

Implementing ERP Systems in China

Report on a Questionnaire Survey

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1 Introduction

Introducing ERP systems to the China market represents a major challenge. First of all, the Chinese corporate landscape is still characterized by the dominance of large structures which have been set up during the period of a centrally planned economy, albeit dotted with newly founded or transformed privately-held Chinese companies and foreign invested firms. In addition, all these organizations are in a state of transformation (including foreign invested companies) which leaves few certainties to build upon.

ERP systems have often been touted as a management philosophy rather than a piece of software. If this is true, it can be expected that introducing ERP systems to the China market poses unique opportunities as well as unique risks. ERP systems might prove to be the vehicle for successfully transforming corporate structures and governance or they might turn out to be incompatible with existing structures and forms of governance.

However, posing the question like this implies a static framework: the characteristics of the systems are either sufficient to enable corporate transformation or they are not. In contrast, our main claim is that the way of introducing the systems into companies might well make the crucial difference between successful organizational transformation and an abandoned project. In order to substantiate this claim and to provide practical hints and handles on how to improve the implementation process, we have conducted a survey of companies which have implemented or were in the process of implementing one specific ERP system, namely SAP's R/3 system. By this method, it is possible to eliminate any 'variation' in the data stemming from differences in implemented systems. Thus, all differences found in the data regarding the outcomes of the implementation projects must be due to either the specific context of the implementation project (including organizational factors such as organization structure, type of operational processes and industry) or to the implementation process itself.

The questionnaire survey was conducted in the period March 1 - May 31 2000. In addition, several case studies have been conducted, two of which have provided sufficient material to write full-fledged Business Cases. Apart from writing Business Cases, these case studies also served as a necessary means to develop the questionnaire and to provide in-depth insights when interpreting the findings of the survey.

The study has been financially and morally supported by SAP Greater China. Specifically, SAP has provided the necessary funds to send out the questionnaires, conduct case studies, and do all administrative work related to the survey (the survey method is described in section 6.1). Moreover, SAP has provided us with their customer list which was an indispensable prerequisite of this study.

The report is structured as follows. First, we describe the implementation projects of the surveyed companies in general terms, i.e. without further analysis of possible causes for specific project results or implementation characteristics (section 2). This section also includes a brief characterization of the sampled firms. In section 3 we analyze the relationship between project characteristics (including both the implementation process and the project outcome) and the

context of the companies implementing the system. This analysis is in itself useful as it provides some hints as to how to improve implementation projects. However, it is also a necessary requirement for doing the next analytical step, namely analyzing the relationships between implementation process characteristics and project outcomes, which is provided in section 4. This section also includes a schematic model of the analysis involving both relationships between project characteristics and context factors as well as relationships between implementation process variables and project outcomes. Here, we only want to emphasize that both types of analyses need to be integrated in order to draw some conclusions about possible causal effects of implementation process characteristics on implementation outcomes. Only if we can be reasonably sure of this type of cause-and-effect relationship between process and outcome variables can we infer how to improve the result of implementation projects by changing the implementation process, which is the ultimate goal of this study.

2 General characteristics of implementation projects

2.1 Ownership, industry, size, and respondents

Most companies in our sample are manufacturing firms (see Figure 1). On average, they employ about 2800 employees, have revenues of 3.8 billion RMB, and are profitable for three and a half years during the past five years (see Table 1). On average, 61% of equity is held by foreign entities (see Figure 2). In 57% of all cases, at least 51% of the firms' equity capital is owned by a foreign entity. 39% of respondents have the legal form of a holding company and another 40% are independent firms (see Figure 3).

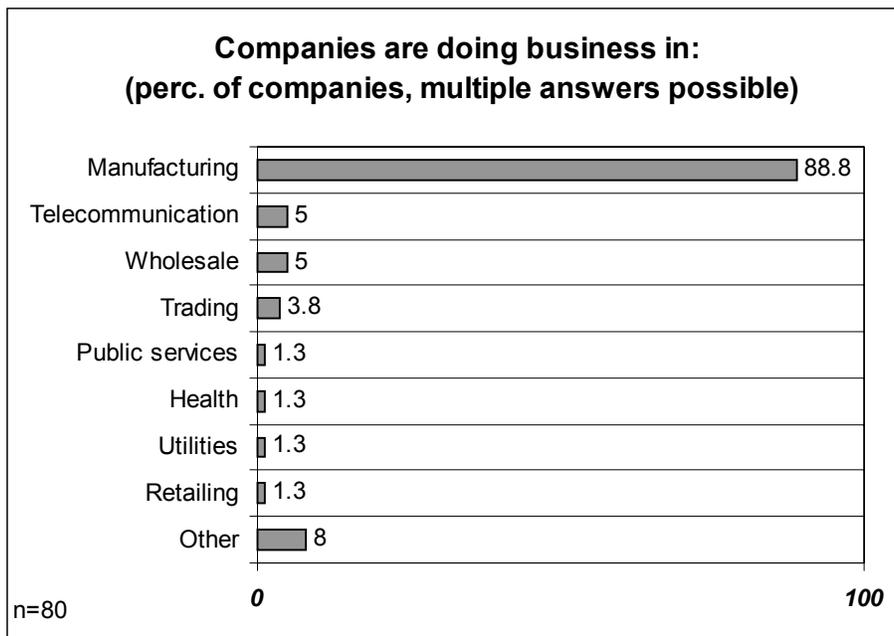


Figure 1: Distribution of industries

Table 1: Company size and profitability

| | Mean | Min | Max | No. of obs. |
|--------------------|------|-----|-------|-------------|
| Revenue (in mill.) | 3847 | 65 | 40500 | 58 |
| Employees | 2786 | 30 | 31600 | 63 |
| Profitable years* | 3.6 | 0 | 5 | 50 |

* Maximum number of profitable years had been restricted to five

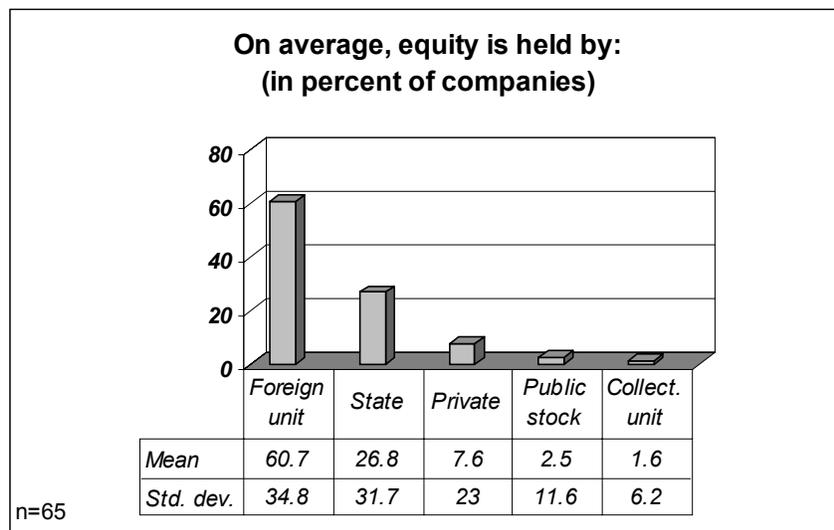


Figure 2: Ownership structure

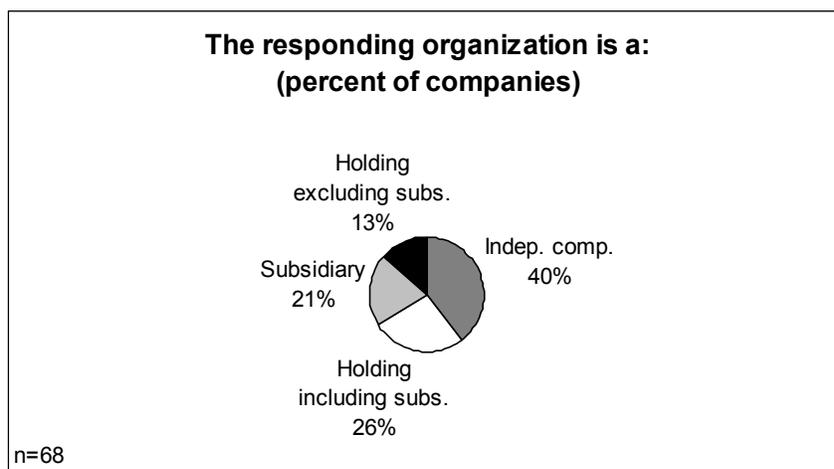


Figure 3: Organizational form of respondents

The company representatives who answered our questionnaire were project managers with responsibility for at least some phases of the whole implementation project in 80% of all cases. Only 3% of the respondents had been newly assigned to the implementation project as project managers (see Figure 4).

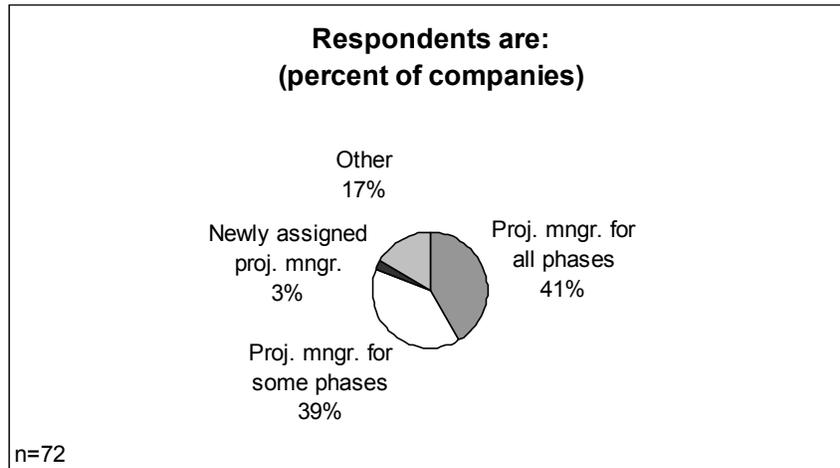


Figure 4: Characteristics of respondents

2.2 Extent of prior business process automation

As an indicator of general IT activity in surveyed firms, we asked for the relative size of IT budgets. Most firms are characterized by IT budgets sizes corresponding to less than 1% of revenues. However, 12% of companies report that their IT budgets exceed 4% of revenues (see Figure 5).

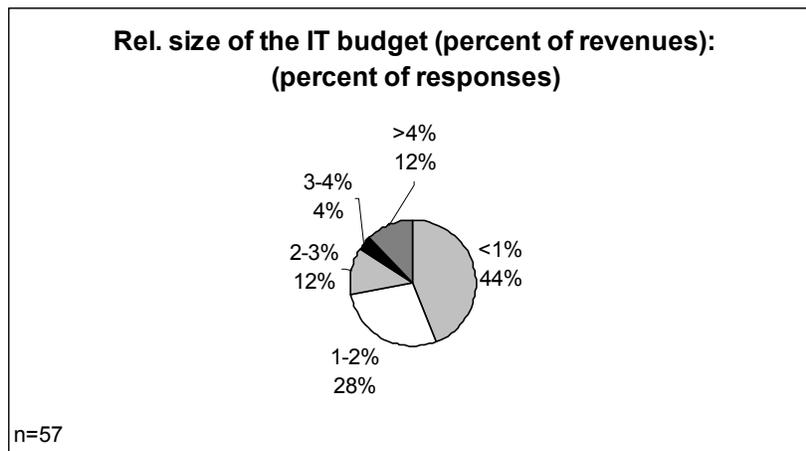


Figure 5: Relative size of the IT budget

Among the 58 firms which revealed information about their existing information systems (i.e. those systems which existed before the R/3 implementation project), 17% had information systems supporting all eight functions mentioned in the questionnaire (finance, cost control, purchasing, inventory management, production planning, production control, sales and distribution and human resources) and 7% had no such information systems prior to the R/3 implementation project. On average, roughly four functions had been supported by information systems.

Among the several functions included in our questionnaire, most firms did have an automated finance system prior to the implementation project. Production control had been supported by a computerized information system in the fewest cases (see Figure 6).

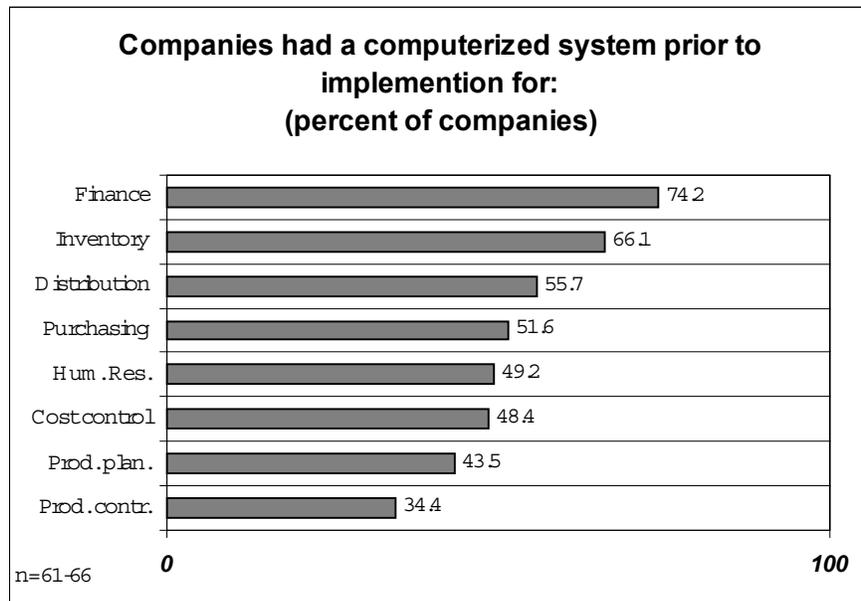


Figure 6: Prior extent of business process automation

2.3 Initiation of implementation project

The R/3 implementation project had been initiated by the CEO in most of the cases (65%). In roughly a third of the cases, a functional department or the IT department (also) took the initiative to implement an R/3 system. Only in one case has the project (also) been initiated by an important customer indicating that inter-company linking of information systems and thus B-to-B e-commerce is currently not an important reason for firms to implement an ERP system.

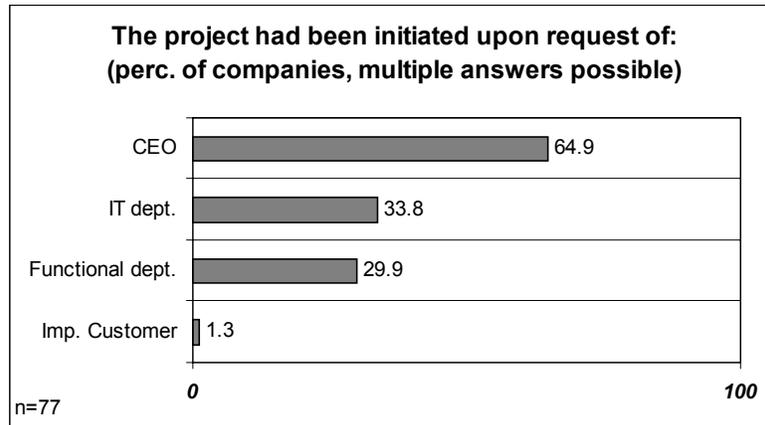


Figure 7: Initiation of project

2.4 Implementation scope and strategy

With regard to the scope of the implementation project, the FI/CO and the MM/SD modules have been most widely implemented among the firms participating in the survey (both 95%). The production planning module has been implemented in 75% of all cases and the human resources module in 5%.

