The impact of implementation process on the perception of enterprise resource planning success

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Abstract

Purpose – The purpose of this paper is to investigate the impact of the implementation process on the ERP's success in the post-adoption stage, measured as system's acceptance, reliability and utility perceived by users, inside the organizations.

Design/methodology/approach – The authors adopted a multiple case study research design. The data collected, provided by IT managers and 120 key-users from four companies, has been used to investigate the impact of the Enterprise Resource Planning (ERP) implementation phases on selected constructs of the Task-Technology Fit (TTF) and Technology Acceptance Model (TAM). The empirical evidences highlight a direct relation between the effectiveness of the implementation phases and the ERP's success.

Findings – The research results emphasize the importance of the quality of the software, but especially the importance of the implementation phases' management, which require technical and managerial ability of the team made up of people from the system integrator and the company's key-users. Evidences suggest that the higher will be the organizational diffusion of an ERP implemented during a successful implementation project, the higher will be the perception of ERP success in the post-adoption stage. Moreover, the users' perception of ERP quality will be maintained over time.

Research limitations/implications – The research has some limits due to its exploratory nature and to the chosen research approach, so the results may lack generalizability; consequently future research will concern with enlargement of the sample that will allow a better generalization of the results.

Practical implications – This exploratory study suggest that companies' managers should be aware that a correct methodology of implementation, strongly influenced by the team, impacts on the technology consistency and therefore, on the ERP system success. So an appropriate choice is to invest more in the creation and development of internal and external project team than in the ERP's brand.

Originality/value – This paper fulfils an identified need to clarify the explicit relationship between the quality of implementation phases and the subsequent ERP success in the post-adoption stage measured in terms of users' perception of information system quality.

Keywords ERP, IT, Implementation process, Multiple case study

Paper type Case study

Introduction

Enterprise Resource Planning (ERP) are management information systems (IS) that optimize the distribution of enterprise resources and help a business to integrate all its

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resources for fast and effective application to improve its operational performance and enhance its competitiveness (Hsiao *et al.*, 2007).

The benefits generally attributed to ERP are an increase in productivity, better warehouse management, a higher efficiency in the information flow, costs reduction and so on (Nonino and Panizzolo, 2007). Nevertheless, ERPs have high implementation costs; as a matter of fact, the cost range is about 2 to 6 per cent of annual sales with the cost of the software being just a tip of the iceberg, as reported by Mabert *et al.* (2001). In large companies, the average cost of an ERP system implementation is approximately equal to 1 per cent of the firm's turnover and the average lead time (from business process analysis to the go live) is about 20 months (PPRA, 2003). However, the huge capital investments in Information and Communication Technology (ICT) do not always determine a clear-cut link to the expected benefits and even, in some cases, the ERP projects end in failure (PPRA, 2003; Legris *et al.*, 2003; Zhang *et al.*, 2005).

A recent research conducted on more than 5,400 IT projects by McKinsey and University of Oxford (Bloch *et al.*, 2012) shows that half IT projects with budgets of over $15 million dollars run, on average, 45 per cent over budget, 7 per cent are behind schedule and deliver 56 per cent less value than predicted. Furthermore, 17 per cent of IT projects go so badly as to threaten the very existence of the company. ERPs are usually implemented in a top-down style, and the organization generally has to adjust its processes to the system in a short period of time (Baroni de Carvalho and Tavares Ferreira, 2001). Furthermore, implementations of ERP projects most often require dramatic redesigns of business processes (Walsh and Schneider, 2002). So a successful implementation of an ERP system is an important factor for future company's competitiveness (Ehie and Madsen, 2005) and market value (Bharadwaj *et al.*, 2009).

More than ten years ago Standish Group (2000) found that among the causes of IT project failures only 14 per cent was due to incompetence of technologies whereas management deficiencies, due to the complexity of the business and of implementation processes, accounts for the remaining 86 per cent. The difficulties of ERP implementations have been widely cited in the literature but, since ten years ago, research on the critical factors for initial and ongoing ERP implementation success was rare and fragmented (Fui-Hoon Nah *et al.*, 2001). Past researches has identified the critical success factors that affect the ERP implementation effectiveness (e.g. Kumar and Hillegersberg, 2000; Esteves and Pastor, 2001; Al-Mudimigh *et al.*, 2001; Dong, 2001; Zhang *et al.*, 2002; Walsh and Schneider, 2002; Al-Mashari, 2003; DeLone and McLean, 2003; Umble *et al.*, 2003; Bloch *et al.*, 2012) like project management, top management influence, building effective and aligned teams, user training, technological infrastructure, alignment of requirements with software potentiality, etc.

A complete understanding of the ICT investment effectiveness cannot ignore the analysis of the ERP success so, in this regard, the literature provides different methods to evaluate it both *ex-ante* (during the selection process of the ERP software – e.g. Stefanou, 2001) and both *ex-post* (after the go live of the ERP).

