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Effective ERP adoption processes: the role of project activators and resource investments

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Abstract

The aim of this paper is to demonstrate whether stakeholders activating a project shape team building, the structure and magnitude of resource investment levels, and to what extent these levels impact ERP project effectiveness. The process view of an ERP project includes project initiation, system justification and funding, implementation, and early system use. Results from a nationwide empirical survey conducted in Austria (N = 88) show that activating actors influence team formation and resource investments, which impact project effectiveness levels. Resource-intensive justification and funding phases tend to precede resource-intensive implementations in heavy-weight projects, which seem to be less effective than light-weight projects. Resource and change conflicts are associated with lower project performance and are more common in resource-intensive ERP projects, where early system use appears to be relatively less stable.

Keywords

ERP stages; IT costs; IT value; adoption decision; team formation; empirical survey

1. Introduction

Effectively assessing and implementing enterprise-wide Information Systems (IS) such as Enterprise Resource Planning (ERP) in organizations remains to be difficult (Gunasekaran et al., 2008, Aloini et al., 2012). The adoption of ERP systems in an organization is a time and cost-intensive venture with far-reaching consequences for the way the entity is structured and conducts its business. Because of the complex acquisition and implementation procedures in companies (Bernroider and Koch, 2001, Uwizeyemungu and Raymond, 2009, Umble et al., 2003), projects are far too often perceived as only partial successes or are even abandoned prior to completion. Managers find it difficult to assess the performance of ERP projects against the backdrop of changing stakeholder perceptions (Besson and Rowe, 2001, Markus et al., 2000a) and demanding resource requirements (Sharma et al., 2008, Bernroider and Koch, 2001).

IS research has only begun to recognize the importance of activators in framing and setting the direction for an ERP adoption project (McLaren and Jariri, 2012, Boonstra, 2006). Being able to appreciate the source of any IT innovation project is essential to understanding its requirements and how the project team materializes. In previous research, early team formation was emphasized as a central aspect of ERP adoptions (Bernroider and Koch, 2001). Project teams may be participative, balanced or biased towards different internal or external stakeholder groups. Effective IS planning should involve extensive participation (Peffers et al., 2003) and avoid conflicts during implementation (Besson and Rowe, 2001).

Organizations continue to struggle with the high levels of resources needed for successful ERP adoption. ERP systems are cross-functional platform solutions associated with great socio-technical complexity, and therefore demand resource-intensive justification and funding stages (Stefanou, 2001) and implementation procedures (Sharma et al., 2008). Business executives are facing a lot of uncertainty about when to invest in which resource to effectively adopt ERP in their organizations.

Against this backdrop, we investigate whether effective ERP adoption projects can be associated with resource investment decisions at different project stages, and analyze the respective roles of stakeholders in ERP project design. Our results offer managerial insights on the timing of effective staffing and resource investment decisions for ERP projects. The three central points of this empirical study include the important role of stakeholders in ERP project initiation, a two-staged view of expended resources for ERP adoption, and the question how these resource investment levels impact the overall performance of the ERP

project. The methodology is a quantitative empirical survey of Austrian ERP adopters. Our stratified random sample comprises 88 mid-sized and large organizations. We used non-parametric statistical methods (independence tests and correlation analysis) and principal component analysis (PCA) to test five research hypotheses.

This study makes a number of contributions to the IS adoption literature:

1. The paper offers new descriptive insights in terms of ERP activators, distributions of various resource metrics over ERP project stages, and ERP project effectiveness levels. This information aims at giving managers an understanding of some common design practices in ERP adoptions.
2. It offers a better understanding of relationships between the roles of ERP activators in team formation and resource investment decisions with regard to different project stages.
3. It distinguishes between resources expended for different project stages. Moreover, we show that levels of expended resources are related between stages.
4. It demonstrates that a broad definition and multiple measures of project effectiveness can describe the failures and successes of ERP projects. We link these measures with levels of expended resources and thereby show that, for example, heavy-weight ERP projects are less effective.

2. Literature review and research motivation

This section very briefly summarizes results of previous research about the nature and scope of ERP projects emphasizing resources expended and the role of stakeholders.

2.1. Nature and scope of ERP projects

ERP projects continue to experience schedule delays, cost escalations and reduced quality when the system is finally operational. Only 13% of organizations think their ERP adoption projects are meeting expectations with regard to improvements in business processes or business value delivery. More than 50% of companies rate their ERP adoption as unsatisfactory (Panorama Consulting Group, 2009). The main reason for this situation is the complexity of the underlying radical organizational change, which is of strategic nature and software-intensive (Besson and Rowe, 2001). An ERP adoption requires high levels of resource investments and has far-reaching organizational implications (Gunasekaran et al., 2008, Stockdale et al., 2008).

Adding to the problem of underachieving ERP projects are changing perceived expectations of stakeholders and their actions to influence the course of the project.

Stakeholders in ERP projects usually try to influence the course of the project (Boonstra, 2006). However, a specific success or failure at one point in time may only be loosely related to the perceived situation at another point in time (Markus et al., 2000a). It seems important to develop some governance and control over stakeholders (Johnstone et al., 2006). The early stage of ERP project initiation may already determine the influence of stakeholders and levels of implementation conflicts (Besson and Rowe, 2001).

The ERP adoption project consists of multiple stages (Bernroider and Koch, 2001). Project management theory suggests distinguishing between two main stages in any IT project: a design and a delivery stage (Maylor, 2010). In the context of ERP, prior literature used the terms "selection," "chartering," and, more recently, "justification and funding" to describe the design stage. Typical design tasks include evaluating requirements, risks, alternatives and implementation options, and framing the project including the funding strategy (Bernroider and Koch, 2001, Aloini et al., 2012). Project delivery, also termed "implementation" or "project phase," relates to adapting organizational routines and introducing the information system to different organizational units. An ERP project may also include a "shakedown" or "early-use" stage, referring to the period after implementation until a routine service is established (Markus and Tanis, 2000). Prior research has shown that ERP projects exhibit different characteristics in these stages, leading to the notion of "ERP dynamics" (Besson and Rowe, 2001). During the project, perceptions of involved stakeholders change from technological to organizational imperative positions. The latter dominate in the implementation stage, when integration/differentiation choices and diverse stakeholder conflicts need to be overcome.