Companies were roughly equally split between a phased (52%) and a Big Bang (48%) implementation strategy. Regarding the succession of modules, most companies started with finance (see Figure 8).

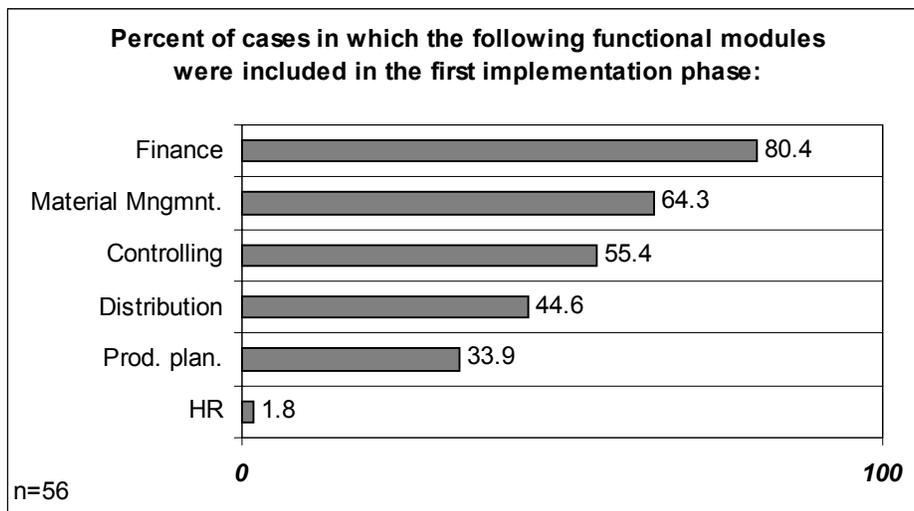


Figure 8: Phasing of modules

2.5 Implementation conflict

We have asked whether or not specific cross-functional issues existed due to the implementation scope and in if so, to what extent cross-functional implementation conflicts emerged during the implementation project. Figure 9 shows that, on average, some cross-functional implementation conflicts occurred between all functional departments involved in the implementation project. There are no marked differences between the several cross-functional relationships with regard to implementation conflict. Statistically, only the first (Sales and Finance) and the last (Purchasing and Inventory) are discernible ($p=.03$).¹

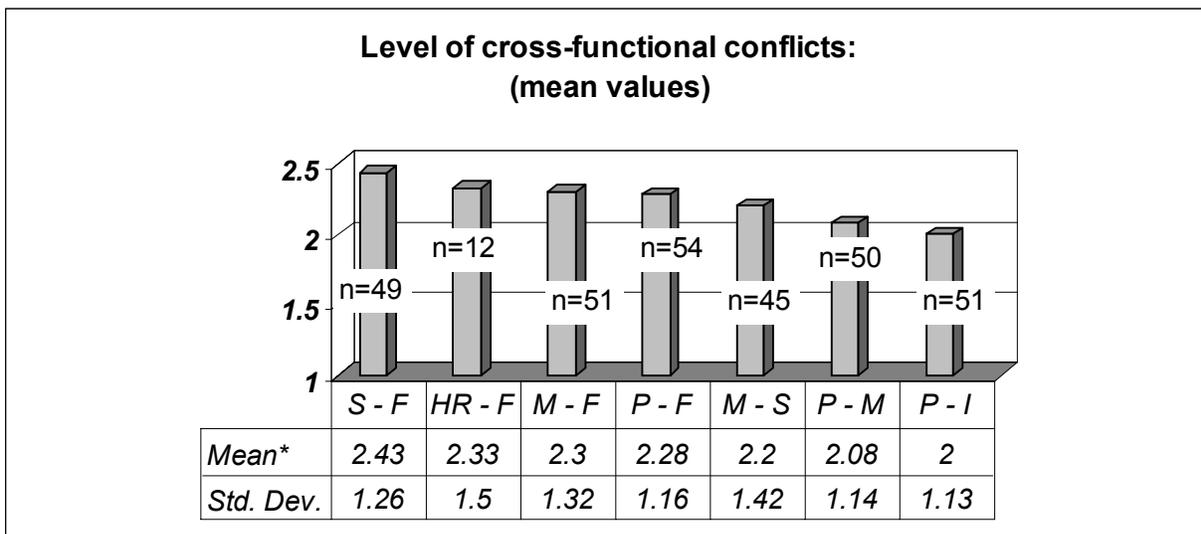


Figure 9: Cross-functional conflicts during implementation

Legend:

S: Sales; F: Finance; M: Manufacturing; P: Purchasing; I: Inventory Management

* Scale: 1: no conflicts emerged; 2: minor conflicts emerged during the implementation phase which, however, were quickly settled by the project team; 3: major conflicts emerged during the implementation phase which could, however, be resolved by the project team; 4: major conflicts emerged during the implementation phase which had to be resolved by the steering committee; (5) major conflicts emerged during the implementation phase which have not yet been resolved

In addition, only the level of conflict between sales and finance can be, on average, considered as non-minor as only this type of conflict is significantly different from level 2 of conflict ($p=.02$).

2.6 Motives for implementing the system

The reasons for implementing the R/3 system were predominantly to improve management controls, as reported in Figure 10. Other important reasons were standardization of processes and enabling of future growth. Less important reasons were improved internal logistical processes, adaptation of processes to international best practice, and increased flexibility. Of minor importance were improved services and creation of new services. However, statistically the

¹ The expression ‘statistically discernible’ is equivalent to the expression ‘statistically significant’.

differences reported in Figure 10 cannot all be discerned. Whereas the motive of improving management controls can be statistically separated in importance from all other motives, the subsequent motives cannot be separated when comparing adjacent reasons but only when skipping one or two motives (e.g., the motive of standardizing business processes cannot be statistically distinguished from that of enabling future growth but from improving logistical processes). These differences are indicated by arrows in Figure 10.

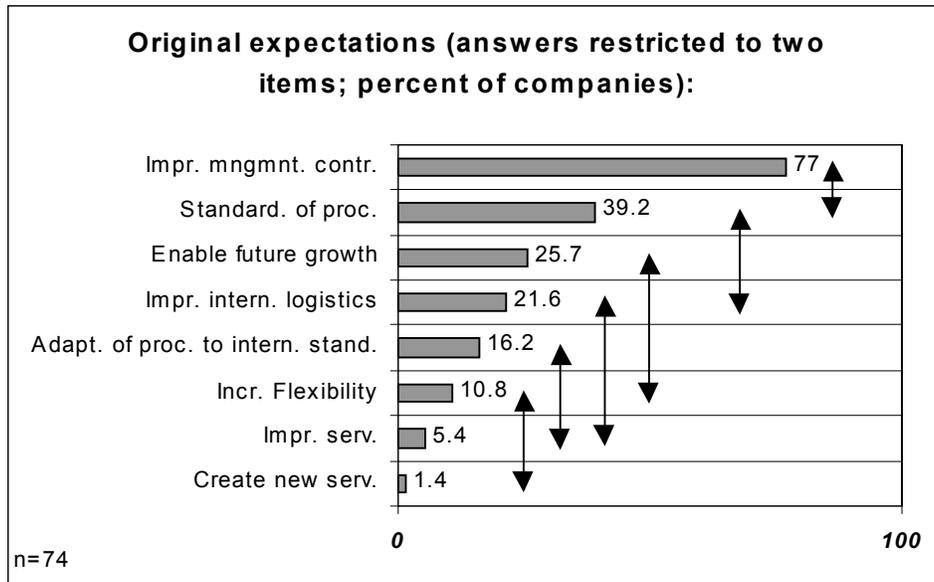


Figure 10: Motives for implementing the ERP system

2.7 Implementation process characteristics

End users have been trained, on average, for 2.8 weeks whereas key users received training for 5.7 weeks on average. The extent of time for parallel systems operations, time for stabilizing the system after cut-over, on-site support by consultants after cut-over, and hotline support after cut-over are all given in Table 2. We think that specifically the time for parallel system operation after cut-over of, on average, 3.3 months merits special mentioning since parallel system operation can create enormous problems of its own (since users have to maintain two systems, the new system might not be used as is necessary for smooth operations thus undermining the legitimacy the system may have enjoyed throughout the organization during implementation). Moreover, in 65% of cases companies opted to operate parallel systems after cut-over. In 75% of cases, companies offered a hotline to users after cut-over.

Table 2: Process characteristics

| | Mean | Std. dev. | No. of obs. |
|--------------------------------------|------|-----------|-------------|
| End user training (weeks) | 2.8 | 2.4 | 58 |
| Key user training (weeks) | 5.7 | 4.7 | 59 |
| Parallel system oper.(months) | 3.3 | 2.6 | 36 |
| Time for stabil. The system (weeks) | 7.5 | 8.2 | 58 |
| Post cut-over supp. by cons.(months) | 2.4 | 3.8 | 61 |
| Hotline after cut-over (months) | 5.6 | 4.5 | 35 |

Users are mostly trained during the testing phase or just before cut-over. However, in 21% of cases users are also trained during the design phase indicating the intention of actively involving users in the design or installation/configuration of the system (see Figure 11).

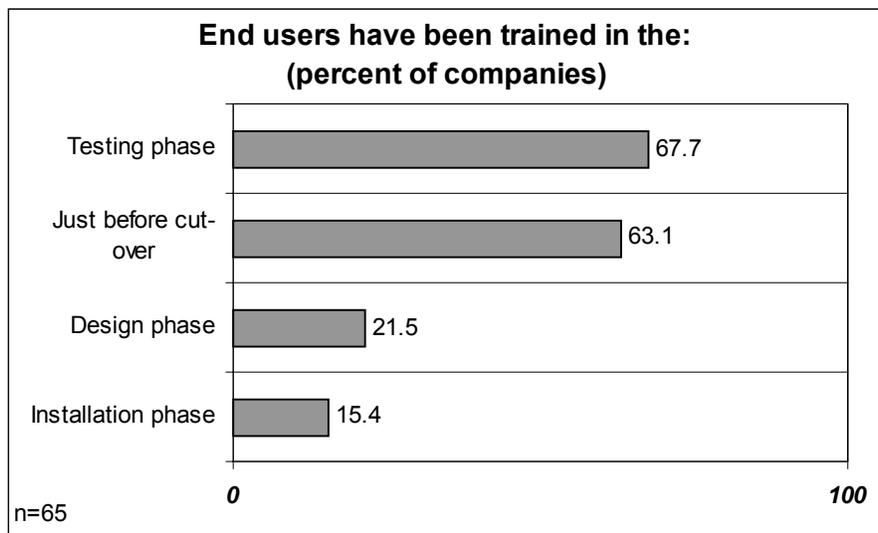


Figure 11: Time of end user training

2.8 User motivation and top management involvement

Most often, companies promised innovation rewards to users for useful proposals to motivate users to contribute to the successful implementation. An explicit promise of promotion upon successful project completion for managers was used in only 6% of cases (see Figure 12).

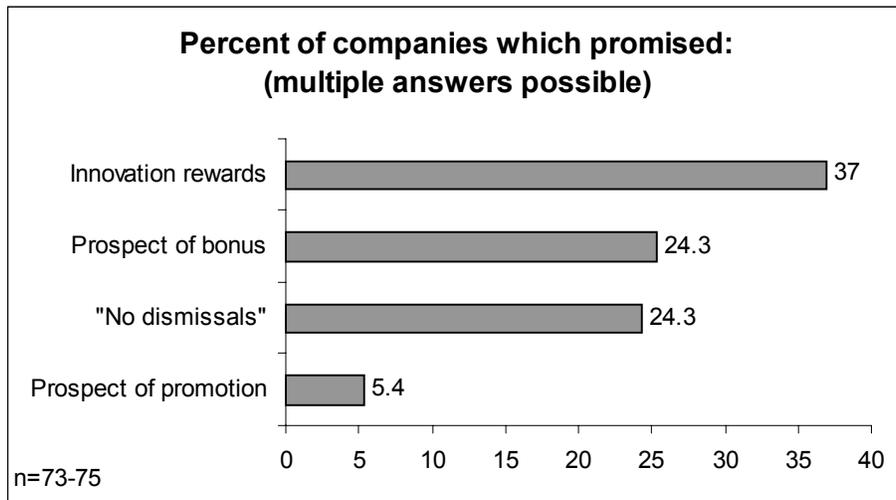


Figure 12: Motivation instruments

In 87% of cases (n=73), senior managers participated in the implementation project. On average, participating senior managers devoted 21% of their working time to the project (n=56).

2.9 External consultants

We asked respondents about the experience and focus of external consultants. On average, the answers suggest that companies are not very satisfied with external consultants (see Figure 13). Comparing the two measures, it seems worrying that many consultants are exclusively focused on software rather than business processes (indicated by a value of just above 5 on a scale of 10), whereas the experience of consultants is significantly above that level.

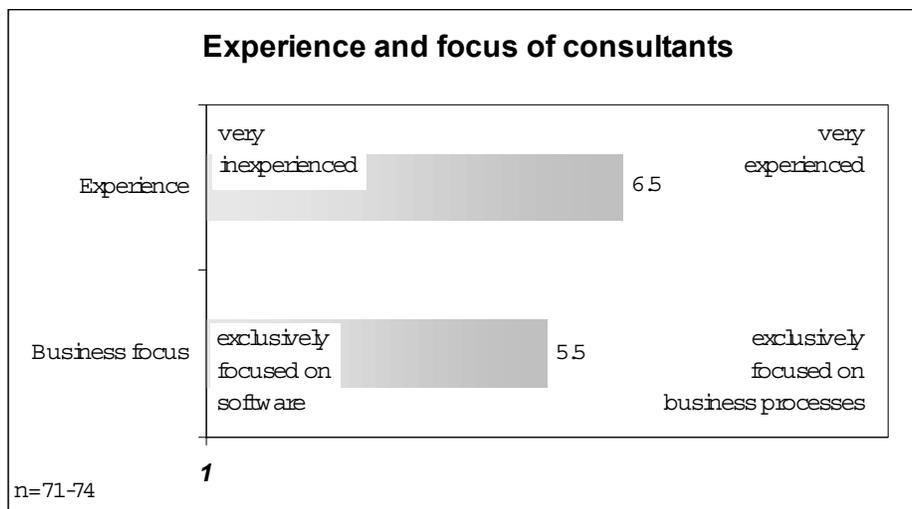


Figure 13: External consultants

2.10 Steering committee

In most cases, one of the two main functions of the steering committee was to make crucial implementation decisions. Approving crucial implementation decisions made by the steering committee, however, was also often mentioned as one of the steering committee's two main functions (see Figure 14).

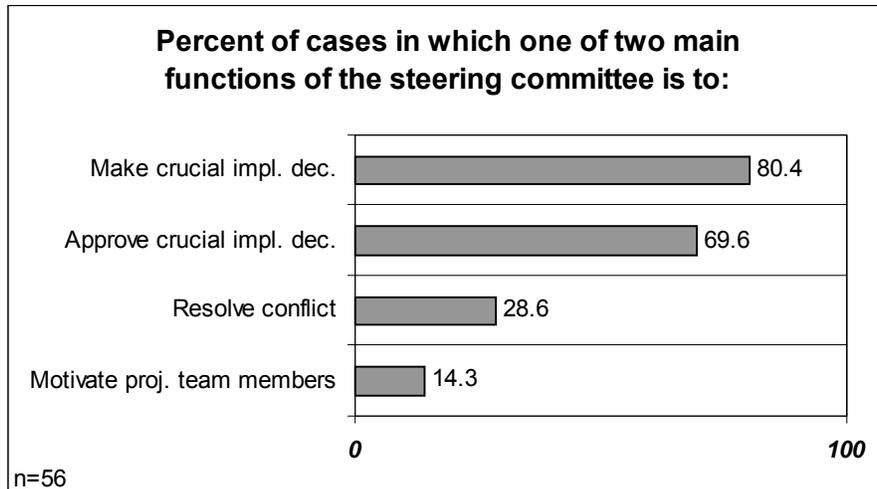


Figure 14: Role of steering committee

Decision making in the steering committee was generally based on the seniority principle. Majority voting and a consensus decision making process were used significantly less frequently (see Figure 15). These two characteristics (role and decision making style of the steering committee) turn out to be important factors in influencing project outcomes (see section 4).