Quality of ERP software regards the pre-implementation phase, the project and the implementation phase while perception concerns the post-adoption stage. The pre-adoption stage predominantly takes a value-based perspective (Venkatesh *et al.*, 2003). Since the pre-adoption stage, one of the necessary conditions for IS success is the user acceptance of the technology (DeLone and McLean, 1992).

In the course of the pre-enterprise system adoption and implementation stages, key-users (i.e. end-user involved in the business process analysis and customization of the ERP system) are influenced by initial perceptions, expectations and by the

performance of the implementation project. But, during the post-adoption stage, the direct interaction with ERP and the usage outcome can change the users' perception of the IS based on those initial cognitions. Nevertheless the IS research has given relatively less attention to post-adoption usage outcome and users' behaviour (Jasperson *et al.*, 2005). The existing literature seems to lack research that clarify the explicit relationship between the quality of implementation phases and the subsequent ERP success in the post-adoption stage measured in terms of users' perception of ERP quality. In our opinion this relationship is plausible and, if exists, the comprehension of which phases of the implementation project impact more on these factors of future success of ERP system could lead to significant academic and managerial implications. Consequently, the question, which has driven our research activities, is:

RQ1. Does implementation process impact on perception of ERP success during the post-adoption stage?

Taking off from this research question, we aimed to investigate if the implementation process (project phases) impacts on the ERP's perceived success in the organizations during the post-adoption stage, also considering other variables which could provide an explanation of its variation. Consequently, we adopted a multiple case study research design with the objective to explore some variables and to offer a contingent view on how there is such an impact and in which type of setting it is more likely to occur.

Literature propose numerous models and theories for the determination of success of generic ISs. Two suitable models for our research purpose are Task-Technology Fit (TTF) and Technology acceptance Model (TAM). In fact, some items of the two models allow the measurement of system's acceptance, reliability and utility perceived by users.

The paper begins analyzing the main features of TTF and TAMs. Afterwards the methods (research sites, data collection, dependent and independent variables) are described. Subsequently, the results of the regression analysis are presented. Finally, we discuss the results of the research and we provide some academic and managerial remarks.

Theoretical background

Evaluating the user's disposition and perception of IS quality is important for assessing IS success (Brown *et al.*, 2002). In this direction, the TTF model studies the relationship between the use of the IS and its performances, through a consistent analysis of the software functions and the users' perceived needs (Dishaw and Strong, 1998). Another model, the TAM (Davis, 1989) evaluates ERP success through the perceived ease of use and perceived usefulness of the final users (e.g. Hwang, 2005).

TTF model

TTF is a model that studies the coherence of the software features with user needs that is the degree of consistency of the systems features with task needs. Specifically, the model aims at providing the basis for the analysis of those factors that explain the employment of an IS and the interactions with the users' performances through the study of the relationship between the clients' tasks needs and the system functionalities. Goodhue and Thompson (1995) demonstrate that TTF is a useful indicator of IS implementation success. The basic hypothesis of TTF is that better technology

coherence brings better performances; in fact, TTF is based on the cost/benefit framework propositions (Payne, 1982; Smith *et al.*, 1982; Creyer *et al.*, 1990) that are:

(1) user performances, that result from the use of technology, depend on technology itself and its coherence with task needs;

(2) coherence influences users' task processes; and

(3) users are able to evaluate coherence, therefore they choose the right technology.

The organizational structural contingency theories (Galbraith, 1973) state that better organizational performances are the results of the fit between organization structure and the organization context. Both contingency theories and TTF model are referred to the fit concept. Nevertheless, the two theories differ in the different level of analysis: the first one refers to the organizational level, while TTF refers to the individual level.

TTF is based on the following constructs: task, technology, relationship between task and technology, effective use of the instrument (Goodhue and Thompson, 1995). The first one refers to the procedures followed by users to transform input in output; the second one refers to the instruments used to complete the user's tasks; the third one refers to the degree of assistance that technology gives to a user to help him doing a part of his own tasks; the fourth one refers to the behaviour in using technology while completing tasks.

The measurement of the coherence of technology and tasks is extremely difficult and many researches faced this argument. Nevertheless if it is difficult to measure performances obtained through the utilization of an IS, we can assume that if users positively evaluate a system, this probably can help increase their performances. So these researches (e.g. Goodhue, 1994, 1998; Goodhue and Thompson, 1995; Goodhue *et al.*, 2000) consider the user's evaluation to measure the IS success. This will be the criterion chosen also for the present study. The measurement of the coherence with tasks, according to Goodhue and Thompson (1995), is structured in eight components (Table III). The first five components (data quality, localizability of data, authorization to access data, data compatibility, training and ease of use) focused on the alignment of task needs for using data in decision making; the second two (production timeliness and systems reliability) focused on daily operational needs and the last component (IS relationship with users) focused on relationship among people.

