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Vicious and Virtuous Cycles in ERP Implementation – A Case Study of Interrelations between Critical Success Factors

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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 (Nelson and Somers 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, i.e. 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.

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 (White et al. 1997, Davenport 1998, Avnet 1999, Buckhout et al. 1999).

Over the past two years, a considerable amount of research has been conducted into critical success factors, or CSFs, for ERP implementations (e.g. Holland and Light 1999, Sumner 1999, Willcocks and 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. We now even have available a ranked version of such a list, based upon a survey amongst managers of organisations that have recently gone through an ERP implementation process (Somers and 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 CSFs also

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

This article describes an exploratory research effort 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 critical success factors 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 (c.f. Senge 1990, Sterman 2000).

Critical Success Factors for ERP Implementations

In a recent article by Toni Somers and Klara Nelson (Somers and 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 on the general literature on IT implementation, BPR (Business Process Reengineering) and project management. This list was then ranked by 52 senior managers. This group consisted mainly of CIOs (Chief Information Officer), MIS (Management Information Systems) managers, directors, vice-presidents (VPs) or executive vice-presidents (EVPs). The companies involved were U.S. firms that had completed their ERP implementation either last year of longer ago. Table 1 shows the resulting ranked list.

Table 1: Mean rankings of CSFs by degree of importance in ERP implementation, adapted from Somers and Nelson (2001).

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

*: Italicised CSFs used in subsequent analysis

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 arbitrarily,

but worked out well in our analyses, as will become apparent later on. Strongly influenced by the excellent 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 a 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 and Pinto 1986, Bingi et al. 1999). This is probably true for most implementations of innovations into organisations (Jarvenpaa and 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 and Walton 1991). But, if top management permanently delegates its responsibilities to technical experts, the chances for project failure are high (Ewushi-Mensah and 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 it appeared as low as #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 was found 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 and King 1983 Slevin and 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 and Nolan 1998) and the suggestion of Austin and McAfee to employ a path-based approach to ERP implementation (Upton and McAfee 1997). On a more methodological level, this viewpoint is in line with the concept of IS development as one of evolutionary complexity (Lycett and Paul 1999)
5. *Project management.* The complexity of ERP 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 and Youssef 1998, p.890). This approach is often taken in textbook on IT project management (e.g. Hoffer et al 1998). However, as organisations and project evolve over time, so should project management priorities. Some degree of improvisation (Macredie and Sandom 1999) may need to be part of the skill set of ERP project managers as well.
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 and 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 and 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 and Sykes 2000).
9. *Vendor Support.*A project as all-pervasive as an ERP implementation can not 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 and Subramanian 1996, Willcocks and 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 still to decide what versions or modules of the package would best fit the organisation. (Piturro 1999). In short, if the wrong choices are made, and these 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 and 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 Nelson and Somers (2001) in a specific case but also to extend it into a richer framework, i.e. 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 (Yin 1989, Eisenhardt 1989). As a research method, case studies, and certainly single ones, score low on generalisability of findings. But on the other hand, their richness of data lends itself 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).

Theory-driven case selection

In order to learn more about CSFs in ERP implementation, we 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 to us, 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). But in this particular instance, we could suffice with a case with 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 could the Somers and Nelson CSFs be interrelated causally?*

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

Case data collection and analysis

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 two 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 life. Our analysis of the findings from these interviews was published shortly afterwards (Akkermans et al. 1998). Almost one 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).

For the purpose of the research for the current article, we have used the basic material as well as our own recollections of the period during and immediately after

the crisis, when we both were working at the ERP project ourselves. We have triangulated our inductive efforts wherever possible with data from our interview rounds.

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 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 two-and-a-half 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 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 focussed 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.

