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# A framework for the ex-ante evaluation of ERP software

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It has been widely reported that a large number of ERP implementations fail to meet expectations. This is indicative, firstly, of the magnitude of the problems involved in ERP systems implementation and, secondly, of the importance of the ex-ante evaluation and selection process of ERP software. This paper argues that ERP evaluation should extend its scope beyond operational improvements arising from the ERP software/product *per se* to the strategic impact of ERP on the competitive position of the organisation. Due to the complexity of ERP software, the intangible nature of both costs and benefits, which evolve over time, and the organisational, technological and behavioural impact of ERP, a broad perspective of the ERP systems evaluation process is needed. The evaluation has to be both quantitative and qualitative and requires an estimation of the perceived costs and benefits throughout the life-cycle of ERP systems. The paper concludes by providing a framework of the key issues involved in the selection process of ERP software and the associated costs and benefits. *European Journal of Information Systems* (2001) **10,** 204–215.

## Introduction

The decade of 1990, as far as the business information systems are concerned, has been characterised by the implementation of Enterprise Resource Planning (ERP) systems in a significant number of enterprises worldwide. ERP systems are currently the prevailing form of business computing for many large organisations in the private and public sector (Gable, 1998). The reasons for adopting ERP can be technical, such as the desire to reduce mainframe system operating costs and/or business, such as the necessity to acquire software, which can support a certain production mode (Markus & Tanis, 2000).

Although a large number of papers have been recently published addressing ERP issues (see Esteves & Pastor, 2001), there is limited research concerning ERP software evaluation. An extensive part of the academic literature deals exclusively with ERP implementation issues ignoring the way decisions are taken and their appropriateness regarding the acquisition of ERP systems. The purpose of this paper is to identify key issues involved in the ex-ante evaluation of ERP software and emphasize the importance of selecting the right ERP software for an organization.

Software selection based on ease of use, usefulness and involvement of end users, as it has been suggested by Montazemi *et al* (1996), is no longer enough for critical systems such as ERP. Brown *et al* (2000) identified several business and IT related factors that influence the purchase of ERP systems. It has been also argued that software procurement is not a transparent process and mission-critical software is vital in achieving both operational and strategic goals and support decision-making (Rosenthal & Salzman, 1990). This paper argues that, given the strategic nature of ERP and the major organisational, technological and behavioural impact of ERP, a broad perspective of ERP systems adoption and evaluation is needed. Technological, business and organisational contexts should be studied in a unified way encouraging the examination of interrelated key acquisition, implementation and maintenance factors. Due to the complexity of ERP software, and the intangible nature of most costs and benefits, the evaluation has to be both quantitative and qualitative and requires a multidimensional and a multiple perspective view of perceived costs and benefits throughout the life-cycle of ERP systems. The paper concludes by providing a framework of the key issues involved in the ex-ante evaluation of ERP software and the associated costs and benefits throughout ERP system's life-cycle.

## ERP software

ERP systems are modular client/server software systems providing support to integrated business processes across functions. The software is customisable in order to support critical existing processes followed by organisations. However, customisation is costly, time consuming, difficult and usually requires experienced external

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consultants. Although some customisation is inevitable, major modification of the software with the purpose of adapting it to existing business processes is difficult and certainly not recommended (see, for example, Davenport, 1996). Most organisations need therefore to substantially re-engineer their processes in accordance with the software's requirements and the embedded industry's best practices.

Currently, a large number of enterprises are either extending their base ERP software with such applications as demand forecasting and supply chain optimisation or they are in the process of implementing core ERP modules, such as logistics, sales and distribution, production, and finance. According to Merrill Lynch, 40% of companies with revenues exceeding $1 billion have already implemented base ERP systems in the USA (Caldwell & Stein, 1998) and now are starting to implement additional applications, a market estimated at $8 billion by 2002. AMR Research, a US-based research firm, predicts that the whole enterprise applications market will reach $78 billion in 2004 compared to $27 million in 1999.

However, it has been estimated that about half of ERP implementations fail to meet expectations (Appleton, 1997). Other recently reported figures show that more than 70 percent of ERP implementations fail to achieve their estimated benefits (Al-Mashari, 2000). According to a recent survey (Themistocleous *et al*, 2001), companies adopting ERP certainly acquire benefits such as an increase in suppliers' and customers' satisfaction and an increase in productivity but the level of the return on investment (ROI) is rather low. Other findings of the same survey suggest that many organisations adopting ERP have serious conflicts with their business strategies and the majority of ERP projects are often characterised by delays and cost overruns. These alarming findings can be mostly attributed to the underestimation of the effort required for successful change management. Indeed, by analysing a large number of extended ERP implementation cases, it was suggested that organisational, behavioural and cultural issues are critical for successful ERP implementation (Stefanou, 1999). Given the cost of the investment required to acquire, implement and operate an ERP system, the interest expressed recently by academics and practitioners concerning the selection of measures and the evaluation techniques of ERP systems is highly justifiable (see, for example, Rosemann & Wiese, 1999; Donovan, 2000). It should be also noted, that the cost of making a decision concerning the acquisition of ERP software can account for as much as 30 percent of the overall cost of the investment and that the ERP selection process can consume up to 20 employees for 14 months (Hecht, 1999). This is indicative of the importance of ERP acquisition/selection process and the relevance of this issue to IS research.