The model is the basis to study the factors that explain the use of ERP systems and the relations with user's performances, observing the relationship between the users' needs and the functionalities offered by the system. TTF is characterized by:

(1) the explicit focalization that explains the relationship between system and performances is based on the importance of TTF;

(2) the purpose of a detailed base for constructs finalized to:

- compensation of the user impact involving on performances; and
- development of diagnosis instruments for ISs.

TAM

When implementing an ERP system, top management commonly faces an unwanted attitude from potential users who resist the implementation process (Aladwani, 2001).

The success of an ERP system can be explained by another model, the TAM proposed by Fred Davis (1989) and widely developed in following years, e.g. in the

so-called TAM2 by Venkatesh and Davis (2000) and TAM3 by Venkatesh and Bala (2008). The TAM framework, and more generally, IT acceptance literature resulted in the Unified Theory of Acceptance and Use of Technology (Venkatesh *et al.*, 2003). TAM framework was the most widely utilized theory to study IT adoption (Dwivedi *et al.*, 2009; Williams *et al.*, 2009) and has been applied in a wide range of IS researches dealing with behavioural intentions and usage of IT (see Turner *et al.*, 2010 for a systematic literature review).

TAM was conceived starting from Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975) developed inside the branch of social psychology during the 1970s. TRA affirm that the individual behaviour is determined by behavioural intention and it is composed by the attitude of the individual and the subject norms of the group. Consequently, TAM aims to evaluate how the acceptance of a technology influences the use of the technology itself and finds its foundation on the idea that perceived ease of use and perceived usefulness finally determine the attitude towards the technology and its actual use. The TAM model shows connections among prior ICT experiences, attitudes with affective components, planned and actual behaviour and attempts to understand and to measure computer anxiety.

According to Davis (1989), the model of the technology acceptance, which explain the actual IT use, is structured in four components (Table III):

(1) perceived usefulness: the individual's perception that using an IT system will enhance job performance;

(2) perceived ease of use: the individual's perception that using an IT system will be free of effort;

(3) attitude towards using IT: the individual's evaluative judgment of the IT system; and

(4) behavioural intentions to use: the individual's motivation or willingness to use the IT system.

The TAM postulates that IS usage is triggered by behavioural intention to use a system jointly determined by individual attitude towards the technology and perceptions of its usefulness. Therefore, perceived usefulness and perceived ease of use are fundamental for predicting the technology acceptance of users, i.e. technology success within an organization. Venkatesh and Davis (1996) studied the antecedents of the perceived ease of use and found that computer self-efficacy and usability act as determinants of perceived ease. Amoako-Gyampah and Salam (2004) developed an extension of the TAM in an ERP implementation environment. Amoako-Gyampah (2007) examined the influence of perceived usefulness and user involvement on the behavioural intention of ERP system usage.

Methods

To address our question we adopted the multiple case study research design, as suggested by Yin (1994) and McCutcheon and Meredith (1993). This methodology is widely accepted in management ISs studies for the formulation and building of theory (Lee, 1989).

The multiple case studies allows researchers to do a holistic and contextualized analysis, to observe the phenomenon in its complexity, to collect a wide array of data and to identify the crucial variables (Yin, 1994). The use of multicase sampling enhances the validity and generalizability of the findings through replication logic

(Miles and Huberman, 1994). In total, two replication criteria should be set for the case selection: one being that they could produce similar result (literal replication) and one being that they could produce contrary results because represent a diversity of the population (theoretical replication) (Eisenhardt, 1989).

We chose case studies both for literal and both for theoretical replication purposes. The unit of analysis is the ERP's user. Therefore, for the literal replication purpose, we selected four companies where there was a substantial number of users (at least 10 per cent) and which implemented a ERP in all the principal functional areas: finance, human resources, manufacturing, marketing, procurement, R&D, sales, after-sales service and IT management. Moreover, for theoretical replication purpose, we selected four companies because they show different market approaches and/or type of ERP implemented, number of years since its implementation, different investment as compared to total turnover and are heterogeneous in terms of turnover, number of employees and business sector (see Table I).

From June of 2010, during a 12 months research time scale, multiple sources of evidence were used in the data collection phase to enhance both validity and reliability. The data used in the case study were obtained from a combination of secondary and primary sources. Primary data gathering involved the four IT managers from the organizations through semi-structured interviews, to enhance the understanding of the processes and to deeply analyze all the potential relevant variables affecting the ERP implementation and its success. A survey to collect data from key-users was used to investigate the quality of the ERP implementation phases on the factors and dimensions of TAM and TTF that represent the ERP success in the post-adoption stage measured in terms of users' acceptance, reliability and utility perceived. We used a multiple regression analysis in which ERP implementation phases were the independent variables and selected TTF and TAM items were the dependent ones.

Secondary sources (company database) were used to enhance the validity of the research through triangulation with multiple means of data collection (Voss *et al.*, 2002).

