranked by the executives that filled in their survey. Indeed, it seems there has not been that much research regarding the impact of project team competence on IT implementation success. Somers and Nelson do refer to some vendor-related documentation (Bancroft *et al.*, 1998) and APICS literature (Kapp, 1998). However, one also has to look into literature from other fields where the importance of team competence has been well recognised, such as Argyris and Schön (1979), McGrath (1984), Senge (1990) or Katzenbach and Smith (1993).
- (3) *Interdepartmental co-operation*. Another surprisingly high-ranking factor is interdepartmental co-operation. Then again, perhaps it is less surprising that the executives ranked this factor so high than that in Somers and Nelson's original list, which was based on their literature review and not on assessments by managers, it appeared as low as No. 20. For surely, ERP systems are really about closely integrating different business functions; this is what sets them apart from many other IT efforts. Therefore, close co-operation between these business functions would seem to be a natural prerequisite (Stefanou, 1999). Indeed, one recent study found closer interdepartmental collaboration as one of the main post-ERP implementation benefits (McAfee, 1998).
- (4) *Clear goals and objectives*. It has long been common knowledge that the first phase of an IT project should start with a conceptualisation of goals and ways to accomplish these (Cleland & King, 1983; Slevin & Pinto, 1987). Clear goals and objectives seem to form a clear-cut CSF, but can actually be rather problematic. This is because, at the outset of an ERP project, it is often very difficult to determine them in a clear-cut manner. Hence the call of Austin and Nolan to manage ERP initiatives as new business ventures, rather than as IT projects (Austin & Nolan, 1998) and the suggestion of Austin and McAfee to employ a path-based approach to ERP implementation (Upton & McAfee, 1997). On a more methodological level, this viewpoint is in line with the concept of IS development as one of evolutionary complexity (Lycett & Paul, 1999).
- (5) *Project management*. The complexity of ERP

Table 1 Mean rankings of CSFs by degree of importance in ERP implementation

<i>Critical success factor^a</i>	<i>Mean</i>
(1) <i>Top management support</i>	4.29
(2) <i>Project team competence</i>	4.20
(3) <i>Interdepartmental co-operation</i>	4.19
(4) <i>Clear goals and objectives</i>	4.15
(5) <i>Project management</i>	4.13
(6) <i>Interdepartmental communication</i>	4.09
(7) <i>Management of expectations</i>	4.06
(8) <i>Project champion</i>	4.03
(9) <i>Vendor support</i>	4.03
(10) <i>Careful package selection</i>	3.89
(11) Data analysis and conversion	3.83
(12) Dedicated resources	3.81
(13) Steering committee	3.97
(14) User training	3.97
(15) Education on new business processes	3.76
(16) BPR	3.68
(17) Minimal customisation	3.68
(18) Architecture choices	3.44
(19) Change management	3.43
(20) Vendor partnership	3.39
(21) Vendor's tools	3.15
(22) Use of consultants	2.90

^aItalicised CSFs used in subsequent analysis.

implementation is very high, given the vast combination of hardware, software and organisational issues involved (Ryan, 1999). One approach to overcoming this kind of complexity is to stress the need for 'a great amount of methodical planning and calculated management' (Soliman & Youssef, 1998 p. 890). This approach is often taken in textbooks on IT project management (eg Hoffer *et al*, 1998). However, as organisations and projects evolve over time, so should project management priorities. Some degree of improvisation (Macredie & Sandom, 1999) may also need to be part of the skill set of ERP project managers.

- (6) *Interdepartmental communication.* The importance of communication across different business functions and departments is well known in the IT implementation literature. According to one author on IT project management, 'communication is the oil that keeps everything working properly' in these contexts (Schwalbe, 2000). Slevin and Pinto (1986) reached similar conclusions for project management in general. As noted above, this need for communication across functional boundaries is all the more important in an ERP context since the primary objective of ERP systems is to integrate business functions (Davenport 1998).
- (7) *Management of expectations.* Successfully managing user expectations has long been known to be important for successful implementations of IT systems in general (Ginzberg, 1981). Misalignment of expectations is common, for instance through overselling of the vendor or by underestimation of the complexity of ERP implementation by the organisation. Therefore, management of expectations remains important through all stages of the implementation life cycle (Hoffer *et al*, 1998).
- (8) *Project champion.* 'The success of technological innovations has often been linked to the presence of a champion, who performs the crucial functions of transformational leadership, facilitation, and marketing the project to the users' (Beath, 1991; quoted from Somers & Nelson, 2001). Usually, this will be somebody at senior management level, so that this person has the authority to make substantial organisational changes happen (McKersie & Walton, 1991). One obvious place to look for such a champion role is with the CIO, or else the CEO (even better) or VP in charge of IT (Willcocks & Sykes, 2000).
- (9) *Vendor support.* A project as all-pervasive as an ERP implementation cannot be delegated to an outside party. In fact, strong reliance on outside consultants or vendor support was found to have a negative correlation with project success for MRP II implementations (Burns *et al*, 1991). On the other hand, a company typically does not have all

the technical and transformational skills in-house for managing such a major undertaking on its own. Therefore, it is also not surprising that other research has shown project success to be positively associated with fit and compatibility with the IT vendors employed (Thong *et al*, 1994; Janson & Subramanian, 1996; Willcocks & Sykes, 2000).

- (10) *Careful package selection.* ERP vendors may claim that their systems are overlapping in functionality but they are not, at least not in full. For instance, some packages are more suited for larger firms, some more for smaller ones. Some packages have become a *de facto* industry, some have a stronger presence in certain parts of the world. And then, once the choice for the package is made there is the decision to be made as to what versions or modules of the package would best fit the organisation (Pituro, 1999). In short, if the wrong choices are made, and these choices have to be made very early on, the company faces either a misfit between package and business processes and strategy, or a need for major modifications, which are time-consuming, costly and risky (Janson & Subramanian, 1996).