It is hard to measure the failure or success of any dynamic and software-intensive project. This particularly applies to ERP projects. In project management, the meaning and choice of performance metrics remain an active area of research. No clear-cut definition of successful and failed projects is available (Agarwal and Rathod, 2006). Process metrics of IT projects usually comprise the implemented scope of original requirements, plan effectiveness, and early operational impacts (Maylor, 2010, Mabert et al., 2006). Early operational impacts refer to the time between going operational and achieving a "routine use" of the system (Markus and Tanis, 2000). This phase was considered in prior studies as a time period of several months causing organizational performance dips, which may be (McAfee, 2002, Jones et al., 2011) or may not be (Markus et al., 2000b) recovered. Performance dips were reported in regard to, e.g., process cycle times, inventory levels, and operating labor costs

(Boonstra, 2006). Outcome quality, either system or information related, is the main independent success variable in the D&M IS success model (DeLone and McLean, 1992). Leading indicators of quality problems are conflicts arising during system implementation. Literature distinguishes between conflicts over strategy (Lee and Myers, 2004), relationship and social conflicts (Jehn and Bendersky, 2003), and task conflicts stemming from disagreements about the nature and fit of tasks and functions, in particular between IS users and developers (Liu et al., 2011b). Consequently, ERP projects should be evaluated against multiple goals to understand their overall levels of effectiveness (Markus et al., 2000a).

2.2. Research problem and objectives

The above discussion has shown that failure to account for changing stakeholder perceptions has repeatedly been identified as a major problem in troubled ERP projects. Furthermore, considerable amounts of a company's resources are invested in multi-staged ERP projects. Finally, it was found that despite the significance of ERP projects, far too many result in only partial success or even abandonment prior to completion. Whilst the mentioned studies have increased our understanding of these three aspects in isolation, little empirical work has been conducted to establish the important associations between these dimensions. To investigate these links further, we now define three research objectives to guide the paper.

Firstly, it is crucial to find out whether early activators impact team formation and influence the resource investment decisions made with regard to different stages of the project. It is possible that despite the literature's consensus on the stakeholders' general importance, the critical issues of staffing a project team and assigning resources to the project are not related to the stakeholders dominating ERP activation.

Secondly, we set out to investigate expended resources not only for the ERP project implementation stage but also for the ERP project justification and funding stage. We seek to understand whether levels of expenditures are related between these two stages, and whether they are influenced by the ERP activators.

Thirdly, in order to contribute to a better understanding of the failures and successes of ERP projects, we need to investigate whether the levels of resources expended in a project stage are associated with particular levels of project effectiveness.

3. Research design

3.1. Conceptual model

Drawing upon the literature review and the three research objectives, we developed a three-tier conceptual model as shown in Figure 1. The dependent variable in our model is ERP

project effectiveness. The middle dimension reflects the expended resources, and the independent variable captures the roles of stakeholders in ERP activation. The next section will develop the hypotheses.

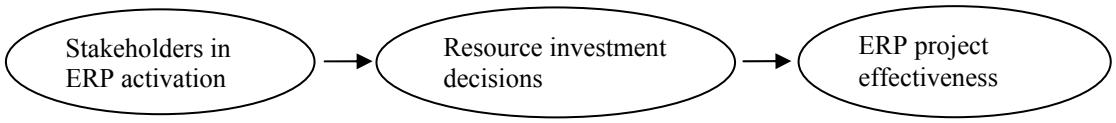

Figure 1. Three-tier conceptual model

3.2. Research hypotheses

Our review of the literature on ERP adoption in section 2 suggests that successful adoption requires both high levels of resource investments and that decisions about the structure and levels of expended resources may be dependent on stakeholder involvement. Next, we will explore each of these anticipated relationships more specifically, and summarize our assumptions as research hypotheses to be tested with the empirical data.

The role of ERP activators

The activators of the ERP project can promote certain team structures, possibly to the advantage of their stakeholder groups. Participative and balanced designs, equally reflecting the values and ideas of many, support effective decision making and increase acceptance rates (Davenport, 1993, Sarker and Lee, 2003, Ke and Wei, 2008). The early screening process can be managed to further a more widespread inclusion of stakeholders in the project team (Hsu et al., 2011). We assume that the source of the initial need has implications for staffing the project. A project initiated by the IT department may be configured as a technology-driven project rather than an organizational change project (Kumar et al., 2002). ERP systems triggered by senior management may, in turn, be perceived as threats to the internal IT department (Besson and Rowe, 2001).

Stakeholders influence the design and course of the ERP project, and potentially to the advantage of their own interest groups (Boonstra, 2006). This should equally apply to stakeholders activating the project with regard to team design, and the levels and structures of expended resources. A technology-driven project may require a more extensive justification and funding stage, while a strategy-led project or a re-organization project may require more overall resources as they reflect more radical shifts in the organization's culture. Early participation of senior management should provide more leadership in the strategic

formulation process (Sarker and Lee, 2003), which may require less support from outside strategy consultants. Therefore, we derive the following hypotheses from prior research.

H1a: The role of the ERP activators is associated with the functional balance of the ERP project team.

H1b: The role of the ERP activators is associated with ERP resource investment decisions at different stages of the project.

The role of expended resources

ERP projects are in general resource-intensive (Bernroider and Koch, 2001). However, we have little information on how resource expenditures for the justification and planning stage are related to expenditures in the implementation stage. Most available studies focus on one or the other stage. It is known that complex projects require more careful planning (Maylor, 2010). The higher the complexity, the more eventualities need to be considered, which likely increases the efforts for all stages of the project. We assume that the complexity of the ERP project will be equally reflected in both stages when it comes to expended efforts.