Research sites

Each selected company operates in a different market (respectively, high technology, manufacturing, toys and food). The turnover of the enterprises is between €23,000,000 and €240,000,000 and the ERP end-users are between 50 and 250. In all, two companies implemented EnterpriseOne (J.D. Edwards) while the other two, respectively, adopted Seven (Solgenia) and Sap/R3 (SAP Ag).

	Companies			
	A	B	C	D
Turnover	€91,000,000	€233,000,000	€23,000,000	€240,000,000
Main product	Nano PC and high performance computers	Panels in medium density fibreboards (MDF)	*Stuffed animals*	Coffee
Employees	564	750	99	702
ERP system (vendor)	Seven (Solgenia)	SAP R/3 (SAP Ag)	Enterprise one (J.D. Edwards)	Enterprise one (J.D. Edwards)
Years since ERP implementation	3	8	5	4
Initial investment in ERP (% turnover)	€650,000 (1.2)	€1,800,000 (0.6)	€600,000 (2.4)	€5,000,000 (2)

Table I. Main characteristics of the selected case studies

Company A designs, develops and markets nano and high performance computers and its revenues amounted to 91 million euros. This company owns different branches working in Europe, America and Asia. It adopted the Seven ERP produced by the Italian company Solgenia and implemented three years before our research.

Company B produces medium density fibreboard (Mdf. wooden floors and office furniture. It accounted revenues of 233 million euros. It owns branches in Italy and Slovenia. The ERP adopted is SAP/3 produced by the German company SAP plus others application package implemented eight years before our research.

Company C designs and sells stuffed animals, but in the last years it differentiated into apparel, sun glasses and jewellery sectors. Its revenues accounted for 23 million euros. It has several offices in the Far East, Germany and Spain. The ERP system, adopted five years before our research, is EnterpriseOne by J.D. Edwards.

Company D is a leading company in the coffee sector with four European branches and an American one. The corporate revenues were 240 million euros. The ERP system, implemented four years before our research, is EnterpriseOne by J.D. Edwards.

Data collection

The research has been carried out through interviews with the four IT managers, a data collection using the companies' database and a survey to the ERP key-users of each company. To assure the coherence and the consistency among interviews, a standard protocol was developed to be checked and to guide our interviews, which aimed at understanding the main features of the ERP system and the implementation dynamics. During two interviews (the first lasting three hours and the second lasting one hour), the four IT managers were asked to describe the evolution of the ERP in their company and the several ERP modules implemented. The analysis then focused on the implementation phases of the system; each phase was accurately described and the problems arisen highlighted. Moreover, a questionnaire was submitted to gather information on ERP characteristics such as initial investment, maintenance costs, etc. Finally, the IT managers and key-users (described below) provided a judgment of the quality of ten ERP implementation phase using a five-point likert scale from 1 (poor) to 5 (excellent).

The data gathering concerning the TAM and TTF selected dimensions was carried out through a survey. The sample dimension was defined on the basis of the total number of ERP end-users and on the basis of the IT managers' awareness of the end-users' level of competence. Consequently, the questionnaire was sent only to the company key-users. As suggested by Hirt and Swanson (1999) the key-users have been selected because they belong to operating departments, generally familiar with business processes and having domain knowledge of their areas. In contrast to key-users, end-users are the final users of the ERP system. They have only very specific knowledge of the parts of the system they need for their work. In order to have a representative and homogeneous sample among the four cases, key-users have been selected according to the following features:

- *functional unit*: this first driver in the sample selection aimed at selecting key-users from all the company functions allowing us to conduct a comprehensive analysis of all the ERP modules implemented;
- *duration of use*: the users with more experience in the ERP utilization have been selected starting on the assumption that the best evaluators are those employees that use it more time; and

- *participation during ERP implementation project*: the third driver is the end-user involvement in the business process analysis and customization of the ERP system.

The questionnaire provided to each key-user contained a first part concerning the general information (age, gender, functional unit, time lag of use, etc.) and a second one regarding the TAM and TTF selected items. Out of 135 possible respondents, 120 completed the survey for a response rate of 89 per cent (Table II).

Independent variables

The independent variables are the phases for an ERP implementation. We proceeded in two stages:

(1) we analyzed existing research and selected some models of the implementation process; and

(2) we collected and analyzed empirical data from case studies and we identified common phases in line with literature.

Ross (1998) developed a five-phase model for ERP implementation: design, implementation, stabilization, continuous improvement and transformation. Parr and Shanks (2000) proposed the project phase model (PPM) based on the following implementation processes: planning, set-up, re-engineer, design, configuring and testing, installation and enhancement. Rajagopal (2002) applied a six-stage model (initiation, adoption, adaptation, acceptance, routinization and infusion) to the ERP context and conducted six case studies. Klee (2005) proposed the following phases: product evaluation, implement - phase I, implement - phase II and beyond, extending value, maintaining value and declining value.