Research methodology

A theory-building case study research design

In this research, our objective has been not just to test the explanatory power of the existing CSF list of Somers and Nelson (2001) in a specific case but also to extend it into a richer framework, ie one that would describe causal interrelations between the individual CSFs. For this purpose, we have employed a case study research design. The case study is a well-known research method for exploratory, theory-building research (Eisenhardt, 1989; Yin, 1989). As a research method, case studies, and certainly single-case ones, score low on generalisability of findings. However, on the other hand, their richness of data lends themselves well for the inductive process of theory building. It is precisely this 'intimate connection with empirical reality that permits the development of a testable, relevant, and valid theory' (Eisenhardt, 1989 p 532).

Action research for research relevance

In this research, the authors themselves were actively involved as consultants to the management of the company. We fulfilled this role for 3 months in the fourth quarter of 1997 and the first quarter of 1998. Afterwards, we changed roles and became neutral observers to the changes the company was undergoing for the next 2 years. As will subsequently become clear, a key turnaround in the ERP effort was initiated during the relatively short period that we were actively involved as consultants. This makes the research reported here clearly

action research (Reason & Bradbury, 2000). The choice for an action research design has several clear benefits in studying a phenomenon such as the current one. First, it provides the ability to observe up close an organisation during a period of strong instability, while it is experiencing its periods of most drastic change, when normally often no outsiders would be allowed. As Arie Lewin once put it: 'If you want to understand something, try to change it' (Daft & Lewin, 1990). Secondly, it ensures the direction of the research to be of guaranteed managerial relevance, since company management is closely involved in the research effort as it progresses (Gill, 1983). Thirdly, it indirectly generates the close relations and common understanding that enable researchers to revisit the company during subsequent periods of change to observe and reflect with members of the organisation on ultimate causes and consequences of the changes observed (Miles & Huberman, 1984).

Measures to ensure rigor and reliability

Case study research in general, and action research in particular, are arguably well suited to ensure relevant IS research regarding organisational change processes (Galliers & Land, 1987), but also pose considerable problems in ensuring sufficient rigor and reliability. By *reliability* is meant the degree in which statements are based on a careful observation of reality, rather than on accidental circumstances regarding measurement instruments or the researchers' own biases as people being personally involved (Yin, 1989). We took several measures to ensure adequate levels of reliability for this research. In general, these all boil down to limiting personal biases by employing as many independent perspectives and sources of data as possible in an iterative process of data collection, analysis, reflection and synthesis. The goal of having different perspectives was accomplished by (1) having *independent interviewers* for post-project evaluation, (2) *interviewing multiple members* of the organisation coming from different backgrounds, (3) performing a so-called *member check* by letting preliminary research results be assessed by these respondents and *peer review* of these findings by presenting them at two subsequent peer-reviewed international academic conferences. The goal of multiple sources of data as to enable triangulation was achieved by collecting data at different points in time, again with different stakeholders and comparing these with project documents and personal research notes.

Theory-driven case selection

In order to learn more about CSFs in ERP implementation, one would normally need at least two cases: one where project success was low and one where success was high. Then, most of the variables that are not of primary interest, such as firm size, industry, time frame, package type etc. would have to be kept identical as

much as possible. This is the concept of *theory-driven case sampling*, as developed by Yin (1989) and Eisenhardt (1989). However, in this particular instance, it was possible to suffice with a case within a single company. This is because we had ample data on a particular implementation where project performance was at first very low, almost leading to a complete failure of the project, and then bounced back again to reach very satisfactory results in the end. In this way, we had both high and low implementation success and, at the same time, identical values for many of the variables not of primary interest, since both stages concerned the same firm.

Research questions

According to Eisenhardt (1989), 'An initial definition of the research question, in at least broad terms, is important in building theory from case studies' (Eisenhardt, 1989 p. 536). For our research, given the state of the art of research on CSFs for ERP implementation, this resulted in the following two *ex ante* research questions:

Research question 1: Can the Somers and Nelson list be helpful in arriving at a better understanding of root causes of ERP implementation success and failure?

Research question 2: If so, in what way can the Somers and Nelson CSFs be interrelated causally?

With these two questions in mind, we have analysed our case material.

Case data collection

The case study in question concerns a medium-sized manufacturing firm in the aviation industry where an ERP system was implemented. Our original case data were collected over a time period of 2 years, spanning the entire period from the early start of the implementation of the ERP system to its operational use. Figure 1 contains a time line for the project.

As can be distilled from Figure 1, we collected information on project success and ascribed causes for it from company representatives in three different instances. The first time was immediately after our own involvement in our capacity as business consultants, when the project had just recently bounced back into good shape. The second time, we sent independent interviewers armed with a semi-structured questionnaire just after the ERP system had gone live. Our analysis of the findings from these interviews was published shortly afterwards (Akkermans *et al.*, 1998). Almost 1 year later, we went back again to discuss our latest insights, based on a comparison of this case with two other IT implementations (Akkermans *et al.*, 1999).