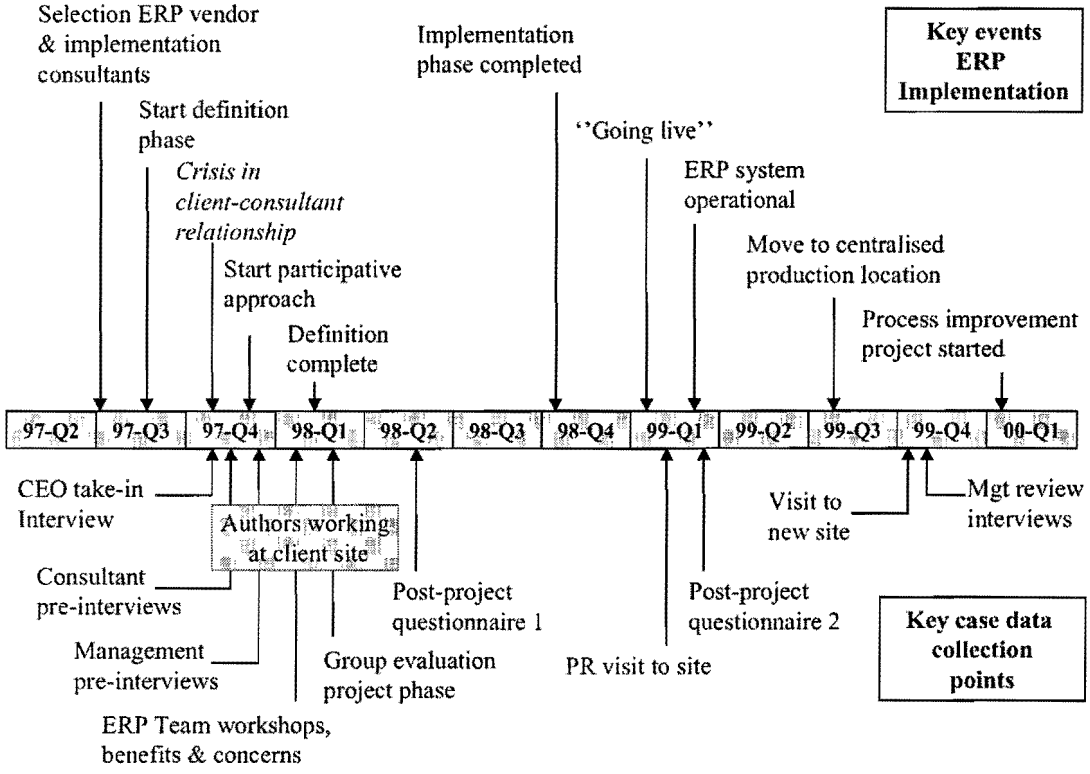

Figure 1: Timeline for key events in ERP implementation and in case data collection

Project crisis

Unfortunately, this approach had 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 lack of collaboration with project team members. These in turn complained of lack of industry expertise and leadership with the external consultants. The CEO, one of whose former jobs had been overseeing the turnkey installation of entire factories, complained of a lack of professionalism to his counterpart. This person in turn, the account manager with the implementation partner, complained about 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 could also serve 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 with senior and middle management to find out what the most pressing issues were going forward. Next came 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 hang 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 had been 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 were the project team members who performed this mapping, after some initial training in the notation method. The consultants operated as facilitators and took care of the computerised tool that could identify 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 because decisions on such debated issues would probably not be taken by the project team but by senior management. Senior management, i.e. the CEO and his management team (MT) of functional managers, agreed to participate in a workshop 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, two 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 three months. It yielded the business processes that could be 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 fifty at some stage. Obviously, more lower-level employees were involved. What was interesting to observe in this stage is that the fifteen 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 now very ambitious October 1998 deadline of the project was met fairly well, and so was its 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 routing and layout. The structure of the manufacturing organisation was changed considerably and a new group of managers was 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, one 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. Moreover, we have tried to distil a causal theory of how these CSFs interrelated for this particular ERP implementation. For this we have used the mapping technique of causal loop diagramming, or CLD (c.f. Senge 1990, Sterman 2000). Figure 2 illustrates what we feel is the core CSF process; Figure 3 shows the root causes for the project crisis that developed and Figure 4 contains a CLD of the counter-measures that was 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'. 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 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 organizational issues: How to solve the Year 2000 issue? Later on, 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 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 over-all project approach was designed and approved by senior management. To get back on track, weekly workshops with all project members have been organized. 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.
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 the approach 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 an 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 a technical specialist 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, the knowledge of the vendor 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 used, was 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 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, e.g. 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.

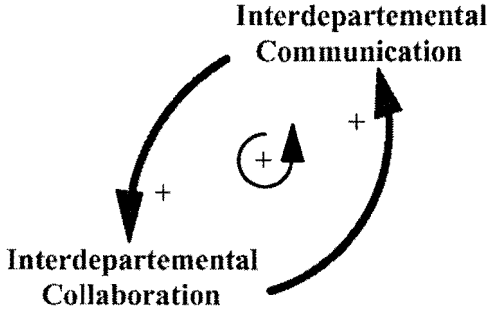

Figure 2: The core reinforcing loop in the ERP integration effort: mutually reinforcing interdepartmental communication and collaboration

In this particular ERP implementation, the project team was at first caught in a vicious cycle of poor interdepartmental 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, communication within the project team focussed 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 around 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.