Starting also from other ERP implementation phases described in literature (Markus and Tanis, 2000; Berchet and Habchi, 2005; Ehie and Madsen, 2005) and carrying out a comparative analysis of the four case studies, we identified ten common phases for the ERP implementation:

(1) *software installation quality:* the ERP installation phase in standard configuration with an initial set of modules;

(2) *business process analysis*: the As-Is and To-Be processes' analysis and the check of the compatibility of ERP modules with the involvement of the key-users (usually one person for each functional unit);

(3) *set-up and prototype development*: starting from the previous phase, the ERP system is parameterized and key-users feedbacks are gathered for the customizations;

(4) *customization*: additional development of customized ERP modules based on the information gathered in the previous phase;

Table II. Characteristics and percentages of respondents (ERP users)

	Companies				
	A	B	C	D	Total
ERP end-users (% of employees)	60 (11)	250 (33)	50 (51)	150 (21)	510
ERP key-users (% end-users)	20 (30)	43 (17)	25 (50)	47 (31)	135 (26)
Respondents (%)	17 (85)	41 (95)	20 (80)	42 (89)	120 (89)

(5) *data recovery*: set-up of the data alignment and transfer interfaces and uploading of the previous database in the new ERP system;

(6) *system test*: all the previous phases converge in the test of all the business processes as formalized at the beginning of the project;

(7) *training*: in each functional unit a focused training has done to end-users, while every key-user participates to the prototype development; the key-users get an informal training due to the active participation in the ERP system customization and implementation phases;

(8) *system delivery*: all the ERP-customized packages implemented in the set-up phase are tested with a fist run in a simulated environment to avoid system crashes;

(9) *go live*: the final assessment and the refinement; the old ERP system (if exist) is interrupted and the new one starts to run; and

(10) *after delivery assistance:* the support to end-users in the first period of the ERP utilization; in particular the deadline is usually associated with the first drafting of the VAT journal report; from this moment the ERP implementation project is considered delivered.

The quality of the ERP implementation phases have been evaluated by IT managers and key-users using a five-point likert scale from 1 (poor) to 5 (excellent).

Dependent variables

We initially selected the TAM and TTF items starting from previous studies (Zanutto, 2005; De Toni and Zanutto, 2006a, b) which investigated the most important variables that represent the success of ERP and ISs. De Toni and Zanutto (2006b) found the main constructs through an empirical study based on a survey with a sample of 300 employees belonging to six large companies. Subsequently we organized a focus group lasting four hours, which involved three professors of computer science, three IT consultants and four IT managers in order to suggest us the best dimensions representing ERP's success as we defined it. Table III shows the final six dimensions selected at the end of the process.

Table III. TAM and TTF factors and dimensions investigated

	Factor affecting ERP success	Selected	Dimensions investigated
TTF	1. Data quality		
	2. Localizability of data		
	3. Authorization to access data		
	4. Compatibility	X	Consistency of the data
	5. Ease of use/training	X	Ease of use of hardware and software
	6. Production timeliness	X	Production timeliness
	7. Systems reliability	X	System reliability
	8. Relationship with users		
TAM	1. Perceived usefulness	X	Perceived usefulness
	2. Perceived ease of use		
	3. Attitude towards using		
	4. Behavioural intentions to use	X	Behavioural intentions to use

The TTF and TAM factors selected have been measured through representative items found in literature (see Appendix). These ones are the dependent variables of our statistical model, in particular:

- *production timeliness*: quickness of the ERP end-users to gather information thanks to interfaces and rapidity of the system response (Bailey and Pearson, 1983; Bruno *et al.*, 2004);
- *data compatibility*: level of completeness, accuracy and effectiveness of the information processed by ERP system (Saarinen, 1996);
- *systems reliability*: probability that the ERP system continue to run under certain conditions for a defined period of time (Lucas and Spitler, 1999);
- *ease of use*: employees' perception of easiness in the use of the ERP system without efforts (Davis, 1989; Goodhue and Thompson, 1995);
- *perceived usefulness:* employees' perception of usefulness of the ERP system's use (Legris *et al.*, 2003); and
- *behavioural intentions to use:* employees' intention of use of the ERP system (Venkatesh and Davis, 2000).

Data analysis and results

The data collected, provided by IT managers during the interviews and gathered through the 120 key-user questionnaires, has been analyzed to evaluate the impact of the ERP implementation phases on the single selected constructs of the TAM and TTF. The dependent and independent variables of the models have been analyzed using a correlation analysis and a multiple regression analysis.

First of all, we studied the ten independent variables using the correlation analysis with the aim to identify a potential multicollinearity. The correlation analysis showed that ten ERP implementation phases are strongly correlated among themselves (Table IV); for this reason, we conducted a principal component analysis (Table V) which shows that the first component maintains the 77 per cent of the information enclosed in the ten selected variables. Consequently, we decided to use only two variables in the regression analysis:

- software installation quality (var1) represented by the first implementation phase; and
- implementation quality (var2 the mean of the second to tenth implementation phases value (the first component).