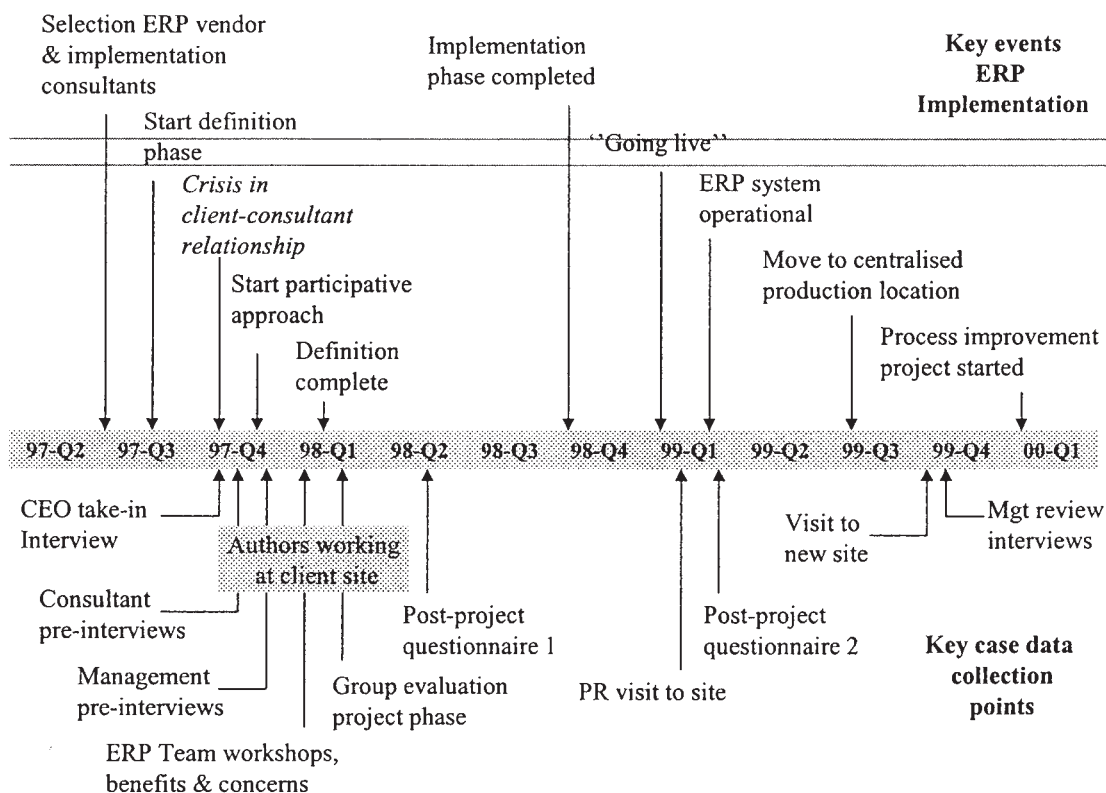


Figure 1 Timeline for key events in ERP implementation and case data collection.

Case data analysis

Irrespective of the considerable amount of bottom-up data collection described above, our case data analysis as it is presented here remains an inductive effort. It consists of three stages.

Stage 1: Assessment of scores for the top 10-CSFs:

Firstly, we have taken the 'top 10' of the Somers and Nelson list and have assessed their values before and after the project crisis. Please note that we do not suggest that these top 10 explain everything there is to elucidate in this case. For instance, CSF No. 22, the relevance of the use of outside consultants, is clearly one we would be tempted to call relevant, since we acted as such. But, our objective is not one of completeness but of parsimony: if the top 10 factors can explain most of what happened and can do so plausibly, why use more?

Stage 2: Causally interrelating CSFs:

We have then, in an inductive effort, used the mapping technique of causal loop diagramming, or CLD (cf Senge, 1990; Sterman, 2000), to interrelate these 10 CSFs causally. We have thought about what generated what, and about feedback loops between the different factors. Most importantly, we have tried to arrive at a causal structure that could explain both the state of events leading to the project crisis as well as the subsequent reversal of fortune of this project.

Stage 3: Formulation of tentative research propositions:

Finally, we have, in reflection on these findings, formulated five preliminary research propositions that come out of this exploratory research as candidates for further investigation in subsequent research. We have called these *propositions*, since they are not yet in the stage of hypotheses ready to be tested. Generalising from a single case is always problematic. We certainly do not suggest that this is possible from this particular case. However, we do believe that these propositions can form the basis for research leading to more generalisable findings.

The case study: an ERP implementation in the aviation industry

Case setting

The aviation industry is characterised by a small number of major global players and many small ones, which all develop and manufacture aeroplanes and helicopters. A major part of the design and production has been contracted out to suppliers. The client's company is one of these European suppliers in the aviation industry, developing, producing and delivering aero-structures such as wings and tails for the civilian and military market. At the client's site, some 700 people are working.

The company is a subdivision of the aviation division of a multinational engine building company. It was taken over by this conglomerate some time beforehand, after

a bankruptcy of its original parent firm. This resulted in major changes: new management, but also new markets to be served. The company changed from being an internal supplier of stable product lines to competing on the external market with a large number of frequently changing production programmes. This change prompted the rise of several new business functions, such as sales and additional parts of F&A. It also led to a need for integration of different departmental activities (sales, engineering, production), which also meant new business processes.

At the start of the ERP project, the crisis atmosphere of the early days after the bankruptcy still lingered on. Then, only a small group of the original employees had been allowed to return and they had experienced considerable turbulence externally and internally. The direct motivation for the ERP system investment was that, IT-wise, a new system was needed to support the new business processes. Moreover, the IT 'legacy systems' that were being used at the time were non-millennium compliant, with a deadline as early as January 1999, due to long lead times in the ordering of some strategic supplies.

Project synopsis

The history of this case extends over more than 2½ years, starting in the second quarter of 1997 and ending in the fourth quarter of 1999, as becomes apparent from Figure 1. In the first half of 1997, the company started with the selection of the ERP package and an ERP implementation partner. The ERP Package became BAAN, at that time the *de facto* ERP leader in the aviation industry. The choice of the implementation partner was less straightforward. The first candidate wanted to start an extensive BPR project prior to the ERP implementation. This was considered unacceptable by company management. Hence, a choice was made for an IT services firm that indicated that they would focus on implementing BAAN for the processes as they were in use at the time, the 'AS IS processes' to use some BPR terminology.

Stage 1: Unsuccessful project initiation:

Unfortunately, the structure of these AS-IS processes was not so clear, which was not so surprising considering the drastic changes these processes had been undergoing. Nevertheless, the external project manager who had been hired to lead the initial 'mapping' or process definition phase started by making all the right moves according to conventional wisdom. He first focused on the development of a detailed project handbook, which would make clear to all involved what had to be done by whom, when and how. Meanwhile, technical BAAN training was planned for the core project group. His fellow external consultant started working on the overall business control model on the basis of standard BAAN templates.

Project crisis:

Unfortunately, this approach led to a serious project crisis by the end of stage 1. What had gone wrong was not at all obvious. The external consultants complained of a lack of collaboration with project team members. These in turn complained of a lack of industry expertise and leadership with the external consultants. The CEO, one of whose former jobs had been overseeing the turn-key installation of entire factories, complained of a lack of professionalism to his counterpart at the IT firm. This person in turn, the account manager with the implementation partner, complained about a lack of understanding of the nature of IT development with company management. Anyway, the project came to a total standstill and the external consultants were sent packing. Both parties came very close to ending their collaboration. Because of potential adverse repercussions that this might have on both sides, the authors were asked by the account manager to try one more time to develop productive work arrangements with the project team and company management. In turn, the CEO appointed from his management team a senior internal project manager to the ERP project, who also served as a project champion for the project.