The so-called Iron Triangle of projects predicts that by accepting higher levels of expended resources (costs and time), higher levels of quality can be realized. These trade-offs can be done deliberately based on goal preferences to achieve an effective project outcome (Barney et al., 2012). Contemporary research suggests more variables or holistic views (e.g. Jha and Iyer, 2007, Marques et al., 2011), but the mentioned principle can still be considered valid.

Related research has provided contradictory results as to whether and which types of conflicts are helpful in IS projects. Empirical research seems to predominately confirm a negative view. For example, it was reported that task conflicts related to requirement diversity correlate negatively with final project performance (Liu et al., 2011a) and that interpersonal conflicts are major barriers to IT project success (Johnstone et al., 2006). However, it was also established that avoiding conflicts is not beneficial for an organizational change (Meissonier and Houzé, 2010), in which conflict is a natural and necessary aspect of any innovation. The complexity of the subject is further increased by fluctuating conflict characteristics in different IS project phases (Yang and Tang, 2004).

Hence, these considerations lead us to the following hypotheses.

H2a: The more resources are expended in the justification and funding stage, the more resources are expended in the ERP implementation stage.

H2b: The more resources are expended for the project, the more effective the ERP project becomes.

H2c: Encountered implementation conflicts are associated with lower ERP system quality and project performance.

3.3. Instrument development and pre-testing

The instrument was derived from previous ERP studies (Bernroider and Koch, 2001, Baki and Çakar, 2005). A panel of ERP experts from two universities in Austria and the UK examined the survey instrument for content validity (Dillman, 1978). In particular, a clear separation of stages from the initial ERP adoption decision to system use was established to structure the instrument and account for the process-oriented view of the study. According to their suggestions, the questionnaire was revised and used in pre-tests conducted in the UK and Austria.

3.4. Variable selection and operationalization

The following list describes how the various variables were conceptualized and measured. Table A3 in the Appendix specifies the instrument with the respective questions, and the IDs and scales of the variables.

Profile of respondents: Respondents were asked to categorize their organization in terms of the numbers of customers (SC) and suppliers (SS). We also asked for the implemented modules of the ERP system (SM). The European Amadeus Database (Bureau-van-Dijk, 2003) provided more firm level information such as the numbers of employees and subsidiaries, legal forms, and the industry sector.

Activation stakeholders and project teams: We considered five different ERP project initiator types (EI) and four different team structures (PT) in differently balanced formations based on prior research on ERP selection (Bernroider and Koch, 2001).

Expended resources: This section distinguished between expended resources for the justification and funding, and implementation project stages. Resources were conceptualized by capturing durations (RT), expended labor time and external support (RL), and monetary costs excluding licensing (RC). We later complemented the analysis with an indirect assessment of personnel costs following suggestions from prior research (Buxmann and König, 1997). This allowed the construction of more estimation variables (RL3-4, RC2). Estimations were based on the given person months (RL1) and the proportion of external support (RL2). The estimated costs, derived from salary estimates (Grohs, 2003), for an

external person month were 23,100 EUR (used to calculate RL4), and for an internal person month 6,000 EUR (used for RL3).

Implementation conflicts: We conceptually linked conflicts to perceived related implementation problems in a very broad view. The options (IS) covered social, task, technical and resource related aspects (Jehn and Bendersky, 2003, Johnstone et al., 2006, Liu et al., 2011b).

System level effectiveness: We considered a number of criteria (SQ) to account for the quality of the implemented ERP system (DeLone and McLean, 1992).

Project performance: We included three dimensions of project performance in the survey. Scope achievements (PP1) reflect the implemented functionalities of the ERP software against the original requirements. Plan performance (PP2) shows the expended efforts against the plan (Maylor, 2010, Mabert et al., 2006). Performance dips after going operational (PP3) reflect early use performance (Markus et al., 2000b, Boonstra, 2006).

General outcome: Finally, this study considered three ERP outcome variables (OU), which we used for separately assessing reliability of responses and non-response bias.

3.5. Data collection procedures

The data was collected in Austria through a nationwide empirical survey based on a stratified and disproportional random sample comprising 1,000 Austrian companies. The sample was randomly drawn from the European Amadeus database (Bureau-van-Dijk, 2003). The large sample size was necessary to ensure a satisfactory representation of ERP adopters from a population of 24,081 organizations. The target population for this study, however, is smaller and can be defined as all registered medium and large enterprises in Austria having at least started to implement ERP. A stratified and disproportional random sample with subgroups according to company size was necessary to avoid under-representing large enterprises. The hardcopy questionnaire was distributed to the business-management of each of the 1,000 companies with a link to an electronic version of the questionnaire. We used follow-up calls and reminder/thank-you emails to explain the study and increase participation. Incentives included the survey report and possible collaboration in case study research.

3.6. Sample characteristics and evaluation of non-response bias

The multi-staged data collection of the empirical survey resulted in 209 valid returns and a 22% initial response rate considering neutral dropouts (49 companies). These dropouts refer to companies with wrong addresses or to companies that no longer existed. In accordance with our target group, we excluded small enterprises, where ERP is not a common IT

strategy, to allow for a more homogenous sample and more reliable statistical analyses. This procedure reduced the initial sample to 152 medium and large enterprises, but increased the response rate to 24%. Additionally, 64 non-adopters and early-stage ERP adopters still evaluating systems were also excluded. This exclusion did not reduce the response rate as the target population was narrowed down by an equal proportion. Consequently, this study used 88 medium and large organizations in data analysis. All of these organizations have progressed at least to the ERP implementation stage according to the four-phase framework of Markus and Tanis (2000). The screening for possible aberrant response behavior, such as random responding (Berry et al., 1992, Thompson, 1975), triggered no further exclusions of data sets.

Table 1 shows sample characteristics derived from primary and secondary data (Bureau-van-Dijk, 2003). Most organizations have high numbers of customers and suppliers. Medium enterprises employ between 50 and 249 persons with an annual turnover not exceeding EUR 50 million (EC, 2003).