A subsequent analysis has demonstrated no correlation (0.071) between software installation (var1) and implementation quality (var2).

The regression analysis confirmed the causal relation among software and implementation quality and the six constructs representing ERP system's acceptance, reliability and utility perceived by users (Table VI).

First, we found that the implementation quality influences the ERP system's reliability and utility perceived by users more than the software quality. As a matter of fact, the software installation quality impacts on the production timeliness, data compatibility, ease of use and perceived usefulness a behavioural intention of use; instead the software installation quality does not seem to influence the system

Table IV.
Means, SDs and correlations

	Mean	SD	A	B	C	D	E	F	1	2	3	4	5	6	7	8	9
Dependent variables																	
A. Production timeliness	3.310	0.781															
B. Data compatibility	3.511	0.603	0.486														
C. Systems reliability	3.517	0.756	0.511	0.399													
D. Ease of use	3.483	0.651	0.543	0.703	0.393												
E. Perceived usefulness	3.539	0.456	0.592	0.540	0.586	0.420											
F. Behavioural intention of use	3.550	0.654	0.472	0.364	0.476	0.331	0.636										
Independent variables																	
1. Software installation quality	4.167	0.374	0.182	0.289	0.079	0.236	0.226	0.211									
2. Business process analysis	3.358	1.383	0.480	0.309	0.304	0.329	0.409	0.447	0.208								
3. Set-up and prototype development	3.850	0.904	0.465	0.275	0.299	0.303	0.385	0.426	0.074	0.991							
4. Customization	3.992	0.835	0.558	0.253	0.300	0.286	0.442	0.373	0.004	0.905	0.922						
5. Data recovery	3.992	0.835	0.558	0.253	0.300	0.286	0.442	0.373	0.004	0.905	0.922	1.000					
6. System test	4.200	0.669	0.195	0.161	0.210	0.191	0.166	0.341	−0.134	0.822	0.856	0.620	0.620				
7. Training	4.342	0.476	0.370	0.148	0.253	0.195	0.277	0.321	−0.322	0.859	0.920	0.873	0.873	0.866			
8. System delivery	4.508	0.502	0.486	0.356	0.299	0.360	0.432	0.463	0.440	0.970	0.928	0.832	0.832	0.721	0.708		
9. Go live	4.300	0.958	0.605	0.295	0.272	0.304	0.498	0.333	0.328	0.724	0.693	0.875	0.875	0.220	0.529	0.746	
10. After delivery assistance	3.992	0.835	0.558	0.253	0.300	0.286	0.442	0.373	0.004	0.905	0.922	1.000	1.000	0.620	0.873	0.832	0.875

Table V.
Principal component analysis

	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5	Comp.6	Comp.7	Comp.8	Comp.9	Comp.10
Independent variables										
1. Software installation quality		−0.769	−0.335	−0.246					0.471	
2. Business process analysis	0.353		−0.212	0.427				0.105		0.972
3. Set-up and prototype development	0.356		−0.167	−0.655	−0.127		−0.305	−0.334	−0.408	0.166
4. Customization	0.351		0.253		0.403		0.657	0.000	−0.437	0.121
5. Data recovery	0.351		0.253		0.311	0.697	−0.302	0.336	0.139	
6. System test	0.276	0.320	−0.562	−0.171			0.422	0.489	−0.235	
7. Training	0.326	0.351		0.138	−0.453		−0.192	−0.335	0.610	−0.155
8. System delivery	0.332	−0.242	−0.283	0.512	0.160		−0.159	−0.262	−0.362	−0.488
9. Go live	0.290	−0.346	0.461		−0.625		0.231	0.232	−0.233	−0.135
10. After delivery assistance	0.351		0.253		0.309	−0.717	−0.276	0.316	0.135	0.000
SD	2.770	1.227	0.907	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Proportion of variance	0.767	0.151	0.082	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Cumulative proportion	0.767	0.918	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

reliability. However, the more interesting results come from the implementation quality as defined by the remaining nine implementation phases. It impacts on all the dependent variables and, consequently, on the ERP success. Furthermore, the 30 per cent of the variance in the production timeliness of the ERP, the 22 per cent of its perceived usefulness and intention of use are explained by the software and implementation quality. The variance of the other three dimensions seems to be less explained in the model.

Discussion, managerial implications and further research

The literature recognizes the implementation project as important for achieving the efficient and efficacy functioning of ERP systems, but little is known about its impact in the subsequent ERP success in the post-adoption stage. We have therefore conducted this study in order to obtain a better understanding of this relation by measuring the ERP success in terms of users' acceptance and reliability and utility perceived.