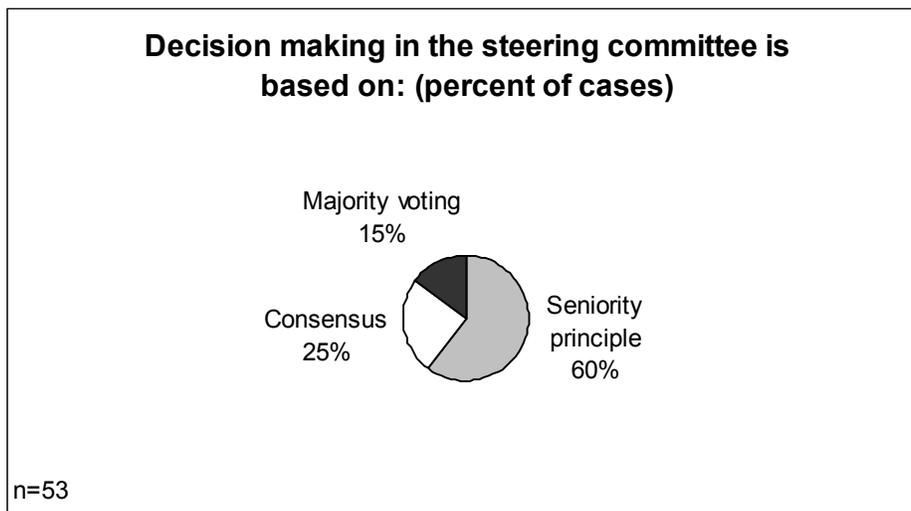


Figure 15: Decision making style of steering committee

2.11 Extent of management satisfaction with project outcomes

Of the 61 firms which answered the question about the degree of overall management satisfaction with project results, roughly two thirds reported that original expectations had been met while in one third of the cases project results were below original expectations although some improvements have still been realized (see Figure 16).

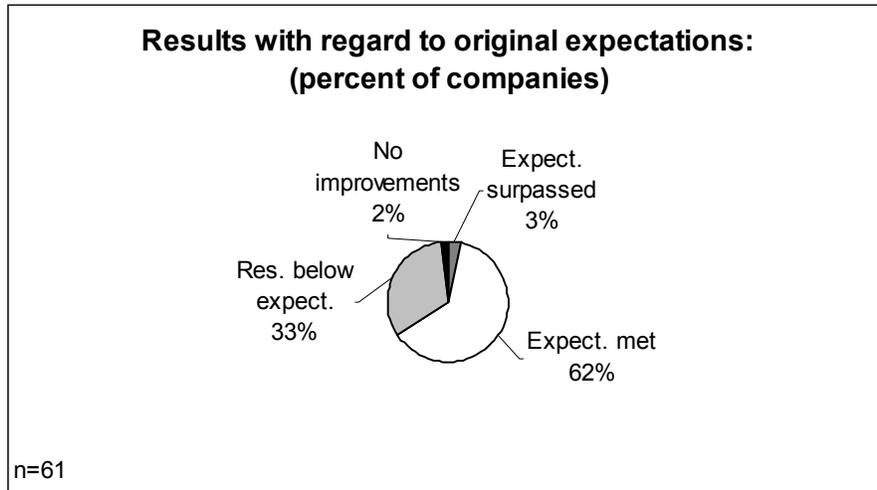


Figure 16: Management satisfaction with project results

2.12 Extent of resulting business process automation

Among the 52 firms which had completed (part of) the implementation project, roughly 50% had automated at least nine of the 16 business processes mentioned in the questionnaire as a result of the implementation project (the average value of automated business processes is 7). Among the processes automated, overhead costing and invoice verification ranks first and sales planning (surprisingly) last (see Figure 17).

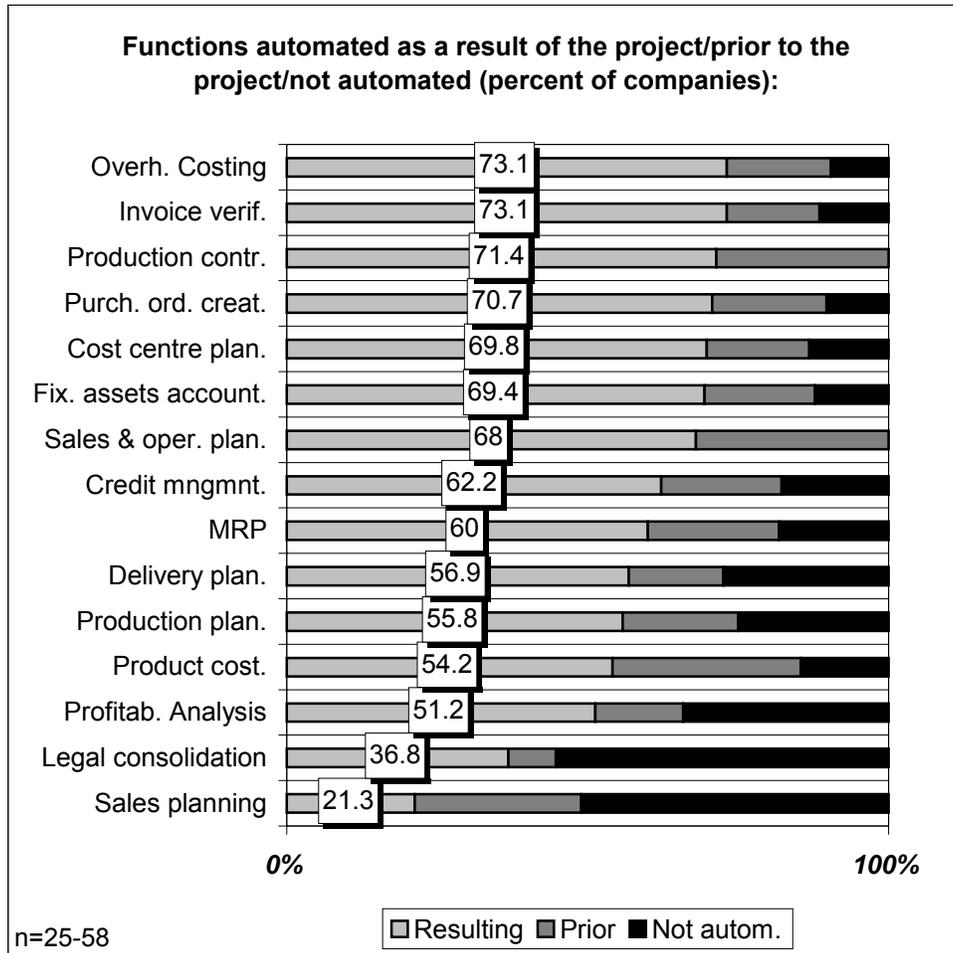


Figure 17: Resulting extent of automation

43 firms answered the question about the extent of automated data exchange between business functions (such as the automatic use of sales planning data in the production planning module). Among these, 56% had automated at least four of the six data exchange relationships mentioned in the questionnaire (the average value for automated data exchange relationships is 3.5). Among the exchange relationships automated, production planning to cost center planning is the most common (see Figure 18).

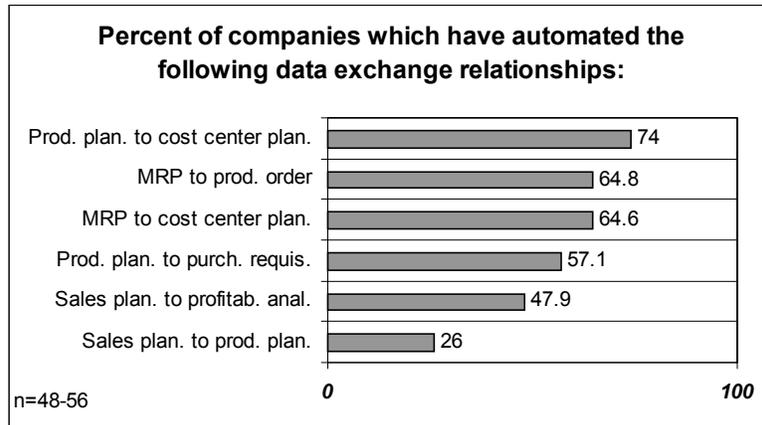


Figure 18: Extent of automated cross-functional data exchange

2.13 Data maintenance problems after cut-over

We asked the extent to which data maintenance problems occurred after cut-over which can be considered as an indicator of the quality of the implementation process, as any unresolved issues will surface here. Figure 19 shows that maintenance problems were most severe with regard to material master data and bill of material-data. This seems plausible as these types of data are used by several departments whereas customer and vendor master data are used by a fewer number of departments.²

² Material master data are generally used by production planning, material requirements planning, purchasing, sales, and finance; Bill of materials-data are generally used by production planning, purchasing, sales, and finance; customer master data are generally used by sales and finance; vendor master data are generally used by purchasing and finance.

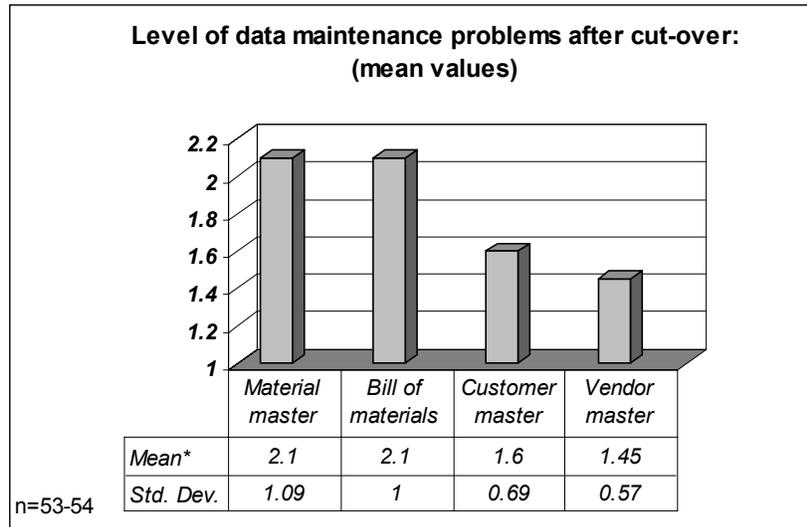


Figure 19: Data maintenance problems

Legend

* Scale: 1: no conflicts emerged; 2: minor conflicts emerged which, however, were quickly settled by the involved departments; 3: major conflicts emerged which could, however, be resolved by the involved departments; 4: major conflicts emerged which had to be resolved by top management; (5) major conflicts emerged which have not yet been resolved

2.14 Lead time reductions

Roughly one fourth of the sampled companies revealed information about reduced lead times. Among the several processes which had been included in the questionnaire, the time for closing the financial accounts had been reduced most dramatically while reductions for purchase lead time, delivery lead time, production lead time and production planning lead time had been reduced on average by around 30% (see Figure 20). However, as only few companies have answered this question, there might be a strong bias in the results since those companies which have not reported lead time reductions but had completed the implementation project (52), might have done so because no significant lead time reductions had been realized.

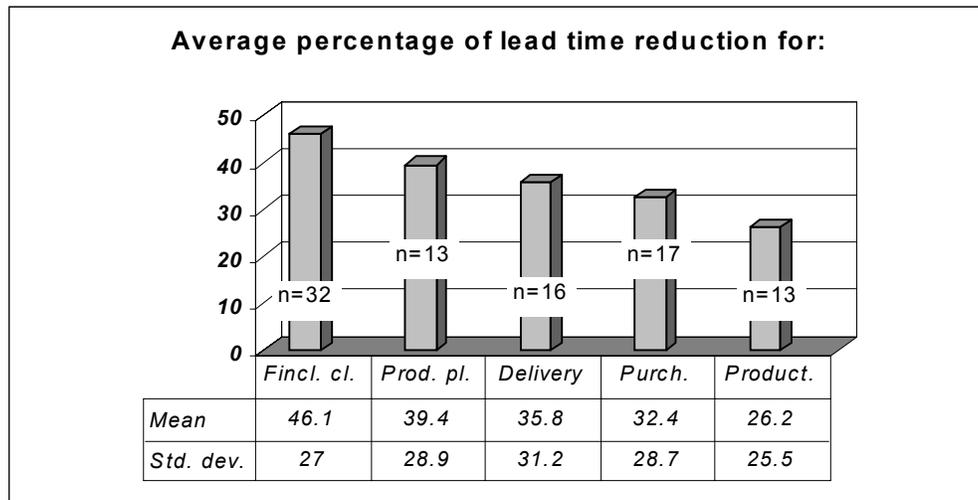


Figure 20: Lead time reductions as a result of the implementation project

2.15 Reasons for perceived financial benefits

Only 33% of companies conducted a formal evaluation of project outcomes after implementation (out of 63 companies answering the corresponding question). 47 companies answered the question whether or not they knew the project's ROI; among these, only 8 (17%) said they knew the projects ROI. Revealingly, the claim that companies know the project's ROI cannot be statistically associated with the company having conducted a formal evaluation of project results.

We also asked for reasons for realized financial benefits as a result of the implementation project as well as for the Return on investment (ROI) itself. However, only five companies revealed information about ROI data. Nonetheless, more companies gave reasons for realized financial benefits so that this information can be used for further analysis.

Among the 23 firms which reported reasons for realized financial benefits, reductions of inventories were mentioned in most of the cases as one of the two most important reasons with all other reasons being significantly less important (such as reduced workforce or reduced purchasing costs; see Figure 21).³ Statistically, only the reason of reduced inventories can be distinguished from all other reasons whereas the differences between the other reasons are mostly not statistically discernible (statistically discernible differences are indicated by arrows in Figure 21). This finding confirms the overall impression that the main benefit of implementing an ERP system stems from better operations rather than from cost savings for individual cost categories.

³ This contrasts sharply with the situation in the US where reduced inventories are one of the least important reasons for realized improvements with most improvements related to increased response times (cf. Mabert et al. 2000).