Table 1 Sample characteristics

Characteristic	Frequency (unweighted)	Percent (weighted)
Organizational size[1]		
Medium-sized enterprises (ME)	31	59.6
Large enterprises (LE)	57	40.4
Number of customers [2]		
Up to 9	2	3.4
More than 10	6	5.9
More than 100	12	14.0
More than 1,000	44	57.7
More than 10,000	7	10.8
More than 100,000	13	8.2
Number of suppliers [2]		
Up to 9	1	.7
More than 10	6	10.8
More than 100	34	47.5
More than 1,000	34	38.4
More than 10,000	3	2.0
More than 100,000	1	.7

[1] Secondary data from the European Amadeus database (Bureau-van-Dijk, 2003)
[2] Primary data from the survey

Potential non-response bias was assessed following two different approaches. The first approach compared respondents and non-respondents. The analysis based on variables from the Amadeus database revealed no significantly different characteristics between these groups

in terms of legal form (e.g., limited or public companies), number of employees, and number of subsidiaries as measured by chi-square (χ^2) and two-sample unpaired t tests (see Appendix Table A1). As this approach can only be calculated for characteristics known for both subgroups, we also compared early versus late respondents. This wave analysis approach regularly used in IS and management accounting surveys (Van der Stede et al., 2006, Wu and Wang, 2006) is based on the assumption that late respondents more likely resemble non-respondents than early respondents. In this case, the following ERP outcome variables were considered: changes in the workforce structure and quantity connected with ERP (O1), competitive edge through ERP (O2), and the availability of IT/IS services after ERP implementation (O3). The detailed chi-square (χ^2) test results were also included in the Appendix (Table A2). The comparison revealed no statistically significant differences for either variable between waves, thus providing no evidence of non-response bias.

3.7. Common method bias

Common method bias or common method variance (CMV) is generally considered in empirical organizational research (Malhotra et al., 2006 , Podsakoff and Organ, 1986). This paper is based on a mono-method research design and a self-report instrument, which may cause a certain amount of covariance shared among all indicators. This research applied the Harman's single-factor test as a diagnostic technique to test for CMV. It involves entering all constructs into a principal components factor analysis to see if either a single factor or a general factor emerges that may account for the majority of covariance among measures (Podsakoff et al., 2003). Seven factors emerged. The first accounted for 34% of the variance. The other six (with eigenvalues greater than one) contributed to the remaining 67% of the variance explained by the set, each accounting for 5% to 19%. This suggests that while there is likely to be some CMV, the effect is relatively small.

3.8. Statistical methods

For data analysis, we used SPSS with activated sampling weights to account for the disproportional, stratified random sample (Purdon and Pickering, 2001). The research hypotheses were mainly tested with non-parametric statistical tests including the Mann-Whitney test and the Spearman rank correlation coefficient (Sprent and Smeeton, 2007). Both tests work well with the ordinal responses in our data set and are more robust than their parametric equivalents. We used Principal Component Analysis (PCA) to achieve an orthogonal transformation to convert possibly correlated variables into a smaller set of linearly uncorrelated factors. Varimax rotation was used to see how groupings of variables

measure the same concept (Hair et al., 1984). The factor scores for the composite variables representing the factors were calculated with the regression approach (Thurstone, 1934). PCA was also applied to test for common method bias to understand the systematic error variance shared among variables due to the measurement method (Podsakoff et al., 2003).

4. Research results

4.1. Descriptive analysis

The aim of this section is to present a descriptive summary with regard to levels of ERP project effectiveness, structures and levels of expended resources, and the distribution of ERP activators over business functions. The following three subsections directly relate to the three specific research objectives proposed earlier. We ran independency tests (Mann-Whitney test) to understand the roles of our control variables (organizational size, implementation scope) and only mention statistically significant findings in this respect. Implementation scope is conceptualized with the number of implemented ERP modules (mean = 2.48 modules).

ERP project effectiveness

We developed three dimensions – conflicts, system quality, and project performance – to gain a richer understanding of project effectiveness.

The occurrences of implementation conflicts are shown in Table 2. In the mean, 2.56 conflicts are observed in an ERP adoption project and almost 90% of all cases experience at least one conflict. Most problematic are resource escalations, system-related incompatibilities, and user resistance. LEs regularly experience more conflicts in ERP implementation (Mann-Whitney test, $p < .05$).

Table 2 Implementation conflicts

Characteristic	ME (%)	LE (%)	All (%)
Time escalation	30.6	43.0	35.4
System did not work as expected	35.3	34.0	34.8
Cost escalation	28.1	43.7	34.2
User resistance	30.6	34.0	31.9
Integration with legacy systems	25.6	30.1	27.4
Capability of organizational infrastructure	20.1	34.7	25.7
Organizational fit	23.1	24.7	23.7
Availability and retention of skilled people	14.7	33.2	21.9
Lack of management support	12.2	8.0	10.6
Number of conflicts (mean)	2.31	2.96	2.56
At least one conflict (%)	89.1	89.2	89.1
More than one conflict (%)	65.9	81.3	71.8

In the mean, organizations implement effective ERP systems (see Table 3). All system level aspects were evaluated on or above the middle threshold of three, which accounts for a neutral assessment. Respondents were most satisfied with the reliability of their ERP systems and least impressed by the ERP system as an enabling technology for follow-on investments.

Table 3 Perceived levels of ERP system effectiveness

System criteria[1]	ME (mean)	LE (mean)	All (mean)
System reliability	4.4	4.1	4.3
System functionality	3.6	3.6	3.6
System internationality	3.6	3.4	3.6
System usability	3.6	3.3	3.4
System interoperability	3.6	3.2	3.4
System flexibility	3.5	3.2	3.4
Connectivity (intra/extranet, mobile comp., …)	3.5	2.8	3.1
Enabling technology for CRM, SCM, etc.	2.9	3.0	3.0

[1] Perceived expectations on an interval scale: 1 = not reached to 5 = exceeded

Effective ERP systems are delivered by slightly underperforming projects with regard to classic project management metrics (see Table 4). ERP projects do not achieve the full scope of original requirements with a reported mean gap of almost 15%. Plan performance is also lower than expected. Furthermore, more than every other project experienced organizational performance dips after switching the system to operational use.