The results of the statistical analysis on the empirical data collected support the idea of a causal relation between the quality of implementing an ERP system and its future success within an enterprise, so the answer to our initial research question is affirmative. Nevertheless, the cross-case analysis allows us to give further results and deepen the result of statistical analysis by considering other variables affecting perception of ERP quality.

Discussion

The first result of our research comes from the correlation analysis after the principal component analysis: the ERP's implementation quality seems to be not correlated (or influenced) with the installation quality, a proxy of the software quality. However, the ERP's implementation phases are strongly correlated each other (and surely influenced by the antecedent one) so we considered that every implementation phase impacts on ERP system's reliability and utility perceived by users. Unfortunately, the dimension of our sample has not allowed us to identify the most important phase clearly.

If our analysis highlights the importance of a high-quality ERP system and the importance of a correct implementation in a company, we found that the most important is the second one. The results of our analysis suggest that implementation quality influences the ERP system's reliability and utility perceived by users more than the software quality. If the first variable is representative of the intrinsic quality of the ERP system, the other depends on the ability of the team composed by people from the system integrator (typically the consulting firm) and the key-users of the company.

After interviews, we conducted a search for cross-case patterns. We compared two and two cases searching for similarities and differences, and we finally compared all

Table VI. Results of regression analysis: the impact of implementation phases on ERP success

	Production timeliness (A)	Data compatibility (B)	Systems reliability (C)	Ease of use (D)	Perceived usefulness (E)	Behavioural intention of use (F)
Intercept	3.30	3.51	3.50	3.48	3.53	3.56
Software installation quality	*1.92**	*3.15***	0.74	*2.46***	*2.38***	*2.19***
Implementation quality	*6.57*****	*3.01***	*3.61*****	*3.55***	*4.95*****	*4.87*****
R^2	*0.30*	*0.15*	*0.11*	*0.14*	*0.22*	*0.21*

Notes: *****$p < 0.001$; ****$p < 0.01$; ***$p < 0.05$; *$p < 0.1$

four cases. We chose a number of cases, which clearly does not support generalizability, but allows for comparison and contrast between the cases as well as a deeper and richer look at each case.

As highlighted in Figure 1, the four cases are characterized two by two by four different variables, which could provide an explanation of a variation of ERP perceived success:

(1) type of ERP system;

(2) initial investment in ERP;

(3) per cent of ERP end-users; and

(4) number of years since ERP implementation.

Typology of ERP system can influence its success because of the intrinsic quality of the software. Initial investment in ERP (during implementation phase) can affect the quality of final realization because directly correlated to the effort of project team (internal and external). The percentage of ERP users on the total employees can impact to perception of its success because the higher the percentage, the higher the diffusion of the ERP inside company, i.e. organizational level of expertise on ERP system. The post-adoption stage is characterized by a deeper understanding of the ERP and the initial perceptions in pre-adoption and implementation phases are revised because of duration of actual usage. Consequently, we expected that time (number of years since ERP implementation) can influence users' opinion.

The percentage of initial investment in the ERP compared to the turnover does not seem to impact and consequently to guarantee a successful ERP implementation (Figure 2). As a matter of fact we observed the higher ERP perceived success, respectively, in the case C and B which shows a big difference in the investments, while the worst case D invested an amount of money similar to the best one C.

Instead, the importance of the implementation process can be deduced by the case of two companies (B and D) where IT managers told us that they had many difficulties during the implementation of the ERP. In the case D the change of the consulting firm and of the ERP system vendor created several criticalities never overcome and demonstrated by ineffectiveness of the system; in the case B we have observed that an excellent internal team has limited the difficulties during the system integrator change.