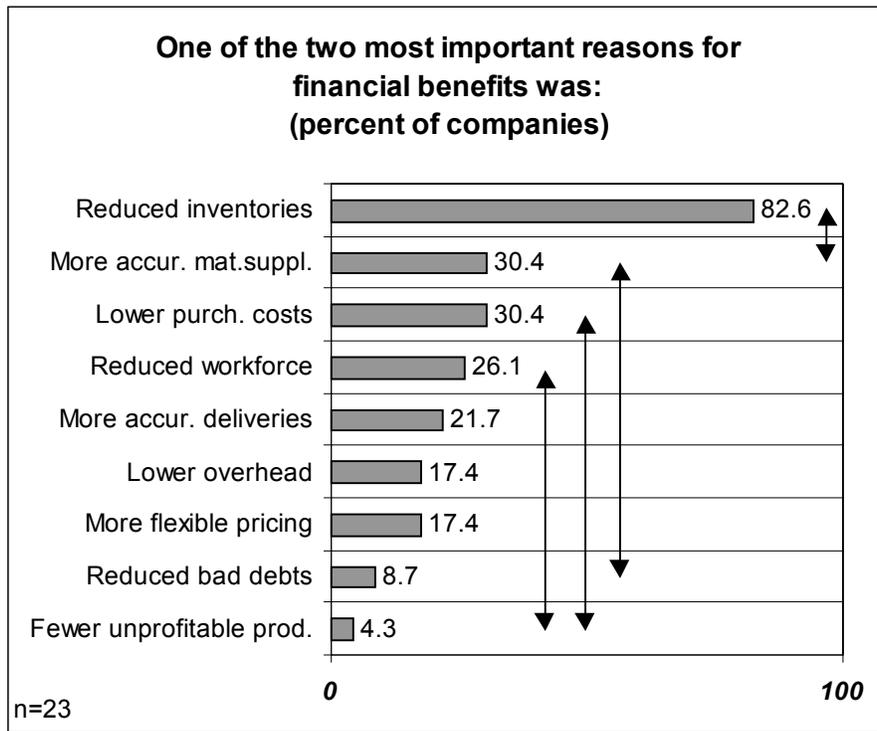


Figure 21: Perceived reasons for realized financial benefits

2.16 Project management targets

Regarding project management targets, most project's budgets have not significantly exceeded planned budgets (see Figure 22) while 43% of companies which answered the question about schedule overruns reported that projects had been more than three months over the original project schedule (see Figure 23). One reason for this difference in project management targets could be that budgets can be split into a formal and an informal budget by adding resources to the project which are not officially included in the project budget (e.g. IT personnel) whereas no such differentiation is possible with regard to schedule targets. Thus, the schedule target figures seem to be more reliable which would indicate that about half of projects are significantly over schedule *and* budget while another half of projects is on time and within budget.

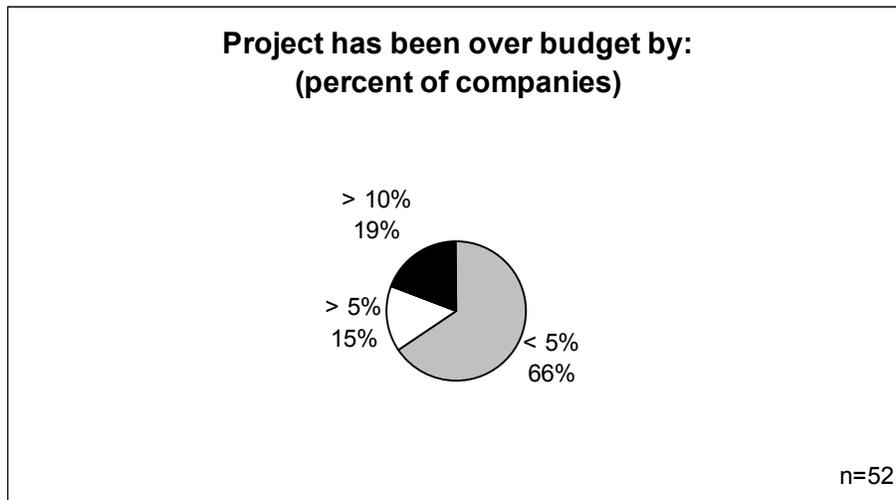


Figure 22: Compliance with project budget

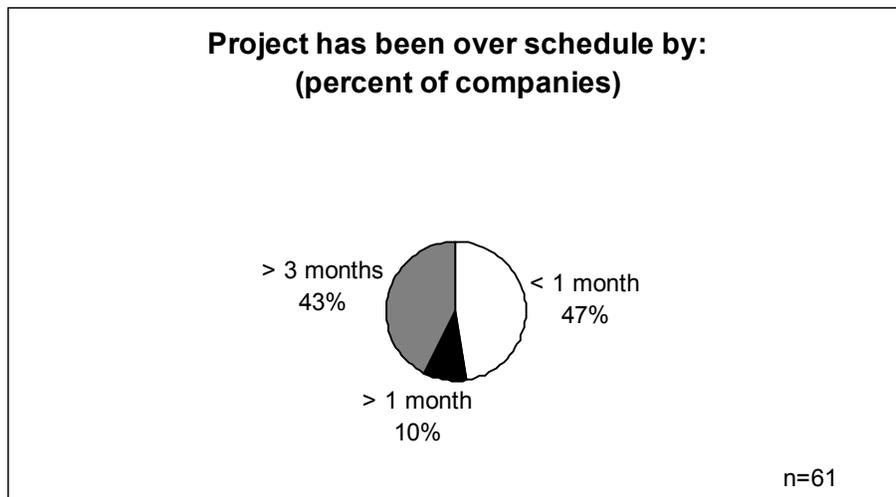


Figure 23: Compliance with project schedule

2.17 Summary

Overall, these descriptive statistics paint a positive picture of implementation results among the surveyed companies. Specifically, most companies seem to be happy with the outcome of the implementation project (two thirds), which contrasts sharply with the situation in the US and in Europe. Moreover, lead times for basic processes have been reduced by between 26% and 46%. However, in 43% of cases the project had been more than three months over schedule while the original project budget was not significantly extended in most cases.

Regarding sample characteristics, responding companies are predominantly manufacturers owned/controlled by foreign entities with a holding structure. Most companies have a very small

relative IT budget (as compared to international benchmarks) of less than one percent of revenues and most have computerized systems for basic functions, namely finance, inventory, purchasing and distribution. The ERP project included in almost all cases the modules for finance/controlling (FI/CO) and purchasing/distribution (MM/SD) and had been predominantly initiated by the CEO. Evenly split among Big Bang-strategies and phased implementation strategies, most companies included the FI/CO module in their first implementation phase. Also, most companies mentioned improving management controls as one of the two most important reasons for implementing an ERP system. Reduced inventory levels are reported as the main source of realized financial benefits. On average, no significant conflicts emerged between functions during implementation and after cut-over.

In the next section, we try to identify associations between the organizational context on the one hand and implementation process characteristics and project outcomes on the other hand in order to get more clues on how to improve implementation processes.

3 The implementation project and its organizational context

In this part of the analysis we try to understand how specific characteristics of the implementation project (including process and outcome characteristics) are associated with the organizational context. The purpose of this analysis is twofold. First, the organizational context might have a *direct* positive or negative impact on the implementation project. In this case, it would be helpful for project managers and consultants to understand these associations and take them into account when implementing an ERP system. Second, organizational characteristics might also have an indirect effect on the project. For example, it might seem as if the extent of end user training has a positive impact on some outcome variables (such as the extent of management satisfaction). However, further analysis then reveals that the extent of end user training is strongly correlated with foreign ownership. Thus, we might hypothesize that foreign ownership rather than the extent of end user training is the factor ‘behind’ this relationship. Taking both foreign ownership and extent of end user training into account should therefore enable us to clarify whether extent of end user training has an ‘independent’ effect on the degree of management satisfaction with project results or whether it is ‘mediated’ by foreign ownership. In order to identify such possible mediating effects, it is therefore important to understand the impact of organizational characteristics before analyzing the association between process and outcome variables in order to take possible mediating effects of the organizational context into account.⁴

This section is organized along implementation process and outcome characteristics. For each process and outcome characteristics, statistically discernible associations with context factors are reported and interpreted. The method of analysis is explained in section 6.1.

⁴ In more technical terms, this analytical process is described as ‘controlling’ an association between two or more variables for a third one. Controlling for a third variable means that the variation in the ‘explanatory’ variables which is common to both is subtracted thus leaving only a reduced amount of variation which can account for the variation in the ‘explained’ variable. If the two explanatory variables have a large percentage of variation in common, the remaining variation may not be sufficient to account for the variation of the explained variable (thus, the correlation between both or one of them and the explained variable may disappear).

3.1 Implementation motives

Ownership is associated with distinct implementation motives. Among a total of eight possible motives, respondents were asked to tick the two most important motives for implementing the ERP system (see Figure 10). Table 3 shows that state-owned firms predominantly try to improve management controls, collectives to adapt business processes to international best practice, and foreign invested companies (with at least 50% of equity owned by a foreign entity) to standardize business processes.

Table 3: Ownership and implementation motives

| | Improve management control | Standardize business processes | Adapt business processes to intern. best practice |
|--------------------|----------------------------|--------------------------------|---|
| State-owned* | .23; .08; 62 | | |
| Collective* | | | .30; .02; 62 |
| Public stock* | | | .26; .04; 62 |
| Foreign share >49% | | .29; .02; 62 | -.28; .03; 62 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Percentage of equity

These findings can be interpreted as indicators of most urgent problems. Following this interpretation, state-owned companies feel a lack of management control and try to use an ERP system to improve upon that situation. Collective units, in contrast, may use the system to show their international competitiveness. This interpretation is corroborated by the association between companies that have gone public and this implementation motive. Having implemented an ERP system or being in the process of implementing an ERP system may thus be seen as a means to demonstrate that the company has successfully transformed towards more modern business practices. Foreign invested firms may feel a need to standardize business processes, which becomes especially pressing as the number of plants and thus joint ventures multiplies.

As companies try to achieve different goals, it seems necessary to accommodate these goals in the implementation process. For example, companies trying to adapt business processes to international best practice will need more help in their reengineering efforts, whereas companies trying to improve management control levels may need support in terms of data quality. The findings reported here may serve to form some ex ante hypotheses when starting a new implementation project (e.g., when starting an implementation project in a collective unit, consultants should be prepared to focus more on reengineering unless otherwise informed).

3.2 Implementation conflict

A clear picture emerges regarding the likelihood of cross-functional conflict during the implementation process which contrasts state-owned companies with foreign-invested or foreign-

controlled companies.⁵ State-ownership is associated with both implementation conflicts involving the finance department on the one hand and the purchasing and manufacturing departments on the other hand and implementation conflicts between the purchasing and the manufacturing department. In contrast, foreign-invested or foreign-controlled firms are unlikely to experience implementation conflict between purchasing and manufacturing (see Table 4).

Table 4: Ownership and implementation conflict

| | Purchasing – Manufacturing | Finance - Purchasing | Finance – Manufacturing |
|----------------------|----------------------------|----------------------|-------------------------|
| State-owned* | .46; .001; 47 | .41; .005; 45 | .32; .03; 46 |
| Public stock* | .40; .005; 47 | | |
| Foreign investment* | -.61; .0001; 47 | | |
| Foreign controlled** | -.54; .0001; 47 | | |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Percentage of equity

** More than 50% of equity held by foreign entity

These findings could be interpreted in several ways. One possibility is to identify the finance department as a source of implementation conflict since it is involved in several types of conflicts. However, more likely seems to be a general issue in conflict resolution. Foreign-invested or controlled companies might have a corporate culture more conducive to solving cross-functional conflict. Moreover, they might have more experience in bringing together functional departments to work together as time-based competition has been a reality for foreign companies for a much longer time than it has for Chinese companies.⁶ In contrast, state-owned enterprises might still be dominated by ‘danweiism’, a tendency to put the interests of the department first and those of the company second.

It, therefore, seems necessary that consultants and project managers focus relatively more on issues of cross-functional cooperation in state-owned enterprises, e.g., by creating cross-functional teams (rather than the usual functional teams) to overcome existing forms of ‘danweiism’.

3.3 Implementation scope

Implementation scope, i.e. the range of modules implemented, is associated with ownership. Specifically, state- and private Chinese ownership are negatively associated with implementation scope. However, formal forms of employee representation, specifically the existence of workers’ committees or regular workers’ meetings, are also negatively associated with implementation

⁵ Public stock companies are state-owned or collective companies which have been transformed into private companies by bringing them to the stock market. Foreign-controlled companies are defined by an equity share of at least 51%.

⁶ See also the results of a survey of manufacturing strategies of wholly Chinese-owned and foreign invested firms in China by Robb and Xie (2001) who find that foreign invested companies focus more on timely deliveries whereas wholly Chinese-owned companies focus on aspects of quality.

scope suggesting that organizational rather than institutional (i.e. ownership) characteristics are the cause of a more narrow implementation scope (see Table 5). Controlling for formal employee representation shows that the association with state-ownership disappears while the association with collective ownership remains. This indicates that state-ownership does not lead directly to a more narrow implementation scope but does so via organizational characteristics (such as formal employee representation) whereas in the case of collective ownership probably other causal links exist.

Table 5: Implementation scope and ownership

| | Implementation scope (sum of modules implemented) |
|---|---|
| State-ownership* | -.26; .04; 62 |
| Collective ownership* | -.30; .02; 62 |
| Formal forms of employee representation** | -.45; .0001; 70 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Percentage of equity

** Employees can report concerns about working conditions to workers' councils or regular workers' meetings

One possible interpretation is that in state-owned companies employees can actually limit the scope of the implementation project by using formal forms of employee representation. A second possibility is that both state-owned and collectively owned companies have less experience with automated business processes and thus proceed more slowly in order to not overwhelm the organization with switching to one of the most sophisticated business applications from a completely paper-based system.

In any case, it is necessary to take into account that state-owned and collectively owned/controlled companies face a steeper road when venturing on the ERP path than do foreign invested companies.

3.4 Experience of external consultants

Companies which have a relatively higher IT budget (measured as a percentage of revenues) are more likely to hire relatively more experienced external consultants. So are companies which offer a higher degree of job security and foreign invested companies. In contrast, state-invested companies tend to hire external consultants which are relatively less experienced (see Table 6).

Table 6: Experience of external consultants, ownership and other context factors

| | Experience of external consultants (on a 10-point Likert scale) |
|------------------------------|---|
| State-invested* | -.23; .07; 63 |
| Foreign-invested* | .26; .04; 63 |
| Relative size of IT budget** | .29; .04; 53 |
| Degree of job security*** | .33; .005; 72 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Percentage of equity

** As percentage of revenues

*** On a 10-point Likert scale with “1” for “very insecure” and “10” for “very secure”

Companies with a higher relative IT budget are probably more sophisticated in terms of IT usage (Nolan 1993). This would sensitize them to the need of hiring experienced consultants (and pay the higher price for them). Companies which offer a higher degree of job security are probably aware of the value of skilled labor (which is difficult to obtain in periods of growth which is why they hold on to their workforce even in times of stagnant or falling demand) and, by extension, value experienced consultants higher. The association with ownership is mediated by the relative size of the IT budget (i.e. it disappears when controlling for both factors); this, however, does not hold for the degree of job security. Thus, foreign invested companies tend to spend more on IT which puts them on a higher level of exposure with IT projects and thus sensitizes them to the value of experienced consultants. However, independent of ownership, companies which offer a relatively higher degree of job security value experience of external consultants relatively more.

This indicates that companies which treat their workforce as a supplier of labor rather than as members of their organization will need more persuasion to pay for more experienced consultants or, alternatively, should be prepared to live with the consequences of less experienced consultants.

3.5 Top management participation

Top management participation (defined as participation of at least one senior manager in the implementation project) is positively associated foreign investment and control and the presence of a group/holding structure and negatively associated with state ownership, a reward system based on bonuses, and formal forms of employee representation (by workers’ committees or regular workers’ meetings) (see Table 7). As formal forms of employee representation may be linked with state ownership, the association between state ownership and top management participation was tested by controlling for formal forms of employee representation. However, the negative association between state ownership and senior management participation remains indicating that state-ownership has either a direct negative impact upon the likelihood of top management participation or another reason (apart from formal forms of employee representation) mediates this association. In contrast, when controlling the association between foreign ownership and senior management participation for a group/holding structure or a reward system based on bonuses, the effect disappears, suggesting that it is mediated by these factors. In

this case, however, the effect of a group structure also disappears which raises the question of which other factor might mediate the effects.