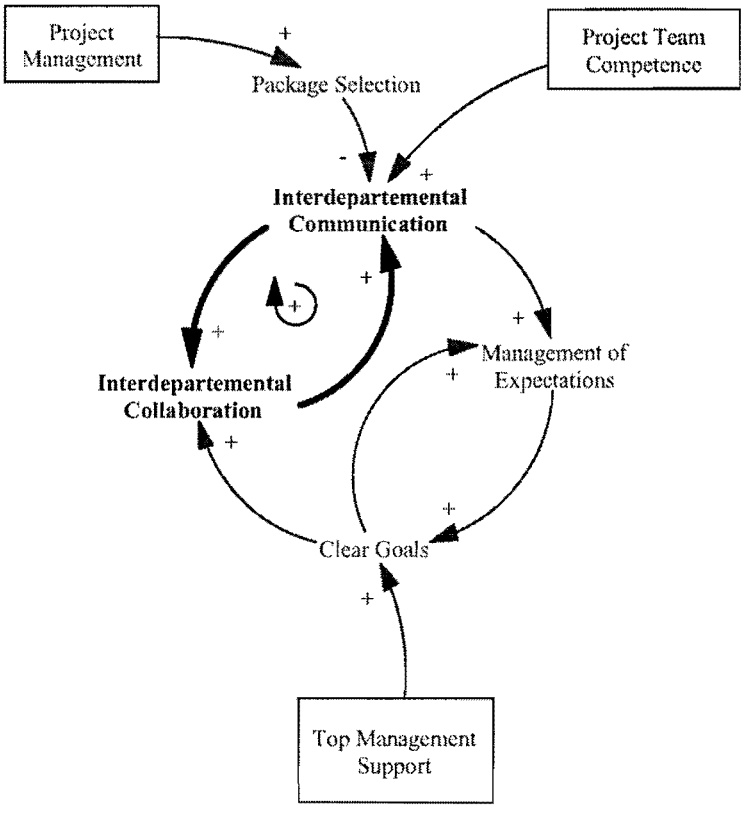

Figure 3: Root causes of the vicious cycle leading to the project crisis

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", i.e. 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 could 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 (i.e. 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 were explaining 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.

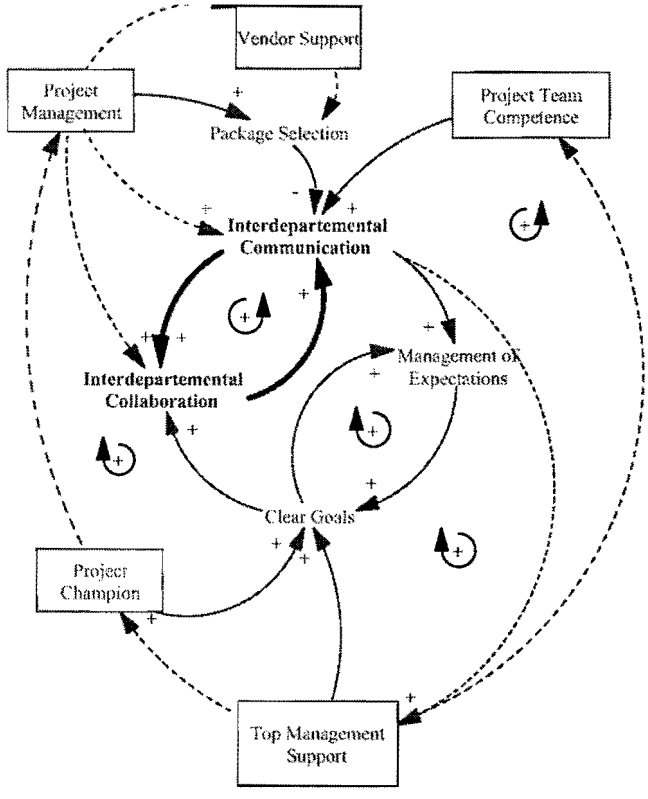

Figure 4: Counter-measures to reverse the vicious cycle into a virtuous one

Top management was not excluded from this intensified 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 also 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 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 ten 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 21 may be required for other cases. But, we would be surprised to see an implementation fail completely where eight out of ten 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 cycle s of ERP implementation performance.*

The correctness of the causal loop diagram built up in Figures 2-4 can not be "proven", since it was an intuitive effort. We, the authors, case investigators and, originally, the 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 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 (e.g. 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 inter-departmental 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 key the 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 fine 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.

***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.

Conclusion

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 (Nelson and Somers 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, i.e. 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, i.e. 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.

References

AKKERMANS HA, VAN HELDEN K, DERKS M (1998) ERP Business Modelling — Missing Link In ERP Implementation. In: P Coughlan, T Dromgoole, J Peppard (eds.) *Operations Management. Future Issues and Competitive Responses. Proceedings 5th International EUROMA Conference,* Dublin, June 1998, 13-19.