Table 4 ERP project performance

Variable	Metric (unit)	Means		
		MEs	LEs	All
PP1	Scope performance (%)	87.4	85.0	86.4
PP2	Plan performance [1]	-.29	-.22	-.26
PP3	Early-use performance	Proportion (Y in %)		
	Sustained dip	0	2.2	.8
	Long-term dip	12.9	18.8	15.1
	Short-term dip	41.3	26.8	35.9
	No dip	45.8	52.2	48.2

[1] Perceived performance on an interval scale: -1 (lower than expected) to +1 (higher than expected)

Structure and levels of expended resources

ERP projects are resource-intensive and show high levels of variation in terms of expended resources. Table 5 provides all considered metrics divided into the justification and funding,

and the implementation stages. The average time to complete an ERP project is 18.9 months with a standard deviation of 12.9 months. This finding compares well with a survey of Swedish ERP projects reporting a mean ERP project time of 17 months with high levels of variability between projects (Olhager and Selldin, 2003). In LEs, overall ERP project costs amount to EUR 1.2 million (RC1) plus EUR 232,000 worth of internal time consumption for the project (RL3). The Swedish study reported average total project costs of USD 1.68 million.

Only the resource metrics related to the implementation stage are significantly dependent on the size of the organizations (Mann-Whitney test, $p < .05$), the metrics for the justification and funding stage are not. This is a surprising result. MEs show a different balance of resource investments over project stages. They need to invest proportionally more in the justification and funding stage than their larger counterparts. The ratio of implementation costs to overall costs is significantly lower in MEs (67.5%) than LEs (93.3%) (Mann-Whitney test, $p < .01$).

Table 5 Expended resource metrics with their means

Var.	Resource investments	Just. & funding			Implementation			Both phases		
		MEs	LEs	All	MEs	LEs	All	MEs	LEs	All
RT1	Time (months)	6.8	7.4	7.0	10.0	15.5	12.2*	16.4	22.6	18.9*
RL1	Int. and ext. labor (person months)	5.8	8.2	6.6	19.8	56.9	35.9**	27.7	61.8	42.0*
RL2	Proportion of ext. labor (%)	16.7	26.2	20.6	26.5	39.4	32.4*	25.6	37.1	30.7*
RL3	Estimated int. labor costs (K€)	31.6	41.8	35.6	112.7	232.3	171.6*	168.5	264.7	205.8
RL4	Estimated ext. labor costs (K€)	28.5	31.47	29.7	102.9	420.7	248.7*	183.4	431.2	278.7
RC1	Overall costs without int. time (K€)	21.8	75.9	35.9	170.5	1,218.7	375.9*	191.5	1,238.9	396.7**
RC2	Overall costs incl. int. time (K€)	53.4	117.1	79.4	285.1	1,447.8	841.2**	357.8	1,530.1	918.6**

Significantly different distributions between MEs and LEs (Mann-Whitney test): * $p < .05$; ** $p < .01$

ERP activators and teams

Senior managers are by far the most common ERP activators; the IT department plays a much less prominent role in this aspect (see Table 6). The other stakeholders known to potentially influence the launch of ERP projects do not make themselves heard. External stakeholders such as vendors and consultants surprisingly seem to have hardly any direct relevance in this early pre-appraisal stage of the project. A notable influence of other non-conventional initiators was especially identified in MEs.

The most common project-team type is biased and dominated by the IT department. However, participative forms are the most common project teams among LEs. The equal

participation of major actors was also found to be essential for the success of IS projects (Besson and Rowe, 2001, Peffers et al., 2003).

Table 6 ERP triggers and team structures

Characteristic	ME (%)	LE (%)	All (%)
Role of ERP initiator (EI)			
EI1: Senior management	52.2	74.2	60.5
EI2: Internal IT department	30.7	12.9	24.0
EI3: Internal organization department	6.1	7.4	6.6
EI4: IT and strategy consultants	1.1	1.8	1.4
EI5: Software vendors	.0	.0	.0
EI6: Other	9.9	3.7	7.5
ERP project team balance (PT)			
PT1: Dominated by business management	21.8	24.7	23.2
PT2: Dominated by IT department	40.8	22.3	32.4
PT3: Dominated by organization department	17.0	8.6	13.1
PT4: Equal participation of all major stakeholders	20.4	35.7	27.4

The distribution between MEs and LEs not differ significantly in any case (Mann-Whitney t., $p < .05$)

4.2. Factor analysis

We applied exploratory Principal Component Analysis (PCA) to the variables measuring conflicts and system-related performance criteria to reduce dimensionality and transform the correlated items into a reduced set of factors. This allowed for a more meaningful testing of the research hypotheses in the following section.

A sensible four-factor solution comprising change, resource, task and integration conflicts emerged from a Varimax-rotated component matrix (see Table 7). This solution fits the discussed theory on conflicts, in which similar categories can be found, well (e.g. Liu et al., 2011b, Besson and Rowe, 2001). Each of the nine indicators loaded above the 0.5 threshold on its respective factor, with cross-loadings below this threshold (Hair et al., 2008) for all but one marginal case (IS6). The four factors accounted for 67% of the variance. Factor scores were used as composite variables in subsequent analyses providing information about the project's placement on the respective factors (Mîndrilă, 2009).