Table 7: Top management participation and context factors

| | Senior manager(s) participated in implementation project |
|--|--|
| State ownership* | -.40; .002; 61 |
| Foreign investment* | .28; .03; 61 |
| Foreign control** | .32; .01; 61 |
| Group structure | .28; .03; 64 |
| Reward system based on bonuses | -.27; .04; 63 |
| Formal forms of employee representation*** | -.26; .03; 70 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Percentage of equity

** More than 50% of equity held by foreign entity

*** Employees can report concerns about working conditions to workers' councils or regular workers' meetings

Thus, both, state-investment and formal forms of employee representation seem to have a negative independent effect on the likelihood of top management participation. This could be explained by a system of authority and prestige which prevents top managers of companies characterized by state-ownership/investment or formal forms of employee representation from participating in ERP projects. Likewise, top managers in these types of companies may not feel comfortable with technology projects and thus prefer not to participate. A reward system based on bonuses may be considered to compensate for the need of top managers to participate in the project. As foreign controlled companies are less likely to use bonuses (-.33; .01; 58), this effect mediates the association between foreign investment/control and top management participation. Thus, it cannot be concluded that top managers in foreign invested/controlled companies are more likely to participate in an ERP project.

These findings raise two issues. First, is it true that a bonus system will compensate for the need of top managers to participate in ERP projects? Second, how can top managers of state-owned companies be persuaded to participate in ERP projects? The answer to these two questions is important for the improvement of ERP implementation projects but cannot be provided on the basis of this study.

3.6 Parallel systems operation after cut-over

Whereas foreign invested companies tend to run previous systems in parallel for a relatively shorter period of time after cut-over, collectively, publicly, and privately invested companies tend to report a relatively longer period of parallel system operation after cut-over (see Table 8).

Table 8: Duration of parallel systems operation and ownership

| | Duration of parallel systems operation |
|------------------------------|--|
| Foreign investment* | -.49; .006; 30 |
| Collective ownership* | .60; .0004; 30 |
| Public ownership* | .42; .02; 30 |
| Private (Chinese) ownership* | .68; .0001; 30 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Percentage of equity

It is possible that foreign invested companies muster more experience as they might have implemented ERP systems in other companies (there is no association between the length of parallel systems operation and previous extent of business process automation; thus, previous experience gained in China does not account for the duration of parallel systems operation). However, findings from in-depth case studies suggest a different interpretation: Chinese managers do not trust the system as much as foreign managers do; thus, they keep the old systems for an extended period of time in order to test the new system and develop trust in its ability to control business processes.

These findings imply that project managers and consultants should take special measures to increase the level of initial trust managers have in the new system since a long duration of parallel systems operation in itself may undermine the (little) initial trust managers have in the system since, in this case, the increased workload of maintaining two systems may prevent users from operating the new system in a way required for delivering the results expected from the new system.

3.7 Project management targets

The negative association between the extent of budget overruns and the degree of job security reported in Table 9 seems to indicate a causal relationship; at least, possible mediating effects suggested by associations between context factors (such as with ownership factors) have been ruled out. The association between the extent of schedule overruns and the degree of job security is still positive, albeit not statistically discernible.

Table 9: Project management targets and degree of job security

| | Extent of budget overruns** | Extent of schedule overruns*** |
|-------------------------|-----------------------------|--------------------------------|
| Degree of job security* | -.48; .0004; 50 | -.21; .10; 58 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* On a 10-point Likert scale with “1” for “very insecure” and “10” for “very secure”

** On a three-point scale with “1” for “less than 5%”, “2” for “more than 5%”, and “3” for “more than 10%”

*** On a three-point scale with “1” for “less than one month”, “2” for “more than one month”, and “3” for “more than three months”

A possible explanation for this finding is that, as to the degree of data maintenance problems after cut-over (see section 3.9), a low degree of job security distracts resources from the project since employees will be concerned with either ensuring continued employment or finding alternative employment during the implementation project. On the other hand, a high degree of job security encourages employees to cooperate with project management since, in the long run, advanced automation of business processes will also benefit employees. Cooperation by employees is especially crucial in ERP implementation projects since the knowledge about current business process resides mostly with employees. As the most likely source for budget overruns consists of additional external human resources (i.e. consultants), budget overruns can be interpreted as either a failure to plan correctly or as an indication of insufficient mobilization of internal resources. The latter possibility provides a direct causal explanation for the finding reported in this section.

The implication of this finding for project management and consultants is that companies with a relatively low degree of perceived job security need more external human resources to compensate for decreased degrees of mobilization of employees to contribute crucial business process knowledge. This is especially important for the establishment of the project budget, as budget and schedule overruns are often taken as an indicator of project success and thus the degree of management satisfaction with project outcomes (see section 4.4).

3.8 Degree of management satisfaction with project results

To measure the degree of management satisfaction with project results with respect to original expectations, respondents have been asked whether project results have surpassed original expectations, met original expectations, been below original expectations, or whether no improvements at all have been realized. Two ways of calculating the association with other variables have been applied: (1) the answers were taken individually and investigated with respect to associations with other variables; (2) the answers were combined into an index ranging from “0” for “no improvements” to “3” for “original expectations surpassed”. The results are reported in Table 10.

Table 10: Extent of management satisfaction and context factors

| | Original expectations met | Results below orig. expectations | No improvements | Index |
|-----------------------------------|---------------------------|----------------------------------|-----------------|---------------|
| State ownership* | -.30; .03; 50 | - | .38; .006; 50 | - |
| Foreign investment* | .26; .06; 50 | - | -.31; .03; 50 | - |
| Prior extent of bus. proc. autom. | .32; .03; 47 | -.31; .03; 47 | - | - |
| Degree of job security** | .39; .002; 59 | -.47; .0001; 59 | - | .42; .001; 59 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Percentage of equity

** On a 10-point Likert scale with “1” for “very insecure” and “10” for “very secure”

Although ownership and prior extent of business process automation show some association with the extent of management satisfaction with project outcomes, these effects do not seem to be very strong since they disappear when using the information of all four questions (i.e. an index of the extent of management satisfaction). Only the impact of the degree of job security remains strong enough to show up in the index as well. Thus, the degree of job security is the only reliable predictor for the extent of management satisfaction with project outcomes when considering context factors. The degree of job security, in turn, has no significant association with other context factors.

These findings suggest that the degree of job security is directly responsible for the extent of management satisfaction with project outcomes. Of course, it is possible that factors not included in this study mediate the identified relationship or that a more complex interaction of factors accounts for this relationship which requires more powerful statistical tools to discover which, due to the small number of observations, cannot be applied here. However, two considerations support a direct, causal interpretation.

(1) ERP projects are frequently associated with business process reengineering which has earned itself a bad reputation as a job killer (see Willmott 1994). This implies that employees may be afraid of losing their jobs as a result of the implementation project and thus spend relatively more time on protecting their jobs, either by trying to reduce the degree of automation, or just by allocating a larger share of their working time to ‘private’ purposes.

(2) The degree of job security is also associated with other, more ‘objective’ outcome characteristics, specifically the extent of data maintenance problems after cut-over (see section 3.10) and project management targets (see section 3.7). As these outcome characteristics are the most visible indicators of project success, it seems reasonable to assume that the degree of management satisfaction is positively influenced by high scores on both scales.

The implication of this finding for project managers and consultants is that companies with a relatively low level of perceived job security should take special measures to diffuse employee anxiety or establish clear rules for job cuts if, indeed, a reduction of workforce is intended.

3.9 Degree of acceptance by users

As Table 11 shows, a negative association was found between the degree of system acceptance by users and formal forms of employee representation. A likely interpretation of this finding is that project managers tend to be unaware of user resistance unless users have a way of expressing their concerns.

Table 11: System acceptance and employee representation

| | Degree of acceptance by users* |
|--|--------------------------------|
| Formal forms of employee representation* | -.28; .03; 57 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Employees can report concerns about working conditions to workers’ councils or regular workers’ meetings

** On a 10-point Likert scale with “1” for “very strong resistance towards the system” and “10” for “no resistance at all”

The implication of this finding is that project managers and consultants need to pay more attention to user responses in order to prevent covert forms of resistance threaten the productive use of the system.

3.10 Data maintenance problems after cut-over

Table 12 reports the findings regarding associations between context factors and data maintenance problems. Again, ownership plays an important role which underscores previous findings. A possible interpretation for this role is that foreign controlled companies have more effective devices in handling cross-functional conflicts. An indication for this explanation is the association with different cross-functional coordination devices as reported in Table 12. However, the causal mechanism seems to be more complex since the effect is mediated by ownership characteristics (it disappears when controlling for state or foreign ownership). Only the positive association with standing cross-departmental committees remains intact when controlling for ownership variables. This implies that handling cross-departmental conflicts requires more than just setting up regular cross-departmental meetings (and foreign controlled firms may be more apt in providing these additional means of cross-functional coordination), whereas standing cross-departmental committees may effectively prevent cross-functional coordination with regard to data maintenance problems. One possible explanation is that a stronger form of institutionalization of cross-functional coordination devices (i.e. committees rather than meetings) leads to a sort of role-specialization in so far as typical ‘committee-roles’ emerge for members who are not central/crucial for departmental operations and thus less familiar with business processes. However, these members are unwilling to involve more knowledgeable colleagues since they might feel that then their own legitimacy would be threatened.

Table 12: Data maintenance problems* and context factors

| | Material master data | Bill of materials |
|--|----------------------|-------------------|
| State ownership** | .31; .01; 46 | - |
| Foreign control *** | -.31; .04; 46 | -.30; .05; 45 |
| Public ownership** | - | .32; .03; 45 |
| Degree of job security**** | - | -.48; .0003; 52 |
| Regular cross-departmental meetings | - | -.30; .03; 51 |
| Standing cross-departmental committees | - | .29; .04; 51 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Scale of data maintenance problems: 1: no conflicts emerged; 2: minor conflicts emerged which, however, were quickly settled by the involved departments; 3: major conflicts emerged which could, however, be resolved by the involved departments; 4: major conflicts emerged which had to be resolved by top management; (5) major conflicts emerged which have not yet been resolved

** Percentage of equity

*** At least 51% of equity held by foreign company

**** On a 10-point Likert scale with “1” for “very insecure” and “10” for “very secure”

These findings alert project managers and consultants to the need of paying more attention to cross-functional coordination in ERP implementation projects in state-owned/controlled

companies. These problems will be aggravated if standing cross-departmental committees exist which might actually prevent cross-functional coordination.

3.11 Lead time reductions

The number of companies which reported lead time reductions was rather small; as a consequence, associations between lead time reductions and context factors need to be interpreted cautiously. As reported in Table 13, manufacturing companies are associated with lead time reductions for the monthly financial closing process. Similarly, implementation scope is positively associated with financial closure lead time reductions. However, when simultaneously considering both variables, the effect of implementation scope disappears, suggesting that this effect is mediated by the type of company (manufacturing vs. non-manufacturing). Foreign invested or controlled companies are more likely to report production lead time reductions and companies which belong to a group structure are less likely to report purchasing lead time reductions.

Table 13: Lead time reductions* and context factors

| | Financial closure | Production | Purchasing |
|-----------------------|-------------------|--------------|---------------|
| Manufacturing | .38; .03; 32 | - | - |
| Implement. scope** | .39; .05; 29 | - | - |
| Foreign investment*** | - | .60; .04; 12 | - |
| Foreign control**** | - | .63; .03; 12 | - |
| Group structure | - | - | -.52; .04; 15 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Respondents have been asked to report the length of time for each listed process required before and after the implementation of the ERP system; the lead time reduction has then been calculated as a percentage of the original lead time

** Number of modules implemented

*** Percentage of equity

**** At least 51% of equity held by foreign company

Manufacturing companies generally start from a rather low level of business process automation (we find a negative association between manufacturing companies and the prior extent of business process automation: -.29; .04; 50). Thus, automating financial bookkeeping may provide the most visible and at the same time most easily achieved benefits as this area is traditionally the first to be automated due to its pre-structured nature. Foreign invested or controlled companies may already be used to time-based competition; thus focusing on reducing their production cycle times may offer the largest lever for reducing total response time. Companies which belong to a group may be forced to consolidate purchasing activities which complicates streamlining the purchasing process as it has to be harmonized across all group members.

For project managers or consultants the more important lesson to be drawn from these findings consists of the small number of companies which have reported lead time reductions at all. Among the 52 companies which have completed (part of) the implementation project, only 19 (36%) have reported on possible lead time reductions. Thus, most companies have no clear idea

about lead time reductions enabled by the ERP system. Since virtually all benefits attributable to an ERP system ultimately stem from lead time reductions, this finding should cause some concern among those interested in implementing ERP systems since companies increasingly demand some hard facts about benefits of ERP systems apart from the project being on-time and in-budget which is too often considered the only yardstick used to measure the ‘success’ of an ERP implementation project.

3.12 Reasons for financial benefits

As reported in Table 14, a number of perceived reasons for realized financial benefits as a result of the implementation project are associated with distinct context characteristics. These associations have been controlled for the conduct of a formal evaluation of project results in order to ensure that perceived financial benefits are based on real analysis rather than wild guesses. None of the associations reported in Table 14 is mediated by the conduct of a formal evaluation of project results. However, notice the small number of observations which indicate the necessity for caution when interpreting the findings.

Table 14: Perceived reasons for financial benefits and context factors

| | Reduced inventories | Lower purch. Costs | Reduced workforce | Reduced bad debts | Lower overhead | More flex. pricing |
|------------------------|---------------------|--------------------|-------------------|-------------------|----------------|--------------------|
| Manufact. | .46; .03; 23 | | | | | |
| State ownership* | | .55; .01; 20 | | | | |
| Size of IT budget** | | | -.58; .004; 22 | | | |
| Private ownership* | | | | .43; .06; 20 | | |
| Foreign contr.*** | | | | | -.49; .03; 20 | |
| Impl. in sev. entities | | | | | | .50; .02; 20 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* As percent of equity

** As a percentage of revenues

*** At least 51% of equity held by foreign entity

As reported above (see Figure 21), reduced inventory levels are mentioned as the most common reason for realized financial benefits. As this reason is associated with manufacturing companies which account for 76% of the total sample (see Figure 1), this finding can be taken as an indication of the relevance of implementing ERP systems in the surveyed companies.

However, specific context conditions indicate specific characteristics of realized financial benefits. State-owned companies seem to benefit most from lower purchasing costs, indicating a huge rationalization potential in this area. Privately owned companies, in turn, seem to suffer

from high levels of bad debts and are able to use the ERP system to improve their credit controls. Companies with several entities, in turn, seemingly have difficulties in aligning their pricing policies across these several entities and successfully use the ERP system to improve on that issue.

Foreign controlled companies do not use the system to reduce overhead costs. This seems plausible as they are relatively new companies which have not yet built up high overhead levels. Companies with a high relative size of their IT budget are less likely to use the system to reduce their workforce. This is also plausible as a high relative IT budget indicates comprehensive automation of business processes implying that the rationalization potential in terms of workforce reduction has already been realized.

These findings provide some useful information when considering implementation of an ERP system. Specifically, the initial thrust of the implementation can be focused on those areas which are most likely to yield financial benefits in order to build credibility. Ultimately, however, the biggest financial benefits will stem from improved operations via reduced inventory levels.