Stage 2: Successful process mapping and functionality specification:

This second attempt at process definitions started off with a short interview round by us, the authors, acting as consultants, with senior and middle management to find out what the most pressing issues were in going forward. Next, we organised a series of workshops, which were successful in achieving a different way of working together. For instance, the first workshop started with a huge 'brown paper session'. The brown paper referred to hung against the wall and contained a large process map of all relevant process steps: from sales via engineering to production, purchasing and distribution. This map we had created beforehand in several informal meetings with small groups of project team members who were experts in specific business areas.

In the brown paper workshop, these team members explained to their colleagues their part of the map and discussed differences in interpretation and missing links. Once consensus was achieved in this manner, the same map formed the starting point for a next stage of process mapping, now more formal and detailed, using a computerised process mapping tool. It is important to note that it was the project team members who performed this mapping, after some initial training in the notation method. We, the consultants, operated as facilitators and took care of the computerised tool that identified inconsistencies between sub-models. This resulted in the detailing out of over 100 processes, all signed-off by their respective process owners. It also resulted in an

active involvement of the project team members and excellent cross-departmental communication.

Another essential element of this stage was the active involvement of senior management, which until then had hardly taken an active part in the ERP project. At the outset of this stage, the following rule was agreed with all parties concerned. If, in the project team workshops, a business issue remained unresolved after 5–10 minutes of discussion it would be flagged as a senior management issue and would no longer be discussed by the team. This was done because decisions on such debated issues would probably not be taken by the project team but by senior management. Senior management, ie the CEO and his management team (MT) of functional managers, agreed to participate in a workshop with us where all these issues would be resolved. At the outset, the CEO expected that this would be a brief exercise, but as it turned out, 2 full half days of hard work and some serious preparation in between were needed. As a side result of this, senior management became much more aware of the ERP project and the impact it would be having on daily work in their departments.

Stage 3: System implementation:

The process definition stage lasted for 3 months. It yielded the business processes that were used to implement the actual ERP system. Here, the authors left and specialists in the BAAN software took over. The number of company people involved in the subsequent system implementation stage was much greater, over 50 at some stage. Obviously, more lower-level employees were involved. We now changed our role to observers. One phenomenon that was immediately interesting to observe in this stage was that the 15 members of the original core project team now became the ambassadors for the ERP effort with their fellow employees. In the previous phase, the lower-level employees had not been involved directly in the ERP process, but now they were trained and asked to participate. Eventually, and to the surprise of many, the by then very ambitious October 1998 deadline of the project was met fairly well, and so was the agreed budget. This was no small feat after the progress delays in stage 1 and the considerable time investments required to conclude stage 2.

Stage 4: System operation:

Despite some glitches in the changeover from the ERP project organisation to business as usual, operational use of the ERP systems has been smooth. In fact, the company has been through a number of similarly complex improvement projects since. Production facilities that were spread over different locations as well as the engineering department were all brought together in one central factory with a strongly simplified routeing and layout. The structure of the manufacturing organisation was changed considerably and a new group of managers was

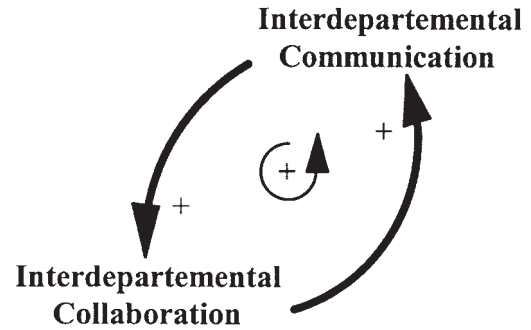


Figure 2 The core reinforcing loop in the ERP integration effort: mutually reinforcing interdepartmental communication and collaboration.

nominated, mainly from the internal ranks (several of them from the core ERP project team). The staff qualification method used by the HRM department was harmonised and function descriptions were rewritten. And finally, 1 year after the ERP system had gone live, a company-wide process improvement project was started, with cycle time reduction and quality improvements as its main goals.

Case data analysis

In this section we describe how we have applied the top 10 items of Somers and Nelson’s (2001) ranked list of CSFs for ERP implementation to the case described above. Also, we present our causal theory of how these CSFs interrelated for this particular ERP implementation. Figure 2 illustrates what we feel is the core CSF process; Figure 3 shows the root causes for the project

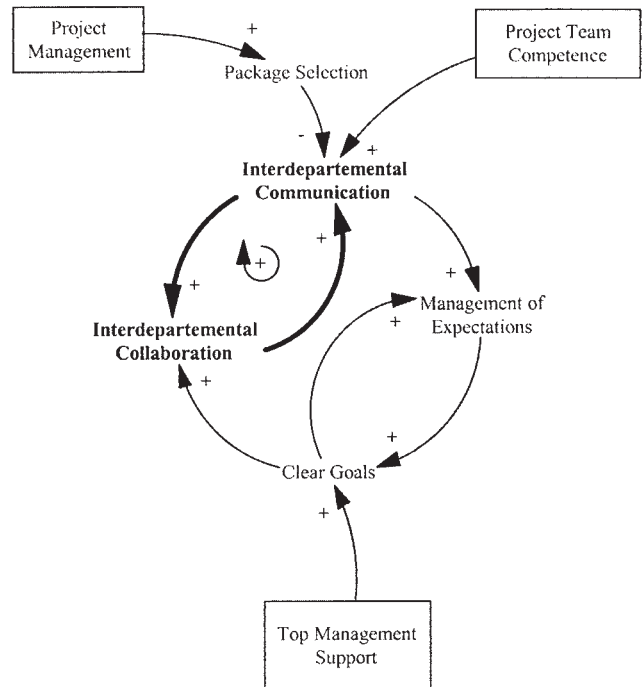


Figure 3 Root causes of the vicious cycle leading to the project crisis.

crisis that developed and Figure 4 contains a CLD of the counter-measures that were taken to overcome this crisis.