Table 7 Rotated component matrix for implementation conflicts

Item	Description	Four-factor solution			
		IC1 – Change conflicts	IC2 – Resource conflicts	IC3 – Task conflicts	IC4 – Integration conflicts
IS1	User resistance	.812	.195	.227	.144
IS2	Capability of organizational infrastructure	.725	.194	-.191	-.377
IS3	Lack of management support	.703	-.351	-.111	.182
IS4	Cost escalation	-.070	.807	-.081	.175
IS5	Time escalation	.083	.804	.130	-.002
IS6	Availability and retention of skilled people	.244	.484	-.450	-.136
IS7	System did not work as expected	.373	.149	.700	.101
IS8	Organizational fit	-.198	-.062	.661	-.293
IS9	Integration with legacy systems	.048	.102	-.086	.850
	Kaiser-Meyer-Olkin measure of sampling adequacy	.56	Bartlett's test of sphericity	Chi-square df Sig.	88.5 36 .000

The same procedure produced a sensible two-factor solution for system-related achievements representing a joint variance of 60% once we dropped one item (see Table 8). We then distinguished between system quality and integration/information quality. Theoretically, this aligns well with the same two-tier quality dimension from the original D&M IS success model (DeLone and McLean, 1992). Again, regression scores for these two factors were used as consolidated measures in subsequent analyses.

Table 8 Rotated component matrix for system quality criteria

Item*	Description	Two-factor solution	
		SQF1 – System quality	SQF2 – Integration quality
SQ1	System functionality	.856	.137
SQ2	System reliability	.815	-.160
SQ3	System flexibility	.649	.189
SQ4	System usability	.557	.468
SQ5	Enabling technology for CRM, SCM, etc.	.194	.825
SQ6	System interoperability	-.215	.664
SQ7	Connectivity (intra/extranet, mobile comp., …)	.376	.644
Kaiser-Meyer-Olkin measure of sampling adequacy			.65
Bartlett's test of sphericity		Chi-Square	66.3
		df	21
		Sig.	.000

* Dropped item: System internationality

4.3. Testing of research hypotheses

The role of ERP activators

ERP activators impact the functional balance of the project team in ERP adoptions (supporting Hypothesis 1a). Table 9 shows that ERP activators from each of the three business functions have the power to influence team composition in favor of their own functional home. For example, an ERP project initiation by stakeholders from the IT department leads to a project team that is dominated by the IT department. Participative teams, widely considered as the preferred team design for large-scale IS changes (Sarker and Lee, 2003, Ke and Wei, 2008), are only likely to develop if an internal organization department activates the ERP adoption project.

Table 9 Correlations between initiation triggers and team formation

No.	ERP team structure	Project activators		
		Senior management	Internal IT department	Internal organization department
PT1	Dominated by business management	.257*	-.295**	-.175
PT2	Dominated by IT department	-.220	.525**	-.206^{T}
PT3	Dominated by organization department	-.178	.050	.240*
PT4	Equal participation of all major stakeholders	.013	-.151	.241^{T}

^{T} $p < .10$; * $p < .05$; ** $p < .01$ (Spearman rank correlation)

Next, we turn our attention to levels of expended resources, which in many cases depend on the role of the ERP activator (supporting Hypothesis 1b). *Senior management* initiates shorter projects, which are less resource-intensive in justification and funding and involve less external labor. *IT departments* trigger projects with lower overall costs. The *organization department* activates projects that are labor-intensive with regard to individual stages and both stages taken together. These projects also imply longer durations particularly during implementation.

Table 10 Correlations between project activators and resource investments

		Project activator								
		Senior management			Internal IT department			Internal organization department		
No.	Resource investments	Just.	Im.	Both	Just.	Im.	Both	Just.	Im.	Both
RT1	Time	-.23*	-	-.23*	-	-	-		.24*	.22^{T}
RL1	Internal and external labor	-.24*	-	-	-	-	-	.23^{T}	.32**	.37*
RL2	Proportion of external labor	-	-	-	-.26^{T}	-	-	.31*	-	-
RL3	Estimated internal labor costs	-	-	-	-	-	-	-	.28^{T}	-
RL4	Estimated external labor costs	-.34*	-.29*	-.32**	-	-	-	.41**	.34*	.32**
RC1	Overall costs without int. time	-	-	-	-	-	-	-	-	-
RC2	Overall costs incl. internal time	-	-	-		-.23^{T}	-.22^{T}	-	-.27^{T}	-

^{T} p < .10; * p < .05; ** p < .01 (Spearman rank correlation); Just.: Justification and funding stage; Impl.: Implementation stage

The role of expended resources

The levels of expended resources in ERP implementation depend on the levels of resources expended in the prior stage (supporting Hypothesis 2a). The findings from the Spearman rank correlation analyses show that every measure from one stage positively correlates with the same measure of the other stage. In addition, several positive and no negative correlations can be seen between one measure from one stage and another measure from the other stage. In other words, high levels of expended resources in the *justification and funding stage* are associated with high levels of expended resources in the *implementation stage* in all dimensions, namely in terms of time, internal and external labor use, and overall project costs.

Table 11 Resource investment correlations between project stages

		Implementation stage						
Justification and funding stage		RT1	RL1	RL2	RL3	RL4	RC1	RC2
RT1	Time	.25*	.30*	-	.26^{T}	-	.39^{T}	-
RL1	Internal and external labor		.62**	-	.56**	.34*	.45^{T}	.27^{T}
RL2	Proportion of external labor			.40**	-	.47**	-	-
RL3	Estimated internal labor costs				.47**	-	-	-
RL4	Estimated external labor costs					.58**	-	-
RC1	Overall costs w/o internal time						.93**	.86**
RC2	Overall costs incl. internal time							.77**

^{T} p < .10; * p < .05; ** p < .01 (Spearman rank correlation)

Contrary to Hypothesis 2b, high levels of expended resources are associated with lower levels of project effectiveness. This finding is supported by measures of project effectiveness from all three domains: Conflicts, System Quality, and Project Performance. Table 12 presents the results in more detail. The data revealed a pattern showing that the

more resources a company assigns to a project, the more conflicts arise during implementation and the worse the project's results in terms of quality and project performance become. Conflicts and adverse project performance most distinctively occur when high levels of resources are expended in the ERP implementation stage.