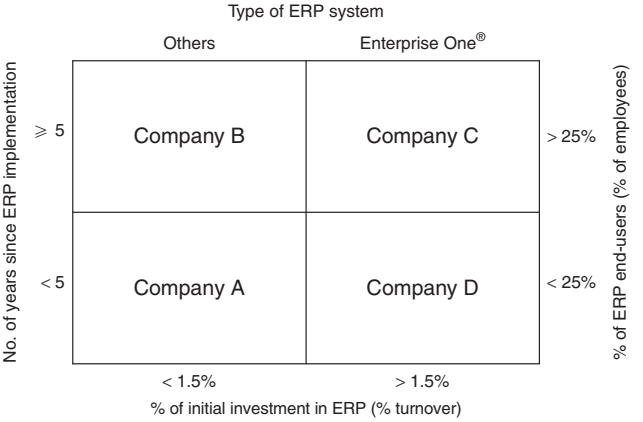

Figure 1. Variables characterizing the selected case studies

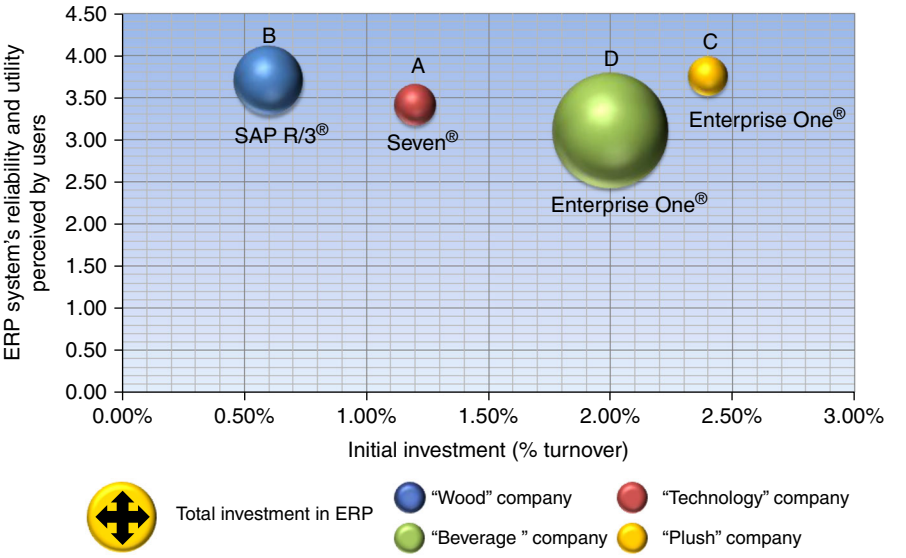

Figure 2.
Impact of initial investment on ERP's reliability and utility perceived by users

The empirical evidences coming from the cross-case analysis suggest that it is fundamental to maintain the internal skills of the key-users in order to guarantee the continuity of the project also if there is a change of the system integrator. So the appropriate choice is to invest in the project team (internal and external) more than in the ERP's brand (in our research Enterprise one® is the best one and the worst ERP system).

The ERP's implementation quality impacts above all on the production timeliness, behavioural intention of use and perceived usefulness. In the D case study we discovered that an inefficient ERP implementation has been done caused by several criticalities (change in ERP advisor, change in the IT manager, etc.). In this company there is major slowing down in the end-user ERP system interaction and the activities are not being carried out on time. Moreover, we have found that data compatibility, behavioural intention of use and perceived usefulness are influenced by the intrinsic quality of the ERP solution adopted by the company. Certainly, the basic programming rules give the right exchange of information among the several ERP modules implemented; a stability platform allows to obtain right data (not contradictory) creating in the key-users a sense of security towards the ERP system.

Finally, we found that the two organizations in which the ERP system is perceived to be more successful are the companies with higher percentage of ERP users on the total employees (degree of company expertise on ERP) and higher number of years since ERP implementation (time).

Synthesizing, evidences suggest that the higher will be the organizational diffusion of an ERP implemented during a successful project, the higher will be the perception of ERP success measured in terms of terms of users' acceptance, reliability and utility perceived in the post-adoption stage; moreover the users' perception of ERP quality will be maintained over time.

Managerial implications and future research

The results of the research show the importance of the intrinsic quality of the software, but especially the importance of the implementation phases, which require a strong

ability of the team composed by people from the system integrator and the key-users of a company. In this sense the results of our research have also practical implications; as a matter of fact, the companies' managers should be aware that a correct methodology of implementation, strongly influenced by the team, impacts on the technology consistency and, therefore, on the ERP system future success. So an appropriate choice is to invest more in the creation and development of internal and external project team than in the ERP's brand.

Finally it must be underlined that our research has some limits due to its exploratory nature and typical of case study researches (e.g. different distribution of respondents among the four cases). Consequently future research will concern with enlargement of the sample that will allow a better generalization of the results and to clearly identify which implementation phase among the ten studied is the most important to predict the ERP system's future acceptance, reliability and utility perceived by users.

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Further reading

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Appendix. TAM and TTF items in the survey

Systems reliability
The ERP is very reliable (Lucas and Spitler, 1999).
I can count on the system to be up and available when I need it.

Production timeliness
ERP, to my knowledge, meets its production schedules such as report delivery and running scheduled (Goodhue and Thompson, 1995).
Regular ERP activities are completed on time (Goodhue and Thompson, 1995).

Data compatibility
There are times when I find that supposedly equivalent data from two different sources is inconsistent (Goodhue and Thompson, 1995).
When it is necessary to compare or aggregate data from two or more different sources, there may be unexpected or difficult inconsistencies.

Ease of use
The ERP computer systems I use are convenient and easy to use (Goodhue and Thompson, 1995).
My interaction with the system is clear and understandable (Davis, 1989; Venkatesh *et al.*, 2003).

Perceived usefulness
Using the ERP system enhances my effectiveness on the job (Legris *et al.*, 2003).
Using the ERP system increases my productivity (Legris *et al.*, 2003).

Behavioural intentions to use
Given I had access to the system I intend to use it (Venkatesh and Davis, 2000).
I plan to use the system (Dishaw and Strong, 1998).

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