3.13 Summary

This analysis clearly demonstrates the importance of institutional factors, namely the ownership structure of the company, for both implementation process characteristics and project outcomes. Specifically, ownership is associated with distinct implementation motives and reported reasons for realized financial benefits. Foreign invested firms are more likely and state-invested firms less likely, to hire relatively experienced consultants. Similarly, in foreign invested companies top management is more likely, and in state-invested companies less likely, to actively participate in the project. Finally, cross-functional implementation conflict is more likely to be relatively higher in state-invested companies and more likely to be relatively lower in foreign invested and controlled companies.

After cut-over, foreign invested firms tend to operate the old system for a shorter period of time than do collectively and privately (Chinese) owned companies. Also, foreign controlled companies are less likely, and state-invested companies are more likely, to experience relatively higher level of data maintenance problems after cut-over. Finally, foreign invested and controlled companies are more likely to report production lead time reductions as a result of the implementation project.

Apart from the institutional structure, the degree of perceived job security and the existence of formal forms of employee representation also turned out to be important factors associated with the implementation process and the project's outcome. Companies with a relatively high degree of perceived job security are more likely to hire relatively more experienced consultants and in companies with formal forms of employee representation, top management is less likely to be actively involved in the implementation project. Also, the single context variable associated with the risk of budget and schedule overruns is the degree of perceived job security which tends to reduce this risk. The same holds for the extent of management satisfaction which is positively associated with the degree of perceived job security. Conversely, companies with formal forms of employee representation tend to report stronger user resistance to the system. Finally, companies

with a relatively high degree of perceived job security tend to have relatively lower levels of conflicts in maintaining BOM (Bill of Material) data after cut-over.

Thus, the following analysis will have to specifically take into account the overall impact of these two sets of variables, namely the institutional structure of companies, and their degree of perceived job security and the existence of formal forms of employee representation when investigating the association between implementation process characteristics and project results.

4 The implementation process and implementation results

This second part of the analysis reports the findings of associations between implementation process and outcome variables. This analysis builds upon the above analysis in so far as it tries to identify possible mediating effects by context factors. If such mediating effects can be ruled out with a reasonable degree of confidence, then it can be tentatively concluded that direct causal relationships are present, which would allow for changing implementation process characteristics in view of certain desired outcomes. Figure 24 summarizes this analytical process.

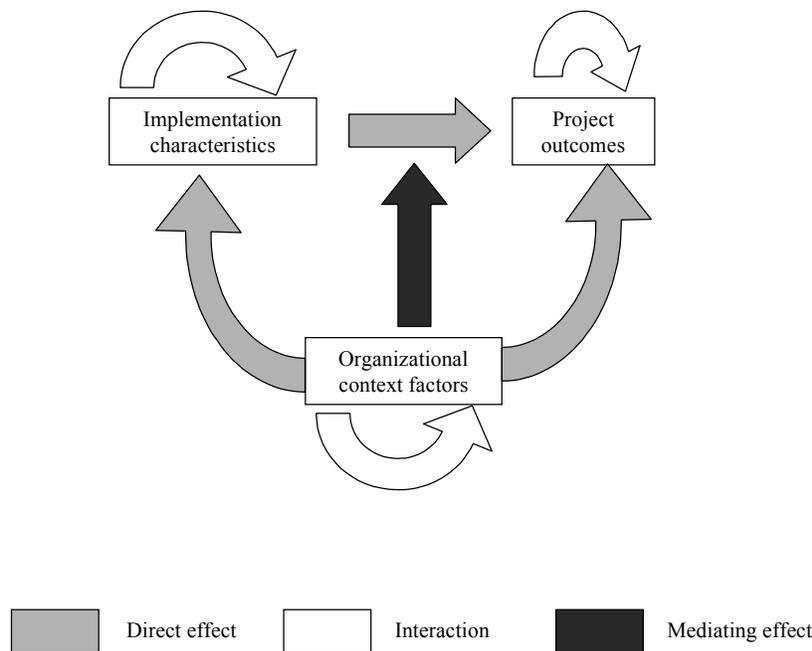


Figure 24: Model of the analysis process

Apart from the relationships reported here, there are also possible relationships among implementation process, context and outcome variables as indicated in Figure 24. The analysis of these relationships is also used to identify possible mediating effects which are, however, not included in this report. For example, ownership characteristics might mediate the effect of size on process or outcome variables. Only if such mediating effects could be ruled out (based on the analysis of interaction relationships) did we include findings of associations between context

factors and process or outcome variables in our analysis. Similarly, in the following analysis we only report associations which we consider to be direct, i.e. not mediated by context factors.

4.1 Implementation conflict

Table 15 shows that four implementation factors are associated with cross-functional implementation conflicts, the frequency of steering committee meetings, the experience of external consultants, a global roll-out, a phased implementation strategy, and the extent of end and key user training. These relationships are not mediated by ownership, a likely candidate, as ownership is associated with cross-functional implementation conflict (albeit not always the same types as appear here, see Table 4), the experience of external consultants (see Table 6), and the extent of end and key user training (not reported here).

Table 15: Implementation conflict* and process variables

| | Manufacturing – Sales | Purchasing – Inventory | Purchasing - Finance | Sales - Finance |
|-------------------------------|-----------------------|------------------------|----------------------|-----------------|
| Freq. of steer. Comm. Meet.** | -.61; .0004; 30 | -.41; .02; 33 | - | - |
| Experience of consultants*** | - | -.26; .06; 51 | -.28; .04; 54 | -.35; .01; 49 |
| Global roll-out | - | - | -.44; .01; 37 | - |
| Phased implementation | - | .27; .06; 49 | .38; .01; 52 | - |
| Ext. of end user training**** | - | - | - | .35; .03; 38 |
| Ext. of key user training**** | - | - | - | .45; .004; 39 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Scale: 1: no conflicts emerged; 2: minor conflicts emerged during the implementation phase which, however, were quickly settled by the project team; 3: major conflicts emerged during the implementation phase which could, however, be resolved by the project team; 4: major conflicts emerged during the implementation phase which had to be resolved by the steering committee; (5) major conflicts emerged during the implementation phase which have not yet been resolved

** Scale: 1: less than once a month; 2: once a month; 3: more than once a month

*** On a 10-point Likert scale with “1” for “very inexperienced” and “10” for very experienced

**** Measured in weeks

The frequency of steering committee meetings seems to mitigate cross-functional conflict along the primary workflow (purchasing-inventory; manufacturing-sales) whereas the experience of external consultants mainly helps reduce cross-functional conflicts involving the finance department. These findings indicate that cross-functional conflicts along primary value activities are due to inherent trade-offs (for example, reducing inventory levels may require shortening purchasing cycles) implying the need for high-level decision making authority (which can be supplied by the steering committee), whereas conflicts involving the finance department are due to a lack of systems knowledge (which can be supplied by external consultants). A phased implementation strategy may lead to the neglect of logistical issues when implementing the finance module (which is typically implemented first, see Figure 8) whereas a global roll-out may mitigate cross-functional conflicts involving the finance department due to the contribution of some expert knowledge provided by headquarters; i.e., here a similar explanation applies as regards the association of cross-functional conflicts and the experience of external consultants.

The positive association with the extent of end and key user training seems, at first glance, surprising. However, it is possible that more knowledgeable users do better understand implications of configuring the system which also includes possible negative effects on their own department. As cross-functional implementation conflicts between sales and finance are the only type of cross-functional implementation conflict significantly larger than the minor conflict-level (see section 3.2), it is here that conflicts are most likely to surface.

These results clearly indicate the important role of both the steering committee and external consultants in ensuring a smooth implementation process. Whereas the importance of external consultants' experience is widely acknowledged, the crucial role of the steering committee has not received a similar degree of attention.

4.2 Types of steering committees

Before proceeding with the analysis of associations between process and outcome variables, we briefly present some results on associations between characteristics of the steering committee. Table 16 presents the eigenvectors of four principal components (linear combinations of the row variables) with an eigenvalue bigger than unity (i.e., they represent those combinations which contribute the most to 'explaining' the total variance in the analyzed set of variables, in this case 86%). Principal components reveal simultaneous associations between several variables. High coefficient values in the table (so-called factor loadings) indicate a strong association with the respective component. When limiting interpretations to factor loadings $>.40$, the first factor can be interpreted as a steering committee characterized by 'traditional' forms of management, namely decision making by the most senior member and a steering committee committed to making important implementation decisions itself. In contrast, the second principal component describes a 'modern' steering committee whose decision making is based on majority voting and whose main function is to supervise the project team rather than to direct it (i.e., it approves crucial implementation decisions rather than making them itself). The third principal component describes a steering committee whose decision making process is based on a consensus principle whereas there is no clear positive association with the steering committee's main function while a strong negative association with resolving cross-functional conflicts as one of the steering committee's main functions exists. Finally, the fourth component is only characterized by one row variable, namely motivating project team members as the steering committee's main function.

Table 16: Types of steering committees: Principal components analysis (eigenvectors)

| | 1 st prin. comp. | 2 nd prin. comp. | 3 rd prin. comp. | 4 th prin. comp. |
|------------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Decision making | | | | |
| Consensus | .38 | -.29 | .61 | -.27 |
| Majority voting | .35 | .44 | -.26 | .37 |
| Seniority principle | -.60 | -.05 | -.33 | -.06 |
| Function of steer. comm.* | | | | |
| Making important decisions | -.43 | .28 | .35 | -.30 |
| Approving important decisions | .35 | .49 | -.13 | -.25 |
| Motivating project team | -.11 | -.13 | .33 | .79 |
| Resolving conflict in project team | .23 | -.62 | -.45 | -.11 |

* Answers had been restricted to two functions of the steering committee out of four.

Thus, two distinct types of steering committees can be identified in the data set, the ‘traditional’ and the ‘modern’ variant. The other two forms cannot be clearly described (apart from the logical implication that a consensus-based decision making style is incompatible with resolving cross-functional conflicts as the main function of the steering committee).

4.3 Project management targets

The risk of budget and schedule overruns is most prominently associated with cross-functional implementation conflict, and the role and decision making style of the steering committee (see Table 17). The associations reported in Table 17 are generally stable, i.e. they are not mediated by likely intermediate variables such as ownership.⁷ In some cases, however, ownership variables seem to have a mediating effect. Specifically, the association between the extent of schedule overruns and cross-functional implementation conflict between purchasing and inventory as well as between the extent of budget overruns and the steering committee focusing on approving crucial implementation decisions seem to be mediated by ownership variables (these associations are indicated by square brackets in Table 17).⁸ Thus, overall it can be concluded that the role and decision making style of the steering committee as well as cross-functional conflicts during

⁷ Controlling for the degree of job security, which is a clear indicator of the risk of budget overruns (see Table 9) leads to a significant weakening of the effects reported here. However, since the association between degree of job security and the extent of budget overruns is very strong, it seems likely that this effect simply dominates those reported here. Thus, both the degree of job security and the role and decision making style of the steering committee are indicative of a modern management style which seems to better fit the requirements of implementing an ERP system.

⁸ In some cases it was difficult to control for mediating effects because of a technical problem in the data analysis, i.e. the estimated models using non-parametric methods (which are required because the dependent variables are measured only on an ordinal scale) were not valid. In these cases, parametric methods have been used to get a feeling for possible mediating effects.

implementation are important factors impacting the risk of budget, and to a lesser extent, schedule overruns.

Table 17: Project management targets and implementation process characteristics

| | Extent of budget overruns* | Extent of schedule overruns** |
|---|----------------------------|-------------------------------|
| Cross-functional implementation conflicts*** | | |
| Purchasing – Manufacturing | .48; .003; 36 | |
| Purchasing – Finance | .41; .01; 36 | |
| Purchasing – Inventory | .37; .02; 37 | [.32; .04; 41] |
| Steering committee decision making style | | |
| Seniority principle | .44; .005; 39 | |
| Consensus principle | -.33; .04; 39 | |
| Steering committee role | | |
| Approve crucial implementation decisions | [-.31; .05; 45] | |
| Make crucial implementation decisions | | .35; .02; 43 |
| Other factors | | |
| Improve services as important implementation motive | | .26; .05; 57 |
| Initiation of project by IT | | .39; .003; 59 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* On a three-point scale with “1” for “less than 5%”, “2” for “more than 5%”, and “3” for “more than 10%”

** On a three-point scale with “1” for “less than one month”, “2” for “more than one month”, and “3” for “more than three months”

*** Scale: 1: no conflicts emerged; 2: minor conflicts emerged during the implementation phase which, however, were quickly settled by the project team; 3: major conflicts emerged during the implementation phase which could, however, be resolved by the project team; 4: major conflicts emerged during the implementation phase which had to be resolved by the steering committee; (5) major conflicts emerged during the implementation phase which have not yet been resolved

In all cases, cross-functional implementation conflicts negatively impacting the risk of budget overruns involve the purchasing function. It seems that here some major problems exist which are systematically overlooked since they are generally not anticipated when setting up the project budget. However, the nature of this problem cannot be derived from this analysis. Project managers and consultants should proactively look for possible problems involving the purchasing department in order to identify and eliminate its source.

The steering committee decision making style has a distinct impact upon the risk of budget overruns, namely application of a seniority principle increases this risk while application of a consensus principle reduces it. One interpretation of this finding is that a seniority decision making principle may encourage top managers to unilaterally change crucial project parameters, possibly without being aware of the impact of these decisions on the budget. In contrast, a consensus principle effectively gives a veto-right to each steering committee member, including

the finance director, thus allowing him or her to block decisions which would risk increasing the project budget.

The association between a steering committee focusing on approving crucial implementation decisions made by the steering committee and the risk of budget overruns is possibly mediated by ownership characteristics and shall therefore not be interpreted here. However, the association between a steering committee making crucial implementation decisions itself and the risk of schedule overruns seems to be original. A possible interpretation is that the project team will be discouraged from making crucial implementation decisions under such conditions, implying significant delays as it has to wait for steering committee meetings for these crucial issues to be decided.

Among the other factors we only want to point to the positive association between IT-initiated projects and the risk of schedule overruns. One possible interpretation of this finding is that in IT-initiated projects project management lacks the organizational clout to enforce project milestones.

The implications of these findings for project managers and consultants are that the role and the decision making style of the steering committee as well as implementation conflicts, are important indicators, and possibly causes of the risk of budget and schedule overruns and thus warrant special attention.

4.4 Degree of management satisfaction

The degree of management satisfaction with project outcomes is associated with cross-functional implementation conflict, the extent of budget and schedule overruns, steering committee characteristics (decision making and role), and the project being (also) initiated upon request of the IT department. The association with implementation conflict variables is generally not mediated by ownership characteristics⁹ but tend to become non-significant when controlling for the degree of job security. However, this could be a domination effect rather than a mediating effect since the association between the degree of job security and the degree of management satisfaction with project outcomes is quite strong (see Table 10). (A similar effect was observed regarding the extent of schedule and budget overruns; see section 4.3). The associations with steering committee characteristics are generally neither mediated by ownership characteristics nor the degree of job security.¹⁰

⁹ The exception being the percentage of public ownership (stocks) which mediates the association between implementation conflict between purchasing and finance and the degree of management satisfaction with project outcomes. The association between majority voting in the steering committee and the degree of management satisfaction with project results could not be controlled for mediating effects using non-parametric methods (the LOGISTIC-procedure in SAS) because the estimated model was not valid; using parametric methods indicated that this association is not mediated by ownership variables.

¹⁰ The exception being the percentage of private Chinese ownership which mediates the association between the degree of management satisfaction with project outcomes and a steering committee focusing on making crucial implementation decision itself.