Table 12 Correlations between resource and project effectiveness metrics

		Conflicts		Quality		Performance
No.	Resource investments	Change	Resources	System	Integration	Early-use
Justification and funding stage						
RT1	Time	.276*	-	-	-	-
RL1	Internal and external labor	-	.242^{T}	-.296^{T}	-	-
RL2	Proportion of external labor	-	.278*	-	-	-
RL3	Estimated internal labor costs	-	-	-	-	-
RL4	Estimated external labor costs	-	-	-	-.361*	-
RC1	Overall costs without internal time	-	.590^{T}	-	-	-
RC2	Overall costs incl. internal time	-	-	-	-	-
Implementation stage						
RT1	Time	.268*	.324**	-	-.395*	-
RL1	Internal and external labor	.260^{T}	.289*	-	-	-.277*
RL2	Proportion of external labor	-	.226^{T}	-	-	-
RL3	Estimated internal labor costs	.409**	-	-	-	-
RL4	Estimated external labor costs	-	.383**	-	-	-.321*
RC1	Overall costs without internal time	-	.412^{T}	-	-	-.551*
RC2	Overall costs incl. internal time	.365**	-	-	-	-

^{T} $p < .10$; * $p < .05$; ** $p < .01$ (Spearman rank correlation)

Finally, we expected implementation conflicts to lead to lower project quality and performance (Hypothesis 2c). This assumption was supported by the data with the exception of integration conflicts. All other types of implementation conflicts led to adverse project outcomes in some aspect. In general, resource conflicts, which are characterized by time and cost escalations, are most distinctively related to less successful ERP projects. Change and task conflicts are associated with higher levels of operational performance in the early-use stage. The significantly high correlation between resource conflicts and plan performance validates the used research instrument. Resource conflicts during implementation explain that expended project efforts were higher than originally planned.

Table 13 Correlations between implementation conflicts and project performance

		Quality		Project performance		
No.	Implementation conflicts	System	Integration	Scope	Plan	Early-use
IC1	Change conflicts	-	-.256^{T}	-	-	-.248*
IC2	Resource conflicts	-.273^{T}	-.449**	-.357**	.410**	-
IC3	Task conflicts	-.285^{T}	-	-	-	-.353**
IC4	Integration conflicts	-	-	-	-	-

^{T} p < .10; * p < .05; ** p < .01 (Spearman rank correlation)

5. Discussion: the roles of ERP activators and expended resources

In this section, we discuss the major findings and make inferences according to the findings on the research hypotheses depicted in Table 14, followed by elaborations on the limitations.

Table 14 Summary of tests of hypotheses

	Relationship	Support
H1a	The role of the ERP activators is associated with the functional balance of the ERP project team.	Yes
H1b	The role of the ERP activators is associated with ERP resource investment decisions at different stages of the project.	Yes
H2a	The more resources are expended in the justification and funding stage, the more resources are expended in the ERP implementation stage.	Yes
H2b	The more resources are expended for the project, the more effective the ERP project becomes.	No
H2c	Encountered implementation conflicts are associated with lower ERP system quality and project performance.	Yes

5.1. The role of ERP activators

In accordance with our expectations, the ERP activators generally impact the design of the project team (H1a) to the disadvantage of the organization. It is known that ERP projects benefit from balanced and participative team designs and need to account early for organizational resistance to change (e.g. Sarker and Lee, 2003, Ke and Wei, 2008). However, ERP activators regularly establish non-participative teams biased towards their own interest groups. The IT department most successfully establishes the most common form, technology-biased project teams. Organizations should establish more control over this team-building process. Methods from literature, such as the Critical Success Chains approach (Peffers et al., 2003), are available to foster cost-effective widespread inclusion of stakeholders in ERP projects.

ERP activators also influence the levels and balance of resource investments over the ERP justification and funding stages, and the implementation stages (H1b). Strategy-led

projects triggered by senior management are indeed shorter and involve lower costs for external support. These projects tend to require less external knowledge through more explicit leadership in the project process (Sarker and Lee, 2003). The internal organization unit triggers many heavy-weight projects, which are labor-intensive and take longer to implement. Organizations need to be aware of the substantially higher resource and complexity implications mainly occurring during system implementation when pursuing original re-organization ideas.

5.2. The role of expended resources

Resource-intensive projects or so-called heavy-weight projects are characterized by resource-intensive justification and funding stages followed by resource-intensive implementation stages (H2a). This in particular applies to internal and external labor time investments. The use of external knowledge (most commonly through consultants) during the justification and funding stage increases the levels of external support needed for the implementation stage. Organizations may inadvertently develop a dependency on consultants by using their help during the appraisal of ERP. Theoretically, this situation applies to organizations with less developed dynamic capabilities to undergo an effective organizational change (Teece et al., 1997). Innovation theory argues, the successful adoption of IT depends on the organizational ability in fully assessing IT (Rogers, 2003). In this context, history matters. In other words, organizations that have not invested in analytical capacities in a quickly moving environment may have greater difficulties to assimilate ERP on their own.

Contrary to expectations, heavy-weight ERP projects are not more effective (H2b). They are related to higher levels of change and resource conflicts, lower levels of achieved system and integration quality, and lower early-use performance. Heavy-weight projects suffer from cost and time escalations and a shortage of skilled people. A trade-off between cost or time with quality within the Iron Triangle of project management does not work with ERP projects. Brooks' law, which predicts that incremental person-power added to a software-intensive project makes it longer, not shorter, seems to apply to ERP projects (Brooks, 1995).

Finally, resource and change conflicts during implementation are associated with lower project performance in various dimensions (H2c). Resource conflicts are related to lower system quality, plan and scope performance. Among the sample projects, conflict resolution has only worked well for task and integration conflicts, which can be tackled by the training measures to avoid early ERP use problems (Jones et al., 2011). However, this is a

very late measure to make ERP projects more effective. Control at an early stage can be achieved by the mentioned Critical Success Chains approach (Peffers et al., 2003), which widely includes participants at the project start without gravely increasing resource expenditures. Due to the important role of conflicts, more research is needed to investigate when and how conflicts should be tackled and resolved (Meissonier and Houzé, 2010).