Assessments for the top-10 CSFs before and after the project crisis

- (1) *Top management support.* Initially, top management support was low and only limited to IT management. A mid-level technical specialist was appointed as a liaison officer. Top management saw the ERP implementation as something equivalent to 'building a factory'. However, later on, senior management was actively involved, playing a crucial role in the decision-making workshops.
- (2) *Project team competence.* The project team consisted mainly of delegated process owners. Although the team members did have in-depth knowledge of their business area, before the crisis the external consultants were doing most of the mapping work. After the crisis, the consultants acted as facilitators and made extensive use of the knowledge of the project team members.
- (3) *Interdepartmental co-operation.* Initially, the functional area of programme management was not convinced of the importance and possibilities of the project. Therefore, they played a minor role in the project. Later on, they became more co-operative

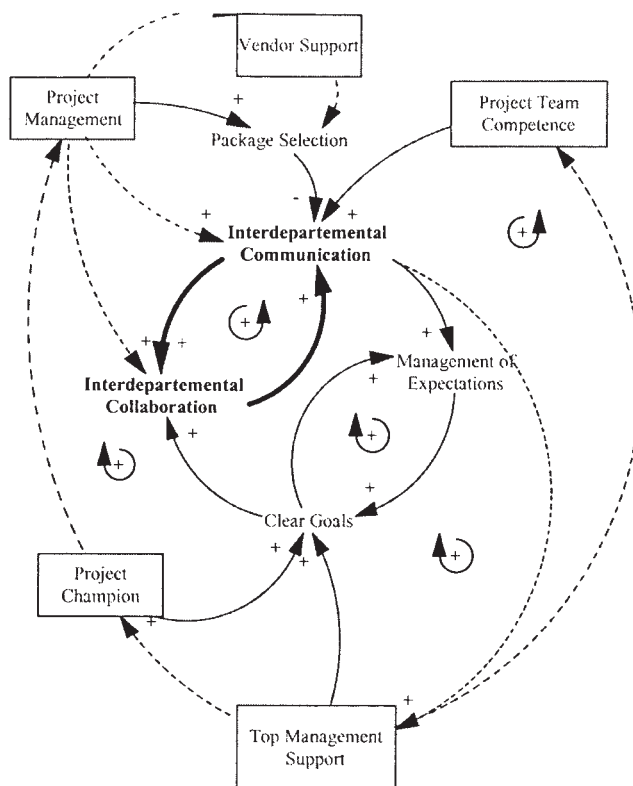


Figure 4 Counter-measures to reverse the vicious cycle into a virtuous one.

and actively involved because they now perceived the added value of the project to their business area. Something similar happened to the purchasing function, where a more knowledgeable person was delegated as project team member.

- (4) *Clear goals and objectives.* Before the project crisis, the focus of the project was on technical and organisational issues: how to solve the year 2000 issue? After the project crisis, the current processes were the basis for selecting the most appropriate ERP modules to guarantee the best support for the company targets.
- (5) *Project management.* The project started with a strong emphasis on writing an extensive and detailed project handbook, so that every party involved would know what to do, when and how. After the crisis, a more flexible approach was chosen. The overall project approach was designed and approved by senior management. To get back on track, weekly workshops with all project members were organised. During these intensive workshops, the focus was on the most pressing (business) issues and on achieving a consistent business process model, not so much on project management *per se*. (Please note that the authors see their impact as consultants best represented under this heading of style of project management.)
- (6) *Interdepartmental communication.* Initially, only the core project group was involved. Consultants were doing the bulk of the work. Due to the character of the workshops after the crisis, in which a consistent company process model was to be developed, interdepartmental communication became one of the most important activities. Open communication and lack of political behaviour characterised this period.
- (7) *Management of expectations.* Initially, the expectations of the project team and those of the external consultants were clearly misaligned. In the second phase of the project, managing expectations became an integral part of our consulting approach, both for contacts with senior management and during project team workshops. This resulted in an interconnected chain of workshops leading to a consistent business model and a well-aligned project team, which subsequently was able to conduct the ERP implementation successfully.
- (8) *Project champion.* The project started without a project champion, with only technical specialists involved. After the crisis, the management team appointed a project champion from its midst who also took care of the 'marketing' of the project to the rest of the organisation.
- (9) *Vendor support.* Initially, there was no vendor support. Later on vendor expertise was made readily available for use by team members. The process of

refining and signing-off process maps together with BAAN specialists played an important part in this. Through this, vendor support was instrumental in a smooth transfer from modelling to implementation phase.

- (10) *Careful package selection.* The selection of the ERP package itself was quickly made, because of the reputation and accumulated client experience of the BAAN company in the aviation industry. However, this selection and the ensuing discussions around what version and modules of the software to use, were based upon on technical arguments. After the crisis, the discussion evolved from a technical one into a more business process fit-driven one.

Interrelations between CSFs: the core reinforcing loop

ERP systems are meant to integrate different business functions and different organisational departments. We feel it is therefore appropriate to say that communication and collaboration across project team members from different departments, CSFs 3 and 6 of the Somers and Nelson (2001) list, are at the core of the ERP implementation process. Not only do these two CSFs go hand in hand, but they also seem to *reinforce* each other, which is an observation not just derived from this particular case, but also an empirical observation that holds for teams in general, as small group research has taught us (McGrath, 1984). That is, as the one goes up, eg the quality of the collaboration increases, then the other will increase as well as a result. People that work together more often communicate more often. Vice versa, better communication will lead to better collaboration. This is what is called in system dynamics terms a 'reinforcing loop' (Senge, 1990; Sterman, 2000). Left to its own devices, this loop will either continue to increase, in an upward spiral of ever-better performance, or become caught in a never-ending downward spiral of ever-lower performance. The former we call a virtuous cycle, the latter a vicious one.

In this particular ERP implementation, the project team was at first caught in a vicious cycle of poor inter-departmental collaboration and communication. After the project crisis, the organisation managed to reverse this process and turn this reinforcing loop into a virtuous cycle, in which it has remained up to the end of the project.