Table 18: Degree of management satisfaction and implementation process characteristics

| | Extent of management satisfaction* |
|---|------------------------------------|
| Implementation conflict** | |
| Purchasing – Finance | -.31; .04; 43 |
| Sales – Finance | -.32; .05; 40 |
| Project management targets | |
| Extent of budget overruns*** | -.44; .001; 49 |
| Extent of schedule overruns**** | -.25; .07; 55 |
| Steering committee | |
| Majority voting | .37; .01; 45 |
| Seniority-based decision making | -.44; .003; 45 |
| Focused on making crucial impl. decisions | -.29; .05; 46 |
| Other | |
| Project initiated by IT | -.32; .01; 59 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* On a four-point scale with “0” for “No improvements have been made”, “1” for “Outcome below original expectations”, “2” for “Outcome met original expectations”, and “3” for “Outcome surpassed original expectations”

** Scale: 1: no conflicts emerged; 2: minor conflicts emerged during the implementation phase which, however, were quickly settled by the project team; 3: major conflicts emerged during the implementation phase which could, however, be resolved by the project team; 4: major conflicts emerged during the implementation phase which had to be resolved by the steering committee; (5) major conflicts emerged during the implementation phase which have not yet been resolved

*** On a three-point scale with “1” for “less than 5%”, “2” for “more than 5%”, and “3” for “more than 10%”

**** On a three-point scale with “1” for “less than one month”, “2” for “more than one month”, and “3” for “more than three months”

Regarding the negative association between the degree of management satisfaction with project results and occurrences of cross-functional implementation conflict, it might be that conflicts during implementation lead to unresolved problems which show up only later. However, the association of management satisfaction with project management targets suggests a different interpretation, namely that cross-functional implementation conflict increases the risk of budget and schedule overruns (see Table 17). As compliance with the project schedule and budget is the most visible indicator of ‘project success’, implementation conflict may thus have an indirect impact on the degree of management satisfaction with project outcomes. This interpretation is supported by further analysis which shows that these associations are mediated by the extent of budget overruns.

A similar mediating effect of project management performance has been found regarding the association of the steering committee focusing on making crucial implementation decisions itself and the degree of management satisfaction with project results. However, the associations between the decision making principles (majority voting and seniority-based) do not seem to be

mediated by project management performance.¹¹ Thus, although generally it can be derived from these findings that management is mostly concerned with project management performance, some broader indicators of ‘project success’ are at play regarding the effect of the steering committee decision making style. One possible interpretation could be that ERP systems display certain characteristics which provide a better fit with ‘modern’ management systems as compared to ‘traditional’ management systems (see section 4.2). Thus, in addition to possible causal relationships between steering committee characteristics and project results (see section 4.3), the issue of fit between information system and management system might explain the associations reported in above.

Again, we find a negative association with projects being (also) initiated by the IT department which is, however, mediated by project management performance (extent of budget and schedule overruns). Thus, a similar explanation as above (see section 4.3) applies.

These findings, on the one hand, corroborate those reported with regard to project management performance. On the other hand, they also indicate a possible bias in management evaluations of project outcomes since these seem to be concerned with project management performance only. This point is also strengthened by the fact that we did not find any other association between the degree of management satisfaction with project results and other, broader indicators of project outcomes.

4.5 Degree of acceptance by users

The degree of user acceptance is negatively associated with the implementation motive of enabling future growth and positively associated with the frequency of steering committee meetings as well as with the participation of senior managers in the implementation project and a measure of the intensity of their participation as reported in Table 19. The associations reported in Table 19 are not mediated by formal forms of employee representation which is a likely mediating variable since it is also associated with the degree of user acceptance (see Table 11).

Table 19: Degree of user acceptance and implementation characteristics

| | Degree of user acceptance* |
|---|----------------------------|
| Implement. motive of enabling future growth | -.35; .01; 55 |
| Frequency of steering committee meetings** | .35; .02; 44 |
| Participation of senior managers in the project | .26; .05; 56 |
| Intensity of senior manager’s participation*** | .34; .03; 39 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* On a 10-point Likert scale with “1” for “very strong resistance towards the system” and “10” for “no resistance at all”

** Scale: 1: less than once a month; 2: once a month; 3: more than once a month

*** Measured as the product of no. of senior managers who participated in the implementation project and the average percentage of their total working time devoted to the project.

¹¹ Again, the association between majority voting and management satisfaction could only be controlled for possible mediating variables by using non-parametric procedures.

The negative association between the motive of enabling future growth and the degree of user acceptance seems puzzling. After all, the prospect of growth should dissipate any anxiety of job losses among employees which could be hypothesized as a major motive of ‘resistance’ to using new computerized information systems. This motive is, together with the motive of standardizing business processes, the second most important among the companies surveyed (see Figure 10). One possible interpretation is that rapidly growing companies already experience high levels of disruptions of day-to-day operations and thus implementation of an ERP system is considered as another source of disruption which adversely affects the ability of employees to ensure smooth operations or, rather, puts unacceptable stress on their daily routines.

The other three associations reported above strongly indicate the importance of active senior management involvement in the implementation project. A possible interpretation of this finding is that such active involvement of senior managers helps to resolve issues which would otherwise surface only after cut-over and lead to use problems. Another, not necessarily mutually exclusive interpretation is that a high degree of senior management involvement signals top management support for the project which discourages open resistance to the system. Finally, top management involvement may also be a motivating force for users as it communicates the importance top management is placing on the successful implementation of the new system.

The main implication of this finding for consultants and project managers is that top management involvement is indeed a major factor in ERP implementation projects as is often claimed (Willcocks et al. 2000; Holland/Light 1999; Bingi et al. 1999; Parr et al. 1999). Moreover, this finding indicates possible reasons for this association and the likely result of active top management involvement, namely to increase user acceptance. In the summary section we will come back to this point.

4.6 Extent of automation

The extent of automation as a result of the implementation project is associated with cross-functional implementation conflicts, the frequency of steering committee meetings, the experience of external consultants, a centralized control of the implementation project in group-structures, and the project being initiated by IT as reported in Table 20. However, these associations refer to two different measures of automation, namely the relative number of functions automated and the relative number of cross-functional data exchange relationships automated as a result of the implementation project. Only the experience of external consultants is associated with both measures. The construction of the measures is explained in the legend of Table 20. Note that the index measuring the extent of automated functions is a reverse index (i.e. it actually measures the relative number of functions not automated as a result of the implementation project for reasons explained in footnote 12). Thus, a positive association indicates a possible *negative* impact of the implementation process variables. As the two indexes measuring the extent of resulting automation were not associated with context factors (and are thus not discussed in section 3), we only controlled for variables associated with each of the implementation process variables reported in Table 20 and found no mediating effects. Therefore, we propose to consider the possibility of causal relationships which are discussed below.

Table 20: Extent of automation and implementation process characteristics

| | Relative no. of functions <u>not</u> automated* | Extent of autom. cross- functional data exchange** |
|---|--|---|
| Cross-functional impl. confl. between sales and finance | .52; .002; 32 | |
| Freq. of steer. comm. Meetings*** | | .42; .02; 30 |
| Initiation of project by IT | | -.31; .05; 39 |
| Project group-wide centrally controlled | | -.42; .02; 30 |
| Experience of consultants**** | -.36 ¹ ; .02; 44 | .35 ¹ ; .03; 38 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* This measure is constructed as follows: the number of functions which were not automated as a result of the project was multiplied by the number of modules implemented; thus a high value of this index indicates that a large number of functions has not been automated although a broad range of modules has been implemented whereas a low value indicates that only a small number of functions has not been automated although only few modules have been implemented. Thus, the index can be considered to measure the failure to automate functions as a result of the implementation project.¹²

** This index has been constructed by dividing the total number of cross-functional data exchange relationships which have been automated as a result of the implementation project by the number of modules implemented

*** Scale: 1: less than once a month; 2: once a month; 3: more than once a month

**** On a 10-point Likert scale with “1” for “very inexperienced” and “10” for very experienced

1: Product-moment correlation coefficient.

As reported in section 2.5, only the level of implementation conflicts between finance and sales can be statistically described by major conflicts among the several types of conflicts listed in the questionnaire. Thus, this type of conflict can be expected to cause further problems including the resulting extent of automation. However, it seems surprising that cross-functional implementation conflicts have a negative impact on the extent of automated functions rather than the extent of cross-functional integration (i.e. the number of automated cross-functional data exchanges). One possible interpretation is that some functions cannot be used or are impractical to use when data are not provided by another module. For example, profitability analysis depends upon financial data input; otherwise it cannot be used in the sales planning environment; (further analysis confirms that a failure to implement this function is associated with the degree of implementation conflict between sales and finance).

The positive association between the frequency of steering committee meetings and the degree of automated data exchange across functions points towards a possible causal relationship: Automating data exchange relationships across functions requires that trade-off decisions have to be made, which often can only be done at a senior management level; if the steering committee meets less frequently, these issues cannot be brought to the steering committee in order to avoid the risk of significant schedule overruns.

¹² The reason for this somewhat cumbersome construction is to prevent companies which had already automated a broad range of functions prior to the implementation project scoring low in the index measuring the resulting degree of automation.

The negative impact of the project being initiated by IT on the extent of automated cross-functional data exchange relationships can be interpreted in a similar vein: IT-led projects lack the authoritative resources to make the trade-off decisions required for automating cross-functional data exchanges. In contrast, the negative impact of group-wide centralized implementation projects points to a possible knowledge issue: in this case, the decision making level might be ‘too senior’ since functional departments might not be represented in the steering committee or only by corporate staff functions leading to a situation in which the steering committee lacks the requisite knowledge to make trade-off decisions across departmental borders.

The positive impact of the degree of external consultants’ experience on both measures comes as no surprise and confirms the importance of hiring experienced consultants. This, in turn, is affected by context factors (see Table 6).

Among the results reported in this section, three touch on recurring ‘themes’: implementation conflict, the activity of the steering committee, and the role of the IT department. This provides further evidence of the crucial role these factors play and thus stresses the necessity for consultants and project managers to take these into account in the planning and execution of an ERP implementation project.

4.7 Data maintenance problems

Most of the statistically discernible associations between variables describing the implementation process and the extent of data maintenance problems after cut-over disappear when controlling for context factors identified in the previous section as being associated with data maintenance problems such as foreign control/state ownership or degree of job security (see Table 12). Only those three associations reported in Table 21 do not seem to be mediated by context factors.

Table 21: Data maintenance problems* after cut-over and implementation characteristics

| | Bill of Materials | Vendor Master |
|-------------------------------------|-------------------|---------------|
| Initiation by IT | .31; .02; 52 | |
| Scope changes during implementation | | -.32; .02; 52 |
| Relative number of consultants** | | -.27; .06; 49 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases;
 * Scale: 1: no conflicts emerged; 2: minor conflicts emerged which, however, were quickly settled by the involved departments; 3: major conflicts emerged which could, however, be resolved by the involved departments; 4: major conflicts emerged which had to be resolved by top management; (5) major conflicts emerged which have not yet been resolved

** Number of consultants divided by total number of project team members

Problems regarding the maintenance of bill of materials are most prominent among all types of data maintenance problems (see Figure 19); thus, general problems with project management are most likely to show up for this problem category. As initiation of the implementation project by IT has been previously shown to be a frequent source of implementation problems or

unsatisfactory project results (see Table 18 and Table 17), we can consider it to be such a general problem. Under this assumption, a possible interpretation is that IT people lack the business understanding to acknowledge the importance of assigning clear responsibility to data maintenance tasks. Alternatively, IT people may lack the organizational clout to enforce such clear assignments of responsibility.

Regarding the negative association between scope changes during implementation and problems concerning vendor master data, one possible interpretation is that such scope changes might mitigate problems which otherwise would lead to data maintenance problems by customization or addition of functions not previously included in the project scope. This interpretation is also supported by the negative association of this problem category with the relative number of external consultants (i.e. in relation to project team size) which indicates that relatively more resources were required to implement the system.

No general recommendation for project managers and consultants is offered with regard to the latter interpretation, as it is only offered as a tentative interpretation here. With regard to the negative impact of IT initiated projects, we defer the general recommendation to the summary section.

4.8 Time for stabilizing the system after cut-over

The time for stabilizing the system after cut-over is associated with the relative number of senior managers and key users in the project team, as reported in Table 22. These associations have been controlled for likely mediating variables (specifically ownership) and found not to be mediated.

Table 22: Time for stabilizing the system and implementation characteristics

| | Time for stabilizing the system after cut-over* |
|---|---|
| Rel. no. of sen. managers in project team** | .52; .0001; 48 |
| Rel. no. of key users in project team** | -.29; .04; 48 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

* Measured by number of weeks

** No. of senior managers/key users divided by total number of project team members

Interpreting the association with the relative number of key users is obvious: on the one hand, more key users bring in more process knowledge thus preventing the creation of potential problems after cut-over and, on the other hand, also increase the project team's ability to quickly solve those problems which still appear after cut-over. However, it seems difficult to find a plausible explanation for the negative association with the relative number of senior managers in the project team. One possible interpretation is that a relatively higher number of senior managers simply implies a relatively lower number of other team members. This would indicate that senior managers and key users are considered to be substitutes. Thus, some companies might rather prefer to bring in department directors and the like for ensuring access to process knowledge, whereas other companies rely more heavily on key users. If this interpretation holds, the implication is that senior managers are not as suitable as key users for this purpose since more problems surface only after the project 'went live'.

The implication for consultants and project managers is to insist upon a broad involvement of key users rather than senior managers in the project team if a trade-off between those groups exists.

4.9 Service level declines after cut-over

As shown in Table 23, temporary service level declines after cut-over are associated with cross-functional implementation conflicts involving the purchasing department and a consensus-based decision making style in the steering committee. These associations are not mediated by context factors associated with each of the implementation characteristics reported in Table 23 (ownership characteristics). (The response variable (service level declines) is not associated with any context factor and thus not discussed in section 3).

Table 23: Service level declines and implementation process characteristics

| | Service levels decline after cut-over* |
|--|--|
| Implementation conflict between purchasing and finance | .36; .03; 34 |
| Implementation confl. between purchasing and inventory | .35; .04; 36 |
| Consensus decision making in steer. comm. | .47; .01; 33 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases
 * Service level was defined as percentage of in-time deliveries

A causal relationship between cross-functional implementation conflict and service level declines can exist if this type of conflict results in some issues not being resolved during implementation. As the associations reported above involve the purchasing department, it seems that service level declines are related to supply problems rather than distribution problems.

Similarly, the association of service level declines and consensus-based decision making in the steering committee hints at the possibility that this type of decision making leaves some issues unresolved due to the ability of any one steering committee member to block a decision.

The implication of these findings for consultants and project managers is that implementation conflicts may be an indicator of later problems unless they are properly handled. Thus, it is important to set up mechanisms for handling implementation conflicts before starting the project. This is especially indicated when the general decision making style in the company is based on a consensus principle.

4.10 Lead time reductions

Lead time reductions for several types of processes are positively associated with the decision making style and the role of the steering committee and negatively associated with the extent of budget overruns, initiation of the project by the IT department, and the conduct of a formal evaluation of project outcomes. These associations have been controlled for likely mediating effects (see Table 13 and Table 9) and found to be generally not mediated. Exceptions include the association between production lead time reductions and role and decision making style of the steering committee which are mediated by foreign ownership (indicated by square brackets in

Table 24). However, as a general caveat for the following interpretation it should once more be noted that the number of observations for these associations is very small.