5.3. Limitations

Finally, it is important to note some limitations. The study is based on self-reported measurements known as the most common form of data collection in the social sciences (Malhotra et al., 2006). The effectiveness of the method is dependent on the respondents' willingness to pay attention and to answer as instructed. Lack of attention or rationality can interfere with inferences drawn from the data (Pokorny et al., 2001). We tried to mitigate this risk with preventive controls (offering incentives and inviting target persons), and with detective controls (screening for possible aberrant response behavior and analyzing common method variance). To a certain extent, however, fluctuating and careless responding cannot be avoided in survey-based approaches. This equally applies to this study, in which the respondents needed to assess their ERP projects retrospectively.

On a different note, the mono-method research design did not accommodate data source triangulation by using multiple sources of data or different data gathering methods to ensure validity of the estimates given (Denzin, 1984, Yin, 2003). Consequently, the acquired responses are likely to be biased towards an internal manager's perception of ERP projects, which to some degree may have inflated reported ERP project success levels. However, the two-factor response bias analysis, which was in particular based on an ERP success metric, did not indicate any bias related to non-responses due to ERP failures. The survey instrument itself was validated by panel and expert discussions and the wording of questions (face validity) and appropriate scales were pre-tested. Related research reported no significant statistical differences between the views of different managerial ERP stakeholder groups (Ifinedo and Nahar, 2006), which supports a coherent internal management perspective on ERP projects presented in this paper.

6. Concluding remarks

This paper presents significant new evidence about the importance of ERP activators and expended resources, based on a large survey of senior managers conducted in Austria. This is one of the few studies that distinguish between investments for different ERP project stages. It was confirmed that early activators impact team formation and influence resource

investment decisions made for the different stages of the project. Moreover, it was shown that these resource investments are interrelated and critical. Heavy-weight projects are less effective and troubled by numerous problems, in particular resource and change conflicts. These, in turn, are related to lower overall project performance. Such insights are of particular importance now that organizations are pressured by stagnant markets and scarce resources while becoming increasingly dependent on changing IT requirements. Yet, they still experience significant issues with respect to larger-scale IT adoptions. Whilst the findings will be of most significance to the organizations operating in the European Union, it is likely that they apply to other regions as well, as ERP projects are seen as global phenomena.

Appendix

Table A1 Comparison of respondents and non-respondents (two-sample unpaired t tests, chi-square (χ^2) test)

Variable (t test)	Respondent (n)	Mean	Assuming	t	df	p (two-sided)	95% confidence interval	
No. of employees	No (737)	247.97	Equal variances	-.58	869	0.56	-350.78	190.98
	Yes (134)	327.87	Non-equal variances	-.73	239.3	0.47	-296.17	136.37
No.of subsidiaries	No (810)	.95	Equal variances	-.71	965	0.48	-.73	.33
	Yes (157)	1.15	Non-equal variances	-.68	210.9	0.50	-.76	.37

Variable (χ^2)	Respondent	n	Respondent	n	χ^2	d.f.	p
Legal form	No	811	Y	157	9.15	8	.33

Table A2 Comparison of early and late respondents (two-sample unpaired t tests, chi-square (χ^2) test)

Variable (χ^2)	Respondent	n	Respondent	n	χ^2	d.f.	p
Changes in workforce	Early	47	Late	25	3.73	3	.30
Competitive edge through ERP	Early	44	Late	20	.783	1	.38
Availability of IT/IS services	Early	46	Late	18	.114	2	.94

Table A3 Research instrument

Section	ID	Questions	Scale
Scope	SM	Which ERP functions/modules were implemented? (select all applicable) Finance Human Resources Manufacturing and Logistics Other	Y/N
	SC	No. of customers? (select one) Up to 9 More than 10 More than 100 More than 1,000 More than 10,000 More than 100,000	Y/N
	SS	No. of suppliers? (select one) Up to 9 More than 10 More than 100 More than 1,000 More than 10,000 More than 100,000	Y/N
Role of ERP activator	EI	Who introduced the idea for ERP? (select one) Top management IT department Business organization department Consultants ERP vendors Other	Y/N
Project team	PT	Structure of involved project team? (select one) Dominated by top management Dominated by the IT department Dominated by the organization department Participative decision making including members of all or almost all parties (matrix) Other	Y/N
Expended resources	RT1a	How long did the decision making process take?	Months
	RL1a	Can you estimate the number of person months spent on decision making only?	Person months
	RL2a	How about the proportion of external person months?	%
	RC1a	How about the overall costs of the decision making process?	Currency
	RT1b	How long did the implementation take?	Months
	RL1b	Can you estimate the number of person months spent on implementation only?	Person months
	RL2b	Can you specify the proportion of external human power involved?	%
	RC1b	How about the overall costs of the ERP implementation (excluding licensing costs)?	Currency

Implementation conflicts	IS	Which problems or conflicts occured during the implementation of the system? (select multiple) User resistance Capability of organizational infrastructure Lack of management support Cost escalation Time escalation Availability and retention of skilled people System did not work as expected Organizational fit Integration with legacy systems	Y/N
Effectiveness of system	SQ	Please answer for every considered criterion whether the expectations were achieved. Functionality of the system System reliability System flexibility System usability Enabling technology for CRM, SCM, etc. System interoperability Connectivity (intra/extranet, mobile comp., …) Internationality of the system	1 = not reached to 5 = exceeded
Project performance	PP1	Can you estimate the % of the desired ERP system functionality that was implemented?	%
	PP2	Was the expended effort for implementation lower, equal to or higher than the estimated amount?	-1 (lower) to +1 (higher than expected)
	PP3	After switching to ERP, a decline in organizational performance was	(1 to 4)
		experienced and it was not recovered	1 (Sustained dip)
		experienced over a long period of time	2 (Long-term dip)
		experienced over a short period of time	3 (Short-term dip)
		not noticed	4 (No dip)
Outcome	OU1	Changes in workforce characteristics after implementation? New positions created Job definitions rewritten Reduced workforce None	Nominal
	OU2	Is ERP aiding the organization to gain a competitive edge?	Y/N
	OU3	Availability of IT/IS services (after switching to ERP)	1 = decreased to 5 = increased

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