AKKERMANS HA, VAN HELDEN K AND HAZEBROEK L (1999) Networking Teams: New Rules for Business Process Redesign Projects. In: Bartezzaghi E, Filippini R, Spina G, Vinelli A (eds): *Managing Operations Networks. Proceedings 6th International Conference of the European Operations Management Association*, Venice, June 1999, Add. 9-16.

ARGYRIS, C, 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** (1), 7.

BANCROFT NH (1996) *Implementing SAP R/3.* Manning Publications, Greenwich CT.

BEATH CA (1991) Supporting the Information Technology Champion. *MIS Quarterly* **15(3)**, 355-372.

BINGI P, SHARMA MK and GODLA JK (1999) Critical Issues Affecting an ERP Implementation. *Information Systems Management* **16(3)** pp. -14

BUCKHOUT SE FREY and J NEMEC JR (1999) Making ERP Succeed; Turning Fear into Promise. *Strategy and Business* 2nd Quarter Booz-Allen and Hamilton.

BURNS OM, TURNIPSEED D, RIGGS WE (1991) Critical success factors in Manufacturing Resource Planning Implementation, *International Journal of Operations and Production Management* **11**(4), 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.

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*, Vol. 14 Nr. 4, 532-550.

EWUSHI-MENSAH K and PRZANYSKI ZH (1991) On Information Systems Project Abandonment: An Exploratory Study of Organizational Practices. *MIS Quarterly* **15(1)** 67-85.

GINZBERG MJ (1981) Early Diagnosis of MIS Implementation Failure: Promising Results and Unanswered Questions. *Management Science* **27(4)**, 459-476.

HOFFER JA, GEORGE JF and VALACICH JS (1998) *Modern Systems Analysis and Design* (2nd Ed.), Addison-Wesley, Reading MA.

HOLLAND CP and LIGHT B (1999) A Critical Success Factors Model for ERP Implementation. *IEEE Software* **16(3)** 30-36

JANSON MA and SUBRAMANIAN A (1996) Packaged Software: Selection and Implementation Policies. *INFOR* **34(2)**, 133-151.

JARVENPAA SL and IVES B (1991) Executive Involvement and Participation in the Management of Information Technology. *MIS Quarterly* **15(2)**, 205-227.

KAPP KM (1998) Avoiding the HAL Syndrome of ERP Implementations. *APICS Magazine* **8(6)**.

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(2)**, 127-135.

MACREDIE RD and SANDOM C (1999) IT-Enbled Change: Evaluating an Improvisational Perspective. *European Journal of Information Systems* **8(4)**, 247-259.

MARBLE RP (2000) Operationalising the Implementation Puzzle: An Argument for Eclecticism in Research and in Practice. *European Journal of Information Systems* **9(3)**, 132-147.

MCAFEE AP (1998) *The Impact of Information Technology on Operational Effectiveness: an Empirical Investigation.* Harvard Business School, Cambridge, Massachusetts, Working Paper.

MCGRATH JE (1984) *Groups: Interaction and Performance.* Prentice-Hall, Englewood Cliffs NJ.

MCKERSIE RB and WALTON RE (1991) Organizational Change. In: Scott Morton MS (ed.) *The Corporation of the 1990s: Information Technology and Organizational Transformation.* Oxford University Press, New York 244-277.

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(3)**, 41-48.

POPPER K (1959). *The logic of scientific discovery.* Taylor & Francis, New York and London.

REEL JS (1999) Critical Success Factors in Software Projects. *IEEE Software* **16(3)** 18-23.

RICHMOND, B (1993) Systems Thinking: Critical Thinking Skills For the 1990s and Beyond. *System Dynamics Review* **9(2)** 113-133.

Rosenhead J (1989) (ed.) *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(2)**, 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(1)** 33-41.

SLEVIN DP and PINTO JK (1987) The Project Implementation Profile: New Tool for Project Managers. *Project Management Journal* **17(4)** 57-70.

SOLIMAN, F, YOUSSEF, MA (1998) The role of SAP software in business process reengineering *International Journal of Production and Operations Management* 19(9/10), 886-895.

SOMERS TM and NELSON K (2001) The Impact of Critical Success Factors across the Stages of Enterprise Resource Planning Implementations. *Proceedigns 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(2)** 209-231.

UPTON, DM, MCAFEE, AP (1997) A path-based approach to information technology in manufacturing. *Harvard Business School Working Paper 97-094.*

WILLCOCKS LP and SYKES R (2000) The Role of the CIO and IT Function in ERP. *Communications of the ACM* **43(4)**, 33-38

YIN RK (1989) *Case Study Research: Design and Methods.* Sage, London.