Table 24: Lead time reductions and implementation characteristics*

| | Production lead time | Purchasing lead time | Delivery lead time | Prod. plan. lead time |
|--|----------------------|----------------------|--------------------|-----------------------|
| Extent of budget overruns | -.87; .0001; 13 | -.63; .0005; 17 | -.55; .03; 16 | |
| Consensus-based dec. mak. in steer. comm. | [.67; .02; 11] | .62; .02; 14 | .68; .01; 14 | |
| Steer. comm. focuses on appr. crucial impl. dec. of proj. team | [.66; .03; 11] | .68; .01; 14 | | |
| Initiation by IT | | | | -.55; .03; 17 |
| Form. eval. of proj. outcomes conducted | | | -.49; .05; 16 | |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases
 * Lead time reductions are measured as percentage of original lead time

The negative association between the extent of budget overruns and lead time reductions for three processes implies that well managed projects also deliver better results. This implication is all the more important as ultimately most benefits related to an ERP implementation stem from faster processes.

The positive association with the role and decision making style of the steering committee points once again at the crucial role of the steering committee for project results. A consensus based-decision making style will guarantee that concerns of all involved departments are reflected in steering committee decisions. Since the main effect of an ERP system is to improve the integration of processes and data across functional boundaries, this is an important issue. However, above we have also seen that a consensus-based decision making principle in the steering committee may lead to a larger number of unresolved issues which only surface after cut-over (see section 4.9). A steering committee focusing on approving crucial implementation decisions made by the project team (rather than making crucial implementation decisions itself) enables timely decision making and encourages project team members to take a more active role in the implementation project. The result is a better integration of processes and data enabling faster processing of business transactions.

Again, we find evidence of a negative impact of IT-initiated projects, in this case with the degree of lead time reductions in production planning. As production planning is probably the most demanding in terms of cross-functional cooperation, a weakness of project management to encourage and support such cooperation will have the biggest negative impact here.

Finally, the negative association between delivery lead time reductions and the conduct of a formal evaluation of the project results provides another reason for caution when interpreting

these findings since it indicates a possible bias in the answers: those companies which have not conducted a formal evaluation of project results are more likely to overestimate realized lead time reductions, at least with regard to delivery lead times.

For this reason, we also won't give further recommendations for consultants and project managers as these results can only be interpreted tentatively.

4.11 ROI known

In section 3.12 we reported on associations between reasons for realized financial benefits as a result of the implementation project and context factors. We don't think it is meaningful to analyze possible associations between these reasons and implementation process characteristics since causal relationships are difficult to hypothesize (this reflects the difficulty of assessing the financial benefits of IS projects per se). However, we find it illustrative to assess which types of companies can credibly claim to know the financial benefits of the implementation project. For this purpose, we have calculated the associations between implementation process characteristics and whether or not companies claim to know the ROI (return on investment) of their implementation project. We have then controlled these associations for two variables which indicate whether or not the companies have conducted a formal evaluation of the project results and whether or not respondents had been newly assigned as project managers without any actual involvement in the project since we found that in this case respondents are more likely to claim that they know the project's ROI. The association reported in Table 25 is not mediated by these two variables.

Table 25: ROI known and implementation process characteristics

| | ROI known |
|--|-----------------|
| Steer. comm. focuses on making crucial impl. decisions | -.53; .0001; 35 |

Legend: x; y; z: x: correlation coefficient; y: probability of association being non-significant; z: number of cases

This finding is interesting as it points to a possible problem in the 'governance' of the surveyed projects. The association reported in Table 25 indicates that if the steering committee focuses on making crucial implementation decisions itself (rather than letting the project team make these decisions) it is less likely to know the project's ROI. A possible interpretation for this finding is that a conflict of interest is involved here (if all crucial implementation decisions have been made by the steering committee, steering committee members are not inclined to blame themselves for a possible failure to realize financial benefits).

The implication of this finding (and the offered interpretation) for general management is that, apart from the many negative impacts of a more 'interventionist' steering committee reported above, there is also an issue of governance which needs to be addressed when defining the role of the steering committee. A clear separation of management and supervision seems desirable in order to ensure that the project will benefit the company as a whole.

4.12 Summary

The findings reported in this section demonstrate the importance of the extent and type of top management involvement in the implementation project. Regarding the extent of top management participation, we found that a relatively high frequency of steering committee meetings reduces the risk of both relatively higher cross-functional conflicts during implementation and a relatively stronger degree of user resistance to the new system after implementation; a relatively higher frequency of steering committee meetings is also associated with a higher degree of automated cross-functional data exchange relationships as a result of the implementation project. Moreover, the degree of user acceptance is positively associated with the very instance and extent of individual top management participation which underscores the importance of top management involvement for this particular outcome variable.

However, apart from the extent of top management involvement, we also find that the *type* of top management involvement has a strong impact on project results. Specifically, a more ‘traditional’ type of top management involvement, characterized by seniority-based decision making and centralized decision making is associated with a higher risk of budget and schedule overruns and a relatively lower degree of management satisfaction with project outcomes. Moreover, companies characterized by centralized decision making are less likely to have conducted a formal evaluation of project results. In contrast, a more ‘modern’ management style characterized by majority- or consensus-based decision making and delegation of crucial implementation decisions to the project team is associated with a lower risk of budget overruns, a higher degree of management satisfaction with project outcomes, and a relatively higher percentage of lead time reductions for purchasing and production. However, companies adopting a consensus-based decision making style in their steering committee are also more likely to experience service-level declines after cut-over.

Regarding the causal mechanism underlying these associations, we can only offer some tentative interpretations. We think that at least three such ‘mechanisms’ need to be considered. First, top management involvement may function as a conduit of conflict resolution throughout the whole project. As conflict emerges in early phases of the project, a relatively high degree of top management involvement may help to resolve it quickly, whereas a relatively low degree of top management involvement might lead to suppressing problems which will thus surface only later, when it is impossible or very costly to resolve them. This interpretation is supported by the association between cross-functional implementation conflict and a number of outcome variables, specifically the extent of schedule and budget overruns, the degree of management satisfaction with project results, the likelihood of service-level declines after cut-over, and the degree of lead time reductions as a result of the implementation project. However, we also found a distinct pattern of mediation in these associations. Specifically, the association between cross-functional conflict during implementation and the degree of management satisfaction seems to be mediated by the extent of budget and schedule overruns. Moreover, the extent of budget and schedule overruns seems to mediate a number of associations between the degree of management satisfaction and some process variables. Thus, the following causal chain can be constructed: extent of top management involvement -> degree of cross-functional implementation conflict -> extent of budget and schedule overruns and likelihood of service declines after cut-over -> degree

of management satisfaction with project results plus some other outcome variables (such as degree of lead time reductions).

Second, a ‘fit issue’ might be involved, i.e. an ERP system is more compatible with a relatively more ‘modern’ management system characterized by the steering committee’s decision making style and the extent of decision authority delegation. An indication for this interpretation is that, although the extent of budget and schedule overruns mediates some associations between steering committee characteristics and the degree of management satisfaction with project results, the effects of the decision making style (seniority-based vs. majority-voting) are not mediated by these variables. Thus, some ‘deeper’ issues might be involved here (apart from the project being in-budget and on-time) which could be related to the fit between the management style and the ‘philosophy’ of an ERP system. After all, the main thrust of an ERP system lies in its ability to bring decision information to operational levels and to control decisions by premises set in the system and by increased possibilities of supervising decision making.

Finally, a governance issue might be involved when considering the type of top management involvement in the implementation process. An indication of this interpretation is the negative association between centralized decision making (the steering committee focuses on making crucial implementation decisions itself) and the likelihood of having conducted a formal evaluation of project results. Thus, a steering committee committed to controlling a project rather than supervising it might be less inclined to evaluate project outcomes since this might entail criticizing its own conduct. Therefore, a clearer division between ‘managing’ and ‘supervision’ might be beneficial for projects since only in this case can the steering committee focus on improving the way of implementing a large-scale information system (as only in this case can it critically reflect on the management of the project itself).

In addition to the extent and type of top management involvement in the project we find that the experience of external consultants is associated with project outcomes, which should come as no surprise. However, we did not find a positive association between the degree of management satisfaction with project results and the degree of consultants’ prior experience. Rather, experienced consultants seem to reduce the level of cross-functional conflict during implementation and contribute to a relatively higher extent of automation as a result of the project. Moreover, the type of cross-functional conflict which is seemingly reduced by relatively more experienced consultants indicates that the positive impact of relatively more experienced consultants is due to their superior knowledge of the involved systems. The same interpretation seems plausible when it comes to the extent of automation achieved as a result of the implementation project. Thus, we can conclude that whereas the impact of the extent and type of top management involvement stems from top management’s ability to make difficult trade-off decisions, the experience of consultants contributes the requisite process and product knowledge.

The final point we want to make in this summary section regards the consistently negative impact of the project being initiated by the IT department. Specifically, IT initiated projects increase the risk of schedule overruns, reduce the degree of management satisfaction with project results, reduce the extent of automated cross-functional data exchange, increase the level of conflict in maintaining BOM data, and are negatively associated with production lead time reductions as a result of the implementation project. There are two possible explanations for these findings. The

first would maintain that IT departments do not understand the business issues involved, i.e. they are too focused on technical issues and thus fail to get business goals into their horizon. This interpretation would be partly supported by the negative impact of IT initiated projects on the extent of lead time reductions. A second interpretation would claim that IT departments lack the authoritative resources to enforce project management discipline. This interpretation is supported by the association with an increased risk of schedule overruns and IT initiative projects. Moreover, both interpretations might apply at the same time. Thus, apart from the crucial role of the extent and type of top management involvement in the implementation project, we conclude that a major predictor of 'successful' projects is whether or not they are initiated by the IT department.

5 Conclusions

Overall, this study has demonstrated three points. First, most implementation projects seem to be 'successful' in view of the degree of management's satisfaction with project results as well as some more 'objective' outcome variables such as lead time reductions. However, we have only a few cases in which companies actually reported on lead time reductions indicating the need for caution when interpreting this finding. It might even be argued that a failure of companies to know realized lead time reductions (if that is the reason for their failure to answer this question in our questionnaire) should be taken as an indication of concern, as companies seem to be too much concerned with project management targets (in-budget/on-time implementation) as a major indicator of project 'success'.

Second, institutional factors have a strong impact on the implementation process as well on the project's outcome. Specifically, ownership structures are associated with the extent of implementation conflict, the degree of top management participation and some measures of project outcomes, with foreign invested/controlled companies consistently reporting 'positive' results and process characteristics and state-owned companies associated with more 'negative' results and process characteristics. Also, the degree of job security turns out to be a strong predictor of project success. These findings could have been expected for several reasons. First of all, foreign invested companies are generally new companies; thus, implementing an ERP system can take a 'fresh approach' without having to consider entrenched business processes. Second, state-owned companies are burdened with a traditional management system which needs to be transformed in order to make good use of an ERP system. Indeed, many companies hope to be able to use an ERP project as a vehicle to transform the management systems. Finally, state-owned companies typically start from scratch, i.e. a purely paper-based control system whereas foreign companies bring with them a long tradition of experimentation with information technologies to support control systems (possibly including previous ERP implementations) which should give them an advantage when implementing an ERP system in China.

Third and finally, however, we find that after controlling for ownership structures, the extent and type of top management involvement are significantly associated with process characteristics and project results. This indicates that, whereas ownership issues certainly constrain management in the way they are implementing an ERP system, they do allow for significant scope in project management approaches. Specifically, the form of supervision and governance of the project has an independent (i.e., from ownership) impact on project results. However, it is not clear whether

this finding can be used as a lever to improve the results of an ERP implementation project. Specifically, can companies at will choose the form of supervision and governance in order to successfully implement an ERP system or is a ‘modern’ form of supervision and governance a precondition for successful ERP implementation? In other words, do companies first have to transform their management systems or can they use the ERP project as a catalyst to do so? This question cannot be answered on the basis of this survey. Rather, we need more in-depth case studies to address the underlying causal and social mechanisms. However, this survey has clearly raised the importance of this issue, namely the method of project supervision and government which, in itself, is an expression of the companies’ management systems. Clearly, ‘modern’ management systems render the highest returns on any ERP implementation project. Also, an ERP system might be used to transform a company’s management system. However, the way to achieve this is still an open question.

6 Appendix

6.1 Method

The goal of the survey was to study the processes of implementing ERP systems in Chinese companies. We limited the survey to users of SAP’s R/3 system for several reasons. First of all, it is difficult to obtain accurate address lists of companies using ERP software; second, in China it is currently illegal to send out unsolicited questionnaires; third, limiting the survey to one ERP brand also eliminates any variation in the data stemming from the differences between several brands. Thus, any variation in the results of the implementation projects which show up in the data must be either due to the specific situation of the company and/or the method of implementing the system. Specifically this last point ideally supported the purpose of our study, namely to identify practices in the implementation project conducive to successful implementation projects.

We were provided with SAP’s customer list as of February 2000. This list included 143 addresses. However, of these 12 belonged to the same company sometimes naming the same project manager. Therefore, we excluded these duplicate addresses. Moreover, we excluded another five companies since we had prior contact with these firms or intended to contact them later for individual case studies. For another 8 companies, we were unable to obtain accurate contact information (i.e. a valid telephone number). Thus, we had a list of 118 companies to contact. A team of three MIS students then started to contact these companies by telephone. The purpose of these calls had been to verify the contact person’s name and address information and to build support for our questionnaire. During these initial calls, 10 companies refused to participate in the survey. Thus, we then sent out a total of 108 questionnaires together with SAP’s annual customer satisfaction survey and a cover letter using Tsinghua University’s brand name. We used registered courier services for sending out the questionnaires (EMS) and included a post-stamped return envelop. We also included a token present and promised the companies a brief summary of survey results due in July the same year. Questionnaires were sent out on the day or one day after successfully contacting the company.

In order to increase the response rate, we would give companies a second call if we didn’t receive the questionnaires after two weeks of sending out. If necessary, we also called companies a third

time. However, we stopped giving companies repeat calls by the middle of May and no company had received a fourth call by that time.

In total, we received 83 questionnaires. Among these, two were not answered (only SAP's customer satisfaction questionnaire had been answered). In another case, only SAP's customer satisfaction questionnaire had been returned leaving us with 80 usable questionnaires. Seven companies told us in our repeat calls that they had sent out the questionnaires although we never received them.

Answers were then coded and extensively checked for validity. All answers whose validity seemed dubious were discarded. Since only part of the companies (61) had completed the implementation project, 19 questionnaires did not include answers about project results. Moreover, questions had often not been answered which increased the number of missing values. Finally, removing dubious answers increased this number even more. Therefore, the analysis of the data was limited to simple correlation analysis since building models including several independent variables would frequently reduce the number of usable observations to below 30.

The analysis then proceeded as follows. First, correlation analysis was conducted for all variables. Then, all statistically discernible associations had been marked and copied into a spreadsheet. Next, these associations were studied in detail; specifically, they were checked for plausibility and tentatively interpreted. Finally, all remaining associations were extensively checked for possible mediating effects as explained above (see sections 3 and 4) before finally interpreting these findings.

We used the product-moment correlation coefficient whenever cardinal measures were implied. In the case of ordinal measures, we used the Spearman correlation coefficient. Similarly, we used Least Square Regression analysis when controlling for variables expressed by cardinal measures and the Logistics procedure when variables were expressed on an ordinal scale. All analyses have been conducted using SAS's statistical software package version 6.12.

6.2 Questionnaire

Appended separately

6.3 References

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