Root causes of the vicious cycle leading to the project crisis

What caused this vicious cycle of poor collaboration and communication? Again, the Somers and Nelson (2001) list is very helpful and informative. Using it as a theoretical framework, we find the following root causes, which are also visualised in Figure 3. First of all, com-

munication within the project team focused on technical issues. Indeed, there was more communication between the project team and the external consultants than internally in the pre-crisis period. These technically oriented discussions were mainly about technical issues regarding the ERP package. This is because, although the choice for the BAAN software had been made earlier on, the choice for the particular set of modules that would be most appropriate for this particular company was still pending at the time.

Why was so much time and attention dedicated to the technical issue of package selection (CSF 10)? At least partly because project management (CSF 5) had a technical orientation as well. It shared this orientation with top management (CSF 1), that stated at the start of the crisis that implementing an ERP system was 'just like assembling a new factory', ie a mechanistic challenge.

Because of the relative lack of open and non-technical communication between the project team members, expectations remained mixed and unmanaged (CSF 7). Hence, project goals and objectives did not become clear (CSF 4). This was intensified by the initially relatively hands-off attitude of top management. At the outset, the management team was not involved in the ERP discussions. Later on, of course, this attitude changed considerably (again, CSF 1).

Counter-measures to reverse the vicious cycle into a virtuous one

During the project crisis the company, and top management in particular, took several decisions that turned this whole vicious cycle around into a clear success, into a virtuous cycle. In theory, for this to happen, any of the CSFs in one of the loops needs to be changed strongly and long enough to make a sustainable change. In practice, it took several strong measures at the same time, which are indicated in Figure 4 by the dotted arrows.

First of all, top management appointed a senior manager as project champion (CSF 8). He and the CEO agreed to change the project management style into a considerably more process and organisational change oriented one. The purely technically oriented external consultants were replaced by colleagues with such a consulting style (ie the authors) and from that moment on, project team communication was much more a point of attention. 'Brown paper' workshops asked for active participation, representatives from different departments explained to each other about their respective business processes, subgroups consisting of employees of diverse backgrounds were set up.

Vendor support (CSF 9) was also more actively sought and concentrated at the same time. Technical discussions were now conducted only after the underlying business processes had been made clear and agreed upon, and often conducted in smaller group settings.

Top management was not excluded from this intensi-

fied communication, on the contrary. Two half-day workshops were conducted with the full management team of the company and this resulted in a much clearer view on the organisational complexities involved and the need for very clear goals and objectives for the project. The project champion also played an important role in this goal-setting process. Top management secured sufficient amounts of project time for the team members. It may be relevant to note that there was no need to make major changes to the project team composition: project team competence had been sufficient before the crisis as well; there was then just no environment for it to flourish in.

Discussion

In this section we reflect on our research findings. Since our observations are limited to a single case, we have to be very cautious in the presentation of our claims. Hence, we will formulate the results from our reflections in the form of *propositions*, to be tested, refuted, confirmed or refined by subsequent research. Our first two propositions reflect back on our original two research questions, propositions 3a to 3c contain additional exploratory thoughts.

Proposition 1: The list of critical success factors as compiled by Nelson and Somers (2001), and more specifically the top 10 of that list, can adequately explain both success and failure of specific ERP implementation projects.

As the previous section has illustrated, the top 10 of the list of CSFs from Table 1 suffices to explain broadly what went wrong in the particular ERP implementation investigated, and also why performance went up after the project crisis. This is not to say that there is no additional detail possible. Also, other factors from the list of 22 may be required for other cases. But, we would be surprised to see an implementation fail completely where eight out of 10 of these CSFs had high values, or an implementation be successful where only two CSFs had high values and all the others ranked low. Of course, other research designs such as surveys would be better suited to establish if this list has any *predictive, ex ante*, value for ERP implementation success. Our point here is that it certainly has analytical, *ex post*, value for understanding ERP implementation success and failure better.

Proposition 2: These critical success factors are causally linked in such a way that they reinforce each other in the same direction, hence leading to either vicious or virtuous cycles of ERP implementation performance.

The correctness of the causal loop diagram built up in Figures 2–4 cannot be ‘proven’, since it was an intuitive effort. We, the authors, case investigators and, originally, external consultants, have tried our best to reconstruct

why things evolved the way they did. The fact that a systemic perspective is second nature to us has no doubt influenced the structure of the diagram. It should therefore be seen as exploratory theory building and as a possible starting point for follow-up research. Nevertheless, a more general idea underlying this specific diagram is that all these CSFs are closely causally related and, hence, that changes in any of them will ripple through in all the others. This we feel is a more fundamental and well-established notion, which lies at the core of most systemic thinking (Checkland, 1981; Eden *et al*, 1983; Rosenhead, 1989; Senge, 1990).

Proposition 3a: The core process on any successful implementation consists of mutually reinforcing communication and collaboration between project team members from different departments and business functions.

Close and active involvement of the end users in the development of any IT system is crucial to its success (eg Mumford, 1983). This active involvement is best organised by way of a project team that includes representatives from all the different business functions affected. Intensive communication and collaboration between the representatives from the various user groups is therefore essential for any IT implementation. On top of this, in the case of ERP we are considering an enterprise-wide information system that affects most if not all business functions in their daily operations. This makes communication and collaboration by definition interdepartmental in nature. It is our observation that these two activities are (a) mutually reinforcing and (b) really lie at the core of any ERP success. A successful ERP project with mediocre to low interdepartmental communication and collaboration seems very unlikely to us, and would be a ‘black swan’ indeed (Popper, 1959).

Proposition 3b: If this core process of communication and collaboration is under-performing, it is highly likely that presence and/or attitude of several of the key stakeholders are also insufficient. These key stakeholders are (a) top management, (b) project team, (c) project management, (d) project champion, (e) package vendor.

The intent of proposition 3a is not to suggest that ERP project teams function in isolation and that their performance alone determines implementation success. Indeed, we have seen in this case that virtually the same project team with the same competence level collaborated and communicated well after the crisis, although it clearly under-performed beforehand. We ascribe this to the fact that several, if not all, of the other key stakeholders that appear as CSFs in the Nelson and Somers list were lacking either in presence (in this case, the project champion), in attitude (top management and project management) or in both (the vendor). These stakeholders indirectly or directly determine the contingencies within

which the project team has to operate and hence control its success.