## Methodology

This paper is based on three sources of data. The first source is an academic literature review, the second is articles drawn from the web and respected practitioners' magazines reporting ERP selection cases and the third is personal semi-structured interviews and structured interviews conducted through e-mail with nine ERP consultants and project implementation leaders. The size of the sample is rather small but not unusual for this kind of qualitative research. The interviews served as a means to test the validity of the theoretical framework proposed in this paper. The textual data of the transcribed interviews with the ERP consultants were combined into a single file and analysed by calculating the frequency with which words or small phrases appeared in the text. It should be noted that the required validity of the findings of this analysis is mainly dependent upon the coherence of the interpretation (Weber, 1990). It should be also noted that Shang and Seddon (2000) have been argued, convincingly, that ERP case studies reported in the trade press and the web can provide reliable data to conduct academic research and can be used as a starting point for understanding the benefits and the costs involved in ERP systems.

## Financial approaches for ERP evaluation

Traditionally, the evaluation of IT/IS investments was mainly based on financial criteria. Financial measures, including Net Present Value (NPV), Internal Rate of Return (IRR), Return on Investment (ROI), and payback in time (for a description of these measures, see Remenyi, 1999) were employed only to show, most of the times, the validity of the so-called 'IT productivity paradox'.

It is now well recognised that IT investments can have a wider range of benefits than the reduction of costs provided by traditional IT applications (Farbey *et al*, 1993). This is especially true for ERP systems, the role of which is crucial in changing the organisational structure and transforming business processes towards simplification and integration. The intangible nature of ERP costs and benefits, which evolve over time, and the complexity of ERP projects, have been acknowledged by many researchers and practitioners alike (Donovan, 2000; Remenyi, 2000). It has been argued, for example, that, the benefits or the costs in complex systems, such as ERP systems, are difficult to be identified and many of them have to be discovered as the implementation progresses (Remenyi, 2000). Therefore, in the case of ERP systems, financial measures, although necessary, are not alone sufficient to support ERP systems justification due to the following reasons:

- A large number of ERP benefits and costs are not easily identifiable, as they span the entire life-cycle of an ERP project.

- Costs and benefits, even when they are identified, are not easily quantifiable, as has been already recognised to be generally the case with IT investments (Powell, 1992).
- Major benefits (and costs) do not emerge from the use of ERP software *per se* but rather from the organisational change induced by ERP and the extendibility of the software to support additional functionality (Donovan, 2000). According to the vice president of AMR Research, 80 percent of the benefits come from the changes in the business enabled by the ERP software (Martin, 1998).

## Non-financial approaches for ERP evaluation

There is now a growing belief that financial measures do not provide the complete picture of the potential and costs of ERP projects, although no one can deny the persuasive nature of such measures. Microsoft's decision, for example, to implement a $25 million system from SAP was based on the estimation that the new system could produce a common procurement system worldwide that could save the company $12 million per year in early-payment discounts (Martin, 1998). However, various attempts have been made to incorporate qualitative elements in the evaluation of IT projects. Information economics, for example, proposed by Parker *et al* (1988), is an attempt to incorporate value and risk in IT evaluation, taking into account intangible benefits such as, for example, improved customer service. Recently, a balanced scorecard (BSC) approach has been proposed for the evaluation, specifically, of ERP software (Rosemann & Wiese, 1999). The BSC was proposed by Kaplan and Norton (1992) for the evaluation of business performance, but it can also be applied for the evaluation of IT projects. The BSC approach can be useful in evaluating ERP, as, in addition to financial measures, it takes into account a wider range of ERP effects (Martinsons *et al,* 1999; Rosemann & Wiese, 1999). Kaplan & Norton (1992) suggested that the evaluation of business progress should be derived from four different perspectives: financial, internal processes, customers and innovative/learning perspectives. Rosemann and Wiese (1999) recommend, that in addition to these classical perspectives, where, regarding ERP, customers are both external and internal (users), a fifth perspective, that is, the project perspective, is needed especially for controlling and evaluating ERP implementations, although not for ERP usage. This perspective covers the individual project requirements, such as the identification of the critical path, the definition of milestones and the evaluation of the efficiency of the project organisation.

It should be noted that formal evaluation methods, such as those briefly discussed above, have not been always entirely successful in practice (Walsham, 1998). The complexity of IT projects, arising mainly from their interaction with the economic, technical and social environment of the organisation should be recognised as a significant barrier for effective evaluation. To tackle this problem, interpretive research, seeking to understand the dynamics of social and contextual interactions may be of much help. Interpretive IS research do not necessarily reject the objectivity of real phenomena (Myers, 1997) but it emphasizes the importance of beliefs, interpretations and methods used by individual researchers. The validity of generalisations does not depend upon statistical inference but on the plausibility and cogency of logical reasoning and on the theoretical interpretation of collected data (Walsham, 1993). Interpretive research recognises that IS are mainly social systems both influencing and influenced by a variety of environmental, organisational, behavioural and cultural issues. A number of qualitative and interpretive techniques, such as mental models and cognitive mapping proposed in the literature (Hines, 2000) can be applied in order to analyse and evaluate ERP projects. Decision makers' instinct (Bannister & Remenyi, 1999), as well as their way of thinking and interpreting information may be, for example, a decisive factor in ERP selection and implementation success. An example of using a cognitive mapping technique is given by Stafyla and Stefanou (2000) in their study of ERP project leaders' beliefs concerning ERP adoption. Cognitive mapping revealed that, for many managers, the competitors' adoption of ERP is a decisive factor for choosing to implement ERP, in an attempt to retain the competitive advantage of their organisations.

## The complexity of the ex-ante evaluation of ERP systems

IT managers are increasingly asked by senior management to justify expenditures, explain the business impact of IT investments and provide detailed ex-ante and ex-post evaluation of information systems (Torkzadeh & Doll, 1999). This paper is mainly concerned with the ex-ante evaluation and the selection process of ERP systems. Ex-ante evaluation is defined as the predictive evaluation which is performed in order to estimate and evaluate the impact of future situations (Remenyi, 1999). Ex-ante evaluation of IT investments is traditionally based mainly on financial estimates, such as NPV and its purpose is to support system justification. Ex-post evaluation usually assesses the value of the implemented system on the basis of both financial and non-financial measures (Remenyi, 1999).

The complexity, however, of ERP software calls for an ex ante evaluation combining both quantitative and qualitative measures, as discussed above. Evaluation managers should realise that, as in the case with ERP

software, its evaluation is also a complex and a continuous, life-long commitment. The complexity of ERP evaluation is attributed to the following reasons, which are briefly discussed below:

- **ERP's nature is both strategic and operational.** Strategic systems aim at making the organisation more flexible and responsive to customer needs. The goal of rendering the enterprise readily adaptable to changing competitive conditions makes strategic systems fundamentally different from back office applications. The evaluation of strategic systems has to be based on the perceived competitive impact, which is different from evaluation based on cost (Clemons, 1991). Moreover, as has been argued by Kaplan (cited by Clemons, 1991), financial techniques, such as discounted cash flow, are constantly misused when applied to evaluation of strategic IT decisions, due to the difficulty of quantification of the value of strategic systems. ERP systems are at the same time both strategic and operational in nature. Therefore the evaluation has to be made from two different perspectives, the strategic and the operational. ERP software's operational costs and benefits (some of them depicted in Table 1) are more easily identifiable and quantifiable than the strategic ones.

  As far as the strategic aspect is concerned, a key factor is the identification of the degree to which the adoption of an ERP system contributes to business strategy of the organisation (Fitzgerald, 1998). While this degree is difficult to assess in quantitative terms, a qualitative assessment is nevertheless possible by interviewing, for example, senior managers or by using other qualitative techniques such as Likert-type scales and cognitive mapping. Various methods can also be employed for assessing the relative importance of alternative options. It has been argued (Clemons, 1991) that, sometimes, when alternative outcomes can be ranked in a structured manner, decisions that cannot be based on numerical data can be made rationally and analytically without having precise estimates of the individual courses of actions. Simulation, probability and sensitivity analysis can be extremely helpful under these circumstances.

  Although some overlapping between strategic and operational factors is inevitable, Table 1 attempts to summarise some factors that need to be considered in the evaluation process at the strategic level, while Table 2 includes factors referring to the operational level. For example, business processes integration is a strategic activity as long as (successful) integration has an impact on the competitive position of the organisation, while at the same time is also operational as long as it results in cost reductions in the daily activities of the organisation.
- **A number of ERP's stakeholders operate outside the organisation's boundaries** (customers, suppliers, business partners in the value chain). For achieving the full potential of ERP, especially under collaborative business structures such as Supply Chain Management (SCM), the co-operation between business partners is essential. Other contemporary business paradigms, such as Customer Relationship Management (CRM), require the co-operation with the organisation's customers. In that respect, the evaluators should consider the impact of ERP on external stakeholders, specifically the customers, suppliers and business partners. In fact, alliance is one of the strategic benefits incurring from ERP implementations (Shang & Seddon, 2000). Successful ERP cases demonstrate the importance of estimating ERP's effects on external stakeholders.

**Table 1** Some factors to be considered in ERP evaluation at the strategic level

| Strategic Level Factors |
|---|
| ○ ERP's contribution to business vision and strategy |
| ○ Alignment of business and technology strategy |
| ○ Flexibility and scalability of IT architecture |
| ○ Flexibility and adaptability of ERP solution to changing conditions |
| ○ Integration of business information and processes |
| ○ Identification of the various components and magnitude of the project's risk |
| ○ Impact of ERP on the decision making process |
| ○ Competitors' adoption of ERP |
| ○ Impact of ERP on cooperative business networks |
| ○ Estimation of future intensity of competition and markets deregulation |
| ○ Impact of the decision to implement or not an ERP system on the competitive position and market share |
| ○ Estimation of the total cost of ERP ownership and impact on organisations' resources |
| ○ Analysis and ranking of alternative options in terms of the competitive position of the organisation |

**Table 2** Some factors to be considered in ERP evaluation at the operational level

| Operational level factors |
|---|
| Impact of ERP on: |
| ○ transactions' costs |
| ○ time to complete transactions |
| ○ degree of business process integration |
| ○ intra- and inter-organisational information sharing |
| ○ business networks |
| ○ reporting |
| ○ customer satisfaction |
| Estimation of costs due to: |
| ○ user resistance |
| ○ personnel training |
| ○ external consultants |
| ○ additional applications |
| ○ system downtime |

For example, Coca-Cola company's IT strategy was to extend its enterprise by extending SAP R/3 to its independent bottling partners under a single master licence it controls, with partners sharing the relevant costs (Violino, 1999). The goal, the increase in revenues by communicating more easily and rapidly with the business partners, could not be achieved without evaluating ERP's costs and benefits on the company's external partners.

- **There is a high percentage of intangible costs and benefits.** According to Brynjolfsson and Yang (1997), there is empirical evidence to suggest that up to nine-tenths of the costs and benefits of computer capital are embodied in intangible assets. Intangible assets are created by investments in software, training and organisational transformations induced by IT. These assets, although not measured financially, have the potential of increasing the value of IT investments. The estimation of the value of these assets in monetary terms is clearly a very difficult endeavour. However, it is important that both tangible and intangible assets and hidden costs should be taken into account from the outset when considering ERP projects. For example, reductions in transaction systems and technical support personnel, cost savings resulting from better inventory management or value chain optimisation, and savings from not upgrading legacy systems can be calculated. Other benefits, such as perceived customer satisfaction and benefits arising from rapid decision making are more difficult to be calculated, but nevertheless existent.

  Intangible or hidden and underestimated costs are also a major concern among ERP specialists (Slater, 1998). Underestimation of the time it takes to implement an ERP system is very common in ERP projects. Consultants' fees, personnel training, data conversion, software's integration testing and self-developed software (Slater, 1998; Rosemann & Wiese, 1999) to name but a few, can be a very heavy burden on the budget for supportive activities. In fact, according to some estimates, services by ERP support industry can exceed the initial software cost by a factor of seven to ten (Martin, 1998; Hecht, 1999). Other costs, characterised by a behavioural aspect, are difficult to be identified and estimated. Such costs, for example, include the lack of commitment to change, which can lead to a dysfunctional operating environment and user resistance resulting in increased operational costs.
- **ERP adoption/implementation results in a major organisational change.** A major implication of ERP deployment is that it involves drastic changes in the organisational structure, business processes and the people of an organisation. These changes are the source of both costs and benefits, tangible and intangible. The re-engineering exercise is undertaken with the aim of achieving the optimisation and integration of business processes according to the software's in-built best practices. Thus, in so far change management is effective, competitive advantage and financial returns on investment are expected. However, the estimation of the effectiveness of change management is not straightforward as it is dependent on the analysis of many uncontrollable factors related to human resources and the psychological climate of the organisation (Stafyla, 2000).
- **Benefits and costs span the entire life-cycle of ERP systems,** from the selection process and implementation project through to systems operation, maintenance and evolution. ERP systems evaluation is a complex, multi-facet activity, which has to take into consideration the whole life-cycle of ERP systems. ERP software is constantly evolving aiming at integrating higher business functions (Klaus & Gable, 2000) and ERP investment should be considered as a life-long commitment (Davenport, 1998). Thus, ERP evaluators should have in mind the whole life-cycle of an ERP project and the diverse but interrelated issues that need to be assessed. A framework of this process is provided in the following section.

## A framework for ERP ex-ante evaluation

A number of authors have proposed ERP life-cycle models in the academic literature, especially in the context of identifying critical success factors for ERP implementation. According to Chang and Gable (2000), improved understanding of ERP life-cycle issues is required for both fruitful research and effective implementation of ERP. The stages of their ERP life cycle model are the following three: pre-implementation, implementation and post-implementation, involving respectively activities such as: (a) requirements definition, business case and software selection; (b) gap analysis, custom modification and project and change management; and (c) roll out, upgrades and payback review. Esteves and Pastor (2001) proposed the following six phases: adoption decision, acquisition, implementation, use and maintenance, evolution and retirement. Somers *et al* (2000) have also suggested a conceptual model of ERP implementation, which consists of six phases: initiation, adoption, adaptation, acceptance, routinisation and infusion. Markus and Tanis' (2000) life cycle consists of four phases: (a) chartering, where the business case is defined and decision to adopt ERP is taken; (b) project, consisting among others of system configuration and roll out; (c) shakedown, referring to the routine use of the system; and (d) onward and upward phase, including system upgrading and user support services. As is obvious from the above, ERP life cycle models proposed by most authors are to a great extent similar and in line

with the stages of the traditional systems development life-cycle (Nah & Lau, 2001).

This paper, based on literature review and adopting the ERP life-cycle concept, proposes a conceptual framework of ERP software ex-ante evaluation, which is depicted in Figure 1. The proposed framework consists of four phases. The first phase considers the business vision as a starting point for ERP initiation/acquisition. The second phase consists of the detailed examination and definition of business needs and of the company's capabilities and various constraints in relation to ERP software specifications. Before proceeding, the desire and commitment to change by all people in the organisation needs to be evaluated; it is a significant force required to fill the gap between business requirements and constraints. This phase considers the selection of the specific modules of the core system that support critical business practices and of any additional applications the enterprise may need in view of the requirements analysis performed in the previous phase. Certain criteria for vendor, product, and implementation partner selection are examined. The third phase refers to the estimation of the costs and benefits required for the ERP implementation project. The fourth phase consists of the analysis of issues involved in ERP operation, maintenance and evolution. Finally, the potential benefits and the total investment required for selecting, purchasing, implementing, operating, maintaining and extending the proposed system are estimated. This estimation includes financial and non-financial measures for both the operational performance and the strategic position of the organisation. It should be noted, that as is always the case with IS development or acquisition and implementation, some iteration is assumed (Avison & Fitzgerald, 1995, p 35) and thus, the procedure suggested in Figure 1 is not purely sequential.

## Clarification of the business vision

The first phase of the proposed framework, the clarification of the business vision, is a starting point for ERP initiation/acquisition. Investment in ERP systems is a strategic action, which can have significant consequences for the competitive position of the organisation. It has been argued that effective IT/IS project implementation requires a clear business vision, which clarifies the organisation's direction, the goals, and the business model behind the implementation of the project (Holland & Light, 1999). It was explained above that ERP requires substantial business process re-engineering and as Davenport and Short (1990) have pointed out, the first step in IT enabled process re-engineering is to develop the business vision and process objectives.

## Comparing needs *vs* capabilities and constraints

The decision concerning the adoption of an ERP system has to be made according to both the current and the future status of the enterprise, which is constrained by various technological, organisational and financial inefficiencies (Table 3). Therefore, at this stage, a detailed critical ERP functionality and enhancements require-

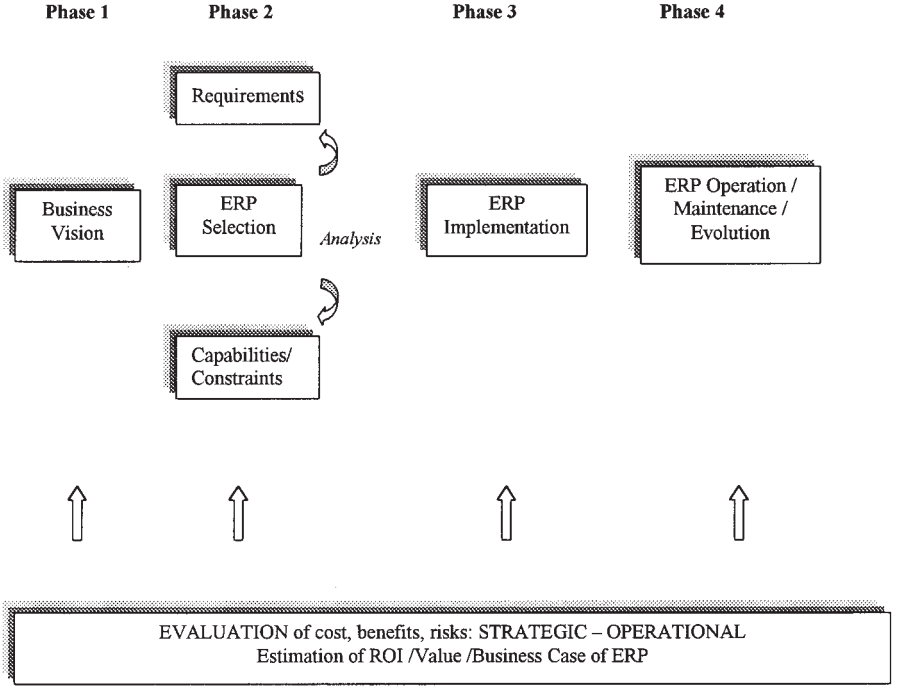


**Figure 1** Major phases of ERP life-cycle.

**Table 3** Requirements *vs* constraints

| *Requirements* | *Constraints* |
|---|---|
| • Operational efficiency<br>• Supply chain optimisation<br>• E-commerce<br>• CRM<br>• Processes integration | • Technical<br>  ○ Legacy systems<br>  ○ IT architecture<br>• Organisational<br>  ○ Business processes<br>  ○ Management structure<br>  ○ Leadership<br>  ○ Commitment<br>  ○ Communication<br>  ○ Training<br>• Financial<br>  ○ Budget limitations<br>• Time constraints |

ments matrix, followed by a list regarding the organisational and technological changes required for the successful implementation of the ERP system should be developed and evaluated according to certain criteria. This is, for example, exactly what Hersey Foods, a US company with revenues exceeding $4 billion a year, had to do with its re-engineering exercise. For this company, re-engineering for ERP involves extracting the best finance, logistics and sales practices from multiple divisions and then standardising them into an integrated ERP system that could provide business consistency, such as credit terms, across all company's divisions (Martin, 1998).

Moss (2000), after describing a Baan software implementation case, concludes that to achieve the goal of business support by implementing an ERP system, companies should avoid the design of a system that the ERP software is capable of providing but which is beyond the capabilities of the company to absorb as a daily routine. For companies wishing to achieve this goal, a well defined set of objectives and an on-going commitment to meeting them are essential from the outset of an ERP project.

### *Business requirements*

Both current and future business needs, arising mainly from external competitive pressures, have to be balanced against various technological, work and organisational constraints. Companies engaging in e-commerce or supply chains operate in a sophisticated business and technological environment. In such cases, the effectiveness of ERP systems, which span beyond traditional organisational boundaries, require collaboration between partners, coordination of decisions, as well as accurate and real-time information flow in a network of enterprises.

There is a great likelihood that the examination of needs and constraints will reveal that for a successful ERP system implementation, a radical change in business processes, towards simplification and efficiency, must take place. Such is the case, for example, when developing systems with a customer perspective or adopting best practices from industry (Avison & Fitzgerald, 1995, p 387). Therefore, a critical factor that should be considered at this stage is the desire and the commitment to continuous change not only by top management but also by the steering committee, the systems' users and by all members of the project's implementation team. It is also likely that ERP acquisition will have to be postponed or rejected in view of the high risks involved (Stefanou, 2000). An example of this final option is provided by the well known case of Dell Computer Corp, in which the implementation of SAP R/3 had to be terminated, in view of the company's CIO's conviction that a single monolith software could not keep pace with the company's growth (Slater, 1999).

### *Constraints*

The constraints are classified in five categories: technical, organisational, human, financial and time constraints.

*Technical constraints:* Costs incurring from using multiple hardware and software platforms could be significantly reduced if there were a common IT architecture, including software and hardware platform, networking and communications, and applications development. Scalability and flexibility of the IT infrastructure is critical in order to support additional applications and systems and it should be assured before proceeding to the ERP procurement process. Changes in the IT infrastructure may be necessary in order to support the ERP system and any other additional applications. This poses another major evaluation problem, because the IT infrastructure is a supportive IT investment with no immediate measurable benefits by its own, but it still needs to be evaluated as far as alternative solutions or vendors are concerned (Fitzgerald, 1998).

*Organisational constraints:* These include, among others, the degree of the decentralisation, the management structure, the style of leadership, the rigidity of business processes, and the company's culture. Resistance to change, prestige, job security feelings and departmental politics are also involved (Bancroft *et al*, 1998, p 131). It should be noted that organisational and cultural factors seem to be very important for successful implementation of ERP and SCM systems (Stefanou, 1999).

*Human resources constraints:* A cross functional implementation team consisting of both business and IT/IS people and of internal personnel and external consultants can be very effective in implementing ERP software. However, the lack of experienced external consultants and trained and educated employees in ERP

philosophy represents a serious constraint that could jeopardize the implementation project.

*Financial and time constraints:* Any project of the scale of ERP systems implementation should have adequate financial resources. A lot of hidden costs, such as the period of training required and unanticipated fees of external consultants, may prove to be a barrier to successful implementation. One final constraint is the time allowed for the selection and implementation process. Unrealistic time frames and deadlines may add unnecessary pressure and lead to project failure.

## Product, vendor and support services evaluation

The second part of the second phase considers the selection of ERP modules that support critical business functions and of any other needed additional application, such as for example SCM. Certain weighted criteria for the selection of *vendor*, *product* and *implementation partner* should be set and evaluated at this phase (Travis, 1999). According to a recent International Data Corp (IDC) survey (Moss, 2000), users, who implemented ERP systems, rate the ability of the vendor to deliver the promised system on time and on budget as the most important issues involved in the ERP buying process. Other important buying criteria are the scalability and flexibility of the ERP solution and the confidence in both the solution and the provider.

Although every one of the established ERP packages offers a broad functionality, they certainly exhibit individual strengths and weaknesses compared to individual business requirements. Certain packages are regarded as having an exceptional functionality in some of their modules, as is the case, for example, with PeopleSoft's Human Resources module. Other vendors are regarded as specialising in certain industries, supporting industry-specific best practices, as for example SAP in Chemicals and Pharmaceuticals, Oracle in Energy and Telecommunications and Baan in Aerospace and Defense industries (Aberdeen Group, 1997).

The availability and functionality of additional applications to support current and future business needs such as SCM or CRM is an important factor in ERP software selection. It should be also examined if the packages under consideration support a certain business practice or operation, which is considered critical, such as make-to-order or make-to-stock manufacturing. Certain characteristics, such as multilanguage and multicurrency capabilities can be the key drivers for selection of an ERP system (Bancroft *et al*, 1998, p 191). Among other factors considered in selecting an ERP system is the availability of experts in the system, the partnering company that will assist in the implementation, the training courses available by the vendor or third parties as well as vendor's financial position and pricing models (Table 4).

**Table 4** ERP product, vendor and support services evaluation

- Requirements fulfilment
- Functionality of ERP system's critical core modules
- Industry-specific solutions offered
- Extended applications availability/compatibility
- Critical business processes supported by ERP system
- External experts availability in ERP system
- Implementation partner availability/expertise
- Training offered by vendor or third party
- Vendor's financial position
- Pricing models offered by vendors

### *All-in-one vs best-of-breed ERP software*

Enterprises searching for competitive advantage have the option of acquiring an all-in-one or a best-of-breed ERP system. Additional applications can be acquired from the vendor of the ERP system, from another vendor closely collaborating with the first, from a third party vendor, built-in-house or outsourced. Table 5 summarises the advantages of best-of-breed and all-in-one approaches.

An example of an all-in-one approach is provided by the multinational Colgate-Palmolive's SAP R/3 solution, which integrated the processes of the company and connected ten thousand users worldwide after a 5-year implementation effort. Worries about the risk of relying on only one vendor were put aside as the company was convinced that this integrated environment offers systems robustness and the additional required functionality to support the company's operations. On the other hand, in an attempt at achieving increased functionality, the Boeing Commercial Airplane Group has adopted the best-of-breed approach by implementing demand-forecasting software by i2 Technologies, ERP by Baan and product data management by Structural Dynamics Research. It has been reported that industry watchers agree that about 80% of companies will adopt the all-

**Table 5** All-in-one *vs* best-of-breed

*All-in-one*
- Consistent integrated processes
- Upgrades compatibility
- Lower cost
- Implementation simpler
- Maintenance easier

*Best-of breed*
- Functionality enhanced
- Flexibility
- Possible competitive advantage
- Extended applications (SCM, CRM, DSS, etc) widely tested
- No dependence on one vendor

in-one solution but the remaining 20% will demand best-of-breed applications from multiple software vendors (Stein, 1999). Obviously, substantial empirical work is needed in order to identify the merits of these two approaches.

## Evaluating the ERP implementation project

ERP implementation has received the greater attention in the relevant literature. This is justifiable because ERP implementation is a complex, resource-consuming and risky activity. At this stage, costs and benefits arising from the ERP implementation project are estimated. Consulting fees, replacing of legacy systems and user training, are some of the areas evaluators should not ignore. Implementation project costs and risks are also dependent on the implementation approach chosen by the organisation. For example, in big bang implementations, fewer interfaces between the modules are required and costs are generally reduced compared to the phased, module-by-module implementation, which requires the development of more interfaces and the existence of the legacy systems until the completion of the implementation project. On the other hand, there is a greater risk of failure in big bang ERP implementations while the phased implementation is generally considered a lower risk approach. Other important issues, such as setting the criteria for the selection of the implementation partner and the time horizon for the completion of the project should also be considered at this stage.

## Operation, maintenance and evolution of the ERP system

As has been pointed out by Kirchmer (1998) many companies think that after the completion of the implementation project, the implementation activities are over. This however is certainly not the case because changes in markets and technology require a continuous check and updating of the ERP software to new releases, or extending it to additional applications such as CRM and SCM. The companies should also improve, where possible, the software-based business processes (Kirchmer, 1998), that is, a certain degree of continuous re-engineering seems to be necessary for achieving or retaining a competitive advantage. On the other hand, benefits may only be achievable at this late stage, when the ERP implementation is mature (Somers *et al*, 2000). Therefore, the fifth phase of the proposed framework includes estimation of the costs and benefits which will arise in the future from operating, maintaining and extending the ERP system with additional functionality. Table 6 summarises potential costs and benefits associated with each phase of the framework.

**Table 6** Potential costs and benefits associated with ERP life-cycle phases

| *Phases of ERP life cycle* | *Estimation of potential tangible and intangible costs, benefits and risks involved in each phase* |
|---|---|
| **Phase 1:** Business vision | Risk associated with non-clarification of business vision and blurred business goals |
| **Phase 2a:** Comparing needs *vs* capabilities and constraints | Technological, organisational, human resources and financial capabilities and inefficiencies (see Table 3)<br>Commitment to continuous change |
| **Phase 2b:** ERP selection | Costs/benefits/risks associated with all-in-one or best-of-breed software options (see Table 5)<br>Costs/benefits associated with issues in Table 4<br>Costs involved in the selection process |
| **Phase 3:** Implementation project | Replacing of legacy systems<br>Consulting fees<br>User training<br>Implementation approaches<br>Implementation partners<br>Completetion time |
| **Phase 4:** Operation, maintenance and evolution | Continuous re-engineering<br>Software upgrades<br>Additional functionality<br>Benefits from ERP maturity both operational and strategic<br>ERP users satisfaction<br>Partners/customers satisfaction |

## Findings from the interviews

Findings from interviews with nine ERP consultants provided partial support for the framework proposed above. Although there is generally an agreement among them regarding the phases of ERP life-cycle and the selection process of ERP software, the majority of interviewees (seven) has not been ever involved with the deployment of qualitative measures in the process of selecting ERP software. The reasons stated are the following: high cost of establishing and measuring qualitative elements, ambiguity regarding the nature of qualitative measures, lack of time to devote to qualitative measurement, lack of instructions by management to establish qualitative measures. Also, despite the fact that the strategic element of ERP is generally acknowledged by all, the evaluation of ERP software in practice does not take explicitly into account strategic elements.

Eight of the interviewees expressed their concern about the high risks involved in ERP software, due to high acquisition and implementation costs, and they think that risk should be evaluated at every phase of the ERP life cycle. Risk was not present in the initial theoretical framework but it seems reasonable that risk analysis should be performed along costs and benefits estimation. Finally, one more new issue emerged by

analysing the interview data, that of ERP outsourcing. ERP outsourcing was mentioned by two interviewees. One of them seemed to consider outsourcing as an option for medium enterprises only, while the other considered it to be potentially useful for all enterprises regardless of their size. Obviously, further empirical research is needed in order to determine the reasons why qualitative and strategically focused measures are not used in ERP ex-ante evaluation, test the validity of the proposed framework and analyse issues concerning ERP outsourcing through an application server provider.

## Conclusions

The plethora of consulting companies offering ERP evaluation/selection services as well as a number of recently published papers and conferences' mini tracks devoted to ERP evaluation indicate that, despite the experience gained from ERP implementations during the last decade, the concept of ERP evaluation/selection is still relevant to IS research and significant for IT/IS success.

The evaluation of ERP requires the understanding of the major impact ERP has on the business strategy, the organisational structure and the role of the people of the organisation throughout its life-cycle. The framework of ERP systems evaluation and selection proposed in this paper is significant in that it makes ERP managers bear in mind that ERP evaluation does not only refer to the analysis of the ERP product *per se*. In addition, and more crucially, it refers to the potential operational and strategic benefits and the total investment required for selecting, purchasing, implementing, operating, maintaining and extending the proposed ERP system with additional applications throughout its life-cycle. Failure to identify the full costs of ERP investment can have serious implications for the success of the ERP project (Irani *et al*, 2000). The framework also provides a basis for identifying critical issues for further research. For example, a fruitful avenue for future research could be the construction of specific metrics related to business operational performance and strategic objectives taking into account ERP's pervasive and permanent nature as demonstrated by the proposed framework.

As Rosenthal and Salzman (1990) have pointed out, the acquisition of software is not just a technical issue but also an important strategic one. The acquisition of applications software and especially ERP software could have profound implications on a number of vital business issues such as the productivity, the quality of the output of the production or services process and the customers' satisfaction, affecting thus the organisation's competitive position. Strategic dimensions of the anticipated benefits may be missed if the evaluation of new technology is preoccupied with traditional quantitative ROI measures and if the significance of procurement in determining the capabilities of new process technology is underestimated by top management (Rosenthal & Salzman, 1990).

The decision to implement an ERP system is certainly a strategic one, which has a major impact on every area of the organisation. Market pressures and technological advantages have been the driving forces behind mergers, acquisitions, and cooperation between organisations in the supply chain in recent years. ERP software has been seen by many companies to offer the required integration of business applications not only inside an organisation but across organisations as well. ERP systems are thus becoming increasingly more complex, aspiring to provide support for business functions that were previously offered by third party vendors. Extended ERP software includes such applications as supply chain optimisation, customer relationship management and decision support systems. Therefore, the dynamic nature of ERP should be recognised and the time horizon of the evaluation should be extended so that certain future business practices are taken into account.

In this respect, ERP systems are significantly different from traditional information systems: ERP formulates the organisation's business and technology strategies. Traditional IT applications were fit into the given business strategy and context. Organisations implementing ERP systems find that they have to adapt to ERP's inbuilt industry best practices, engaging thus in a significant reengineering of their processes, while at the same time gaining benefits for following these best practices. The financial benefits and the costs of this re-engineering induced by ERP can not be easily estimated. In addition, a number of qualitative, cultural and behavioural factors should be evaluated such as the degree of transformational leadership in the organisation required for effective change management, the willingness for information sharing and the commitment to change by all, which can be crucial for the successful implementation and effective operation of ERP systems, especially in SCM environments (Stefanou, 1999). These factors should play a major role in the decision whether or not to acquire an ERP system.

Describing operational benefits arising from transaction processing improvements is not alone sufficient to justify ERP systems' investment. As has been argued, organisational change, in accordance with the software's supported industry's best practices, is required if any benefits are to be realised (Zylstra, 1999). Therefore, any evaluation of ERP should provide detailed analysis of

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having to extend its scope beyond operational improvements induced by the software's functionality and generally expressed by a reduction in costs to the strategic impact of ERP on the competitive position of the organisation, which is usually based on qualitative indices and estimates. The identification of the financial costs and benefits and the qualitative estimates should be done taking into account ERP's permanent and dynamic nature, from the selection process activities to its operation, maintenance and evolution. The integrative nature of ERP software and the interaction among intra-organisational and inter-organisational users, creates a complex socio-technical system in which a large percentage of costs and benefits are well hidden or they emerge after ERP implementation, induced by the organisation's attempt to retain its competitive advantage by utilising and extending core ERP functionality. Senior management has the responsibility to understand the dynamics and the integrative, permanent and strategic nature of ERP as well as the prevailing competitive conditions in the global marketplace before proceeding into ERP software acquisition.

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