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European Journal of Operational Research 146 (2003) 352–364

EUROPEAN  
JOURNAL  
OF OPERATIONAL  
RESEARCH

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# Enterprise resource planning: A taxonomy of critical factors

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Received 27 June 2002; accepted 27 June 2002

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## Abstract

This paper presents a novel taxonomy of the critical success factors in enterprise resource planning (ERP) implementation process. ERP benefits cannot be fully realised unless a strong alignment and reconciliation mechanism is established between technical and organisational imperatives based on the principles of process orientation. It is suggested in the taxonomy that measurement takes place in a balanced perspective, and for the purpose of providing useful information that can enable the decision making process and, which can help deliver the corporate objectives and therefore lead the business competitively forward. Upon this premise, the taxonomy is based on a comprehensive analysis of ERP literature combining research studies and organisational experiences. The taxonomy reflects the essential features of ERP systems, as being built based on the principles of business process management. Furthermore, it illustrates that ERP benefits are realised when a tight link is established between implementation approach and business process performance measures.

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*Keywords:* ERP; Critical success factors; Taxonomy; Deployment; Evaluation

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## 1. Introduction

Today, one of the major sources of competitive advantage has been the ability to speed up the supply-chain process (Gumaer, 1996). This demand led to a significant development in information systems (IS) known as enterprise resource planning (ERP) systems. Instead of developing IT

system in-house, more and more companies are turning to off-the-shelf ERP solutions to plan their IT resources more effectively and manage their legacy systems (Holland and Light, 1999). Various figures have pointed to the fact that ERP systems have become one of the largest IT investment in the 1990s (Chung and Snyder, 1999). In fact, the implementation of an ERP system can be considered as one of the most effective ways towards traceability, since it facilitates integration between modules, data storing/retrieving processes and management and analysis functionalities, combined with the typical functionalities of stand-alone applications (Rizzi and Zamboni, 1999). The

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notion of “integration” can be traced back to the early days of computing in organisations, when Blumenthal (1969) developed a framework and integrated architecture for organizational IS (Kumar and Hillegersberg, 2000).

Even if an organization could, over a short period of time, confirm final success of implementation of ERP, the real business value may not be realised as quick. The realisation of a lasting commitment has begun to dawn upon many organisations. For instance, some of the early implementers of SAP who installed the R/2 system version face a costly, time-consuming upgrade process to R/3 (Davenport, 1998a,b). The complexity of ERP and its associated high costs and implementation problems are forcing many organisations to rethink their plans for acquiring and implementing such enterprise systems (Kumar and Hillegersberg, 2000).

Despite the significant benefits that ERP software packages provide in managing and integrating cross-functional business processes, they often cost millions of dollars to buy, several times as much to install, and, more importantly, they result in disruptive organizational changes (Volkoff, 1999). It is on this basis that some companies have enjoyed considerable improvements whilst others have had to scale back their initiatives and to accept minimum payoffs, or even decide to give up on ERP implementation (Soh et al., 2000).

This paper discusses the theoretical basis of ERP systems in relation to the benefits realization process. A theoretically and practically grounded taxonomy of ERP critical success factors is therefore developed. The taxonomy demonstrates the linkages between ERP critical factors of success, ERP success and ERP benefits. It should therefore contribute to an enhanced process of ERP benefits realization, where critical factors bridge the link between ERP implementation and improvement in business performance across strategy, business processes, IT, structure, culture and management systems.

## 2. ERP definitions and drivers

Like many newer fields in IS, the definition of ERP software, synonyms are integrated stan-

dard software packages, enterprise systems, enterprise wide-systems, enterprise business-systems, integrated vendor software, and enterprise application systems (Gable, 1998; Holsapple and Sena, 1999; Rosemann, 1999), has been defined by various authors but with not much differences. Rosemann (1999) defines ERP system as a customizable, standard application software which includes integrated business solutions for the core processes (e.g. production planning and control, warehouse management) and the main administrative functions (e.g., accounting, human resource management) of an enterprise. Slightly differently, Gable (1998), however, defines it as a comprehensive package software solutions seek to integrate the complete range of a business processes and functions in order to present a holistic view of the business from a single information and IT architecture.

Since the focus of manufacturing systems in the 1960s was on traditional inventory control concepts, most of the software packages were limited generally to inventory based on traditional inventory processes (Gumaer, 1996; S, 2000). Due to the need for software designed specifically for manufacturing operations, the focus of manufacturing systems have moved to material requirement planning (MRP) systems which translated the Master Schedule built for the end items into time-phased net requirements for the sub-assemblies, components and raw materials planning and procurement (Gumaer, 1996; S, 2000). Since 1975, the MRP system has been extended from a simple MRP tool to become the standard manufacturing resource planning (MRPII) (Chung and Snyder, 1999). In addition, Shtub (1999) states that the MRP systems, which trade with resource capacities, are known as MRPII systems. However, the shortcomings of MRPII in managing a production facility's orders, production plans, and inventories, and the need to integrate these new techniques led together to the development of a rather more integrated solution called ERP (Chung and Snyder, 1999). ERP systems work essentially at integrating inventory data with financial, sales, and human resources data, allowing organisations to price their products, produce financial statements, and manage effectively their resources of people,

materials, and money (Markus et al., 2000). The emergence of ERP in the early 1990s led to the inclusion of other functions such as accounting and sales management (Gupta, 2000). In fact, ERP advocates believe that ERP could combine both business processes in the organization and IT into one integrated solution, which MRP and MRP II were not able to provide (Chung and Snyder, 1999).

In recent years, while the rise of the Internet has been the subject of most of the media's attention, the business world's focus on enterprise systems may in fact