The use of outside consultants by itself, factor 22 in the Somers and Nelson list, is not a clear candidate for reversing such an adverse state of affairs. In this particular case, the authors feel that, as action researchers and consultants, they have had a role in changing the project management style after the crisis. The usefulness of their role in this stage has been confirmed by the evaluation interviews conducted by independent researchers. However, in general, the positive role of extensive use of outside consultants is doubtful at best. As pointed out earlier, in the MRP II implementation literature, the use of outside consultants has been found to have a negative correlation with implementation success in one study (Burns *et al*, 1991). The changes required for successful ERP implementations are simply too pervasive to delegate to a third party. This may also explain the rock-bottom rank that this factor has received in the Somers and Nelson list.

Proposition 3c: Reversing an under-performing ERP implementation is possible by simultaneous and reinforcing changes in presence or attitudes of these stakeholders.

Our case may be unusual because it consists of two episodes that are so very different in their successfulness. From it, we can learn that it is possible to reverse a seemingly hopeless situation into a very successful one. But for this to happen it is essential that the key stakeholders mend their ways and start supporting the effort much more actively and wisely. Each of the changes described in itself may not have been enough to induce such a reversal of fortune, but collectively they certainly have been. This should be a hopeful message for other ERP projects in dire straits.

Conclusions

ERP system implementations are complex undertakings and many of them are unsuccessful. It is therefore important to find out what the critical success factors, or CSFs, are, that drive ERP project success. Recent research has given us several good candidate lists of such

CSFs. The research described here in this article has taken one such list (Somers & Nelson, 2001) and has applied the top 10 CSFs of that list to a case study of a specific ERP implementation that had been investigated by the authors at an earlier time. In this case from the aviation industry, a period of poor project performance was followed by a very successful follow-up after a crisis had made project continuation doubtful.

Case analysis shows that the Nelson and Somers framework was indeed suitable to identify and summarise root causes of success and failure. It also showed that all these CSFs were interrelated in the sense that changes in one of them influenced all the others, directly or indirectly. Moreover, they all influenced each other in the same direction, ie all positive or all negative, leading to a self-perpetuating or cycle of good or poor performance.

Because ERP systems are about integrating different business functions, interdepartmental communication and collaboration within the project team was found to be the core process for project progress. Presence and attitudes of the surrounding stakeholders, ie top management, project management, project champion and software vendor, were identified as the root causes driving performance of this core process. At the time of the crisis, simultaneous and mutually reinforcing changes in presence and attitudes of all these stakeholders enabled the transition from a vicious into a virtuous cycle of project performance. The fact that this was possible in this particular case may give hope to those ERP implementations that seem to be dead in the water in other companies.

Acknowledgements – This article has been several years in the making. Over the course of its conception we have become indebted to many people, a few of whom we would like to name here. Firstly, we would like to thank the people we had the pleasure of working with at the case company for their support and willingness to collaborate in our research effort, in particular Erick Vink, Hans Remmerswaal and Kees de Koning. We thank our research assistants Chantal Verhoof and Jeroen Kroondijk for providing an independent perspective to this research by conducting post-project interviews and analysing these. With special emphasis, we acknowledge the very helpful and insightful comments made by two anonymous reviewers and the associate editor on an earlier version of this paper, which led to a total revision of this text and—we feel—a much-improved eventual result. Earlier on, Professors Luk van Wassenhove (INSEAD) and M. Lynne Marcus (City University of Hong Kong) made discerning comments that helped our research progress.

References

- AKKERMANS HA, VAN HELDEN K and DERKS M (1998) ERP business modelling—missing link in ERP implementation. In *Operations Management. Future Issues and Competitive Responses. Proc 5th International EUROMA Conference* (COUGHLAN P, DROMGOOLE T, PEPPARD J, Eds), Dublin, June 1998, 13–19.
- AKKERMANS HA, VAN HELDEN K and HAZEBROEK L (1999) Networking teams: new rules for business process redesign projects. In *Managing Operations Networks. Proc 6th International Conference of the European Operations Management Association* (BARTEZZAGHI E, FILIPPINI R, SPINA G, VINELLI A, Eds), Venice, June 1999, Add. 9–16.
- ARGYRIS C and SCHÖN DA (1978) *Organizational Learning: A Theory of Action Perspective*. Addison Wesley, Reading, MA.
- AUSTIN RD and NOLAN RL (1998) MANAGE ERP INITIATIVES AS NEW VENTURES, NOT IT PROJECTS. *Harvard Business School Working Paper 99-024*.
- AVNET (1999) ERP not living up to promise. *Global Supply Chain* 2, 7.
- BANCROFT NH, SEIP H and SPRENGEL A (1998) *Implementing SAP R/3*. Manning Publications, Greenwich, CT.
- BEATH CA (1991) Supporting the information technology champion. *MIS Quarterly* 15, 355–372.
- BINGI P, SHARMA MK and GODLA JK (1999) Critical issues affecting

- an ERP implementation. *Information Systems Management* **16**, 7–14.
- BUCKHOUT SE, FREY J and NEMEC JR (1999) *Making ERP succeed; turning fear into promise. Strategy and Business*, 2nd quarter. Booz-Allen and Hamilton <http://www.strategy-business.com>.
- BURNS OM, TURNIPSEED D and RIGGS WE (1991) Critical success factors in manufacturing resource planning implementation. *International Journal of Operations and Production Management* **11**, 5–19.
- CHECKLAND P (1981) *Systems Thinking, Systems Practice*. Wiley, Chichester.
- CLELAND DI and KING WR (1983) *Systems Analysis and Project Management*. McGraw-Hill, New York, NY.
- DAFT RL and LEWIN AY (1990) Can organization studies begin to break out of the normal science straitjacket? An editorial essay. *Organization Science* **1**, 1–9.
- DAVENPORT T (1998) Putting the enterprise into the enterprise system. *Harvard Business Review* July–August, 121–131.
- EDEN C, JONES S and SIMS D (1983) *Messing About In Problems. An Informal Structured Approach to their Identification and Management*. Pergamon Press, Oxford.
- EISENHARDT KM (1989) Building theories from case study research. *Academy of Management Review* **14**, 532–550.
- EWUSHI-MENSAH K and PRZANYSKI ZH (1991) On information systems project abandonment: an exploratory study of organizational practices. *MIS Quarterly* **15**, 67–85.
- GALLIERS RD and LAND FF (1987) Choosing appropriate information systems research methodologies. *Communications of the ACM* **30**, 900–902.
- GILL J (1983) Research as action: an experiment in utilising the social sciences. In *The Use and Abuse of Social Science* (Heller F, Ed.), Sage, London.
- GINZBERG MJ (1981) Early diagnosis of MIS implementation failure: promising results and unanswered questions. *Management Science* **27**, 459–476.
- HOFFER JA, GEORGE JF and VALACICH JS (1998) *Modern Systems Analysis and Design* (2nd edn), Addison-Wesley, Reading MA.
- HOLLAND CP and LIGHT B (1999) A critical success factors model for ERP implementation. *IEEE Software* **16**, 30–36.
- JANSON MA and SUBRAMANIAN A (1996) Packaged software: selection and implementation policies. *INFOR* **34**, 133–151.
- JARVENPAA SL and IVES B (1991) Executive involvement and participation in the management of information technology. *MIS Quarterly* **15**, 205–227.
- KAPP KM (1998) Avoiding the HAL syndrome of ERP implementations. *APICS Magazine* **8**.
- KATZENBACH JR and SMITH DK (1993) *The Wisdom of Teams. Creating the High-Performance Organization*. Harvard Business School Press, Cambridge, MA.
- LYCETT M and PAUL RJ (1999) Information systems development: a perspective on the challenge of evolutionary complexity. *European Journal of Information Systems* **8**, 127–135.
- MACREDIE RD and SANDOM C (1999) IT-enabled change: evaluating an improvisational perspective. *European Journal of Information Systems* **8**, 247–259.
- MARBLE RP (2000) Operationalising the implementation puzzle: an argument for eclecticism in research and in practice. *European Journal of Information Systems* **9**, 132–147.
- MCAFEE AP (1998) *The Impact of Information Technology on Operational Effectiveness: an Empirical Investigation*. Harvard Business School, Cambridge, MA, Working Paper.
- MCGRATH JE (1984) *Groups: Interaction and Performance*. Prentice-Hall, Englewood Cliffs, NJ.
- MCKERSIE RB and WALTON RE (1991) Organizational Change. In *The Corporation of the 1990s: Information Technology and Organizational Transformation* (Scott Morton MS, Ed.), pp 244–277. Oxford University Press, New York.
- MILES M. and HUBERMAN AM (1984) *Qualitative Data Analysis. A Sourcebook of New Methods*. Sage, London.
- MUMFORD E (1983) *Designing Human Systems for New Technology*. Manchester Business School, Manchester.
- PITURRO M (1999) How midsize companies are buying ERP. *Journal of Accountancy* **188**, 41–48.
- POPPER K (1959). *The Logic of Scientific Discovery*. Taylor & Francis, New York and London.
- REASON P and BRADBURY H (eds) (2000) *Handbook of Action Research: Participative Inquiry and Practice*. Sage, London.
- REEL JS (1999) Critical success factors in software projects. *IEEE Software* **16** 18–23.
- RICHMOND B (1993) Systems thinking: critical thinking skills for the 1990s and beyond. *System Dynamics Review* **9**, 113–133.
- ROSENHEAD J (Ed.) (1989) *Rational Analysis for a Problematic World. Problem Structuring Methods for Complexity, Uncertainty and Conflict*. Wiley, Chichester.
- RYAN HW (1999) Managing development in the era of large complex systems. *Information Systems Management* **16**, 89–91
- SCHWALBE K (2000) *Information Technology Project Management*, Course Technology, Cambridge MA.
- SENGE (1990) *The Fifth Discipline. The Art and Practice of the Learning Organization*. Doubleday Currency, New York.
- SLEVIN DP and PINTO JK (1986) Balancing strategy and tactics in project implementation. *Sloan Management Review* **29**, 33–41.
- SLEVIN DP and PINTO JK (1987) The project implementation profile: new tool for project managers. *Project Management Journal* **17**, 57–70.
- SOLIMAN F and YOUSSEF MA (1998) The role of SAP software in business process reengineering. *International Journal of Production and Operations Management* **19**, 886–895.
- SOMERS TM and NELSON K (2001) The impact of critical success factors across the stages of enterprise resource planning implementations. *Proceedings of the 34th Hawaii International Conference on Systems Sciences (HICSS-3)*, January 3–6 Maui, Hawaii (CD-ROM).
- STEFANOU C (1999) Supply chain management and organizational key factors for successful implementation of enterprise resource planning (ERP) systems. *Proceedings of the Americas Conference on Information Systems*, Milwaukee, WI 800–802.
- STERMAN JS (2000) *Business Dynamics. Systems Thinking and Modeling for a Complex World*. McGraw-Hill, New York.
- SUMNER M (1999) Critical success factors in enterprise wide information management systems. *Proceedings of the Americas Conference on Information Systems*, Milwaukee WI 232–234.
- THONG JYL, YAP CS and RAMAN KS (1994) Engagement of external expertise in information systems implementation. *Journal of Management Information Systems* **11**, 209–231.
- UPTON DM and MCAFEE AP (1997) A path-based approach to information technology in manufacturing. *Harvard Business School Working Paper 97-094*.
- WILCOCKS LP and SYKES R (2000) The role of the CIO and IT function in ERP. *Communications of the ACM* **43**, 33–38.
- YIN RK (1989) *Case Study Research: Design and Methods*. Sage, London.

About the authors

Henk Akkermans is an assistant professor at the Department of Technology Management of Eindhoven University of Technology in The Netherlands and one of the founder/owners of Minase, a consulting group aimed at facilitating development of inter- and intra-organisational networks. Henk Akkermans's current research interests regard the development of such networks, in particular from an operations management perspective. He has published in academic journals on a variety of operations management, strategy and ICT-related subjects.

Kees van Helden was born in 1962 in Rotterdam, The Netherlands. For several years he has worked for different companies as a senior management consultant, focusing on business process modelling, performance improvement and change management. In 2000 he founded his own consultancy firm A-DéCoM Consulting BV. Change management, with an emphasis on cultural and communication aspects as prerequisites for effective change, is the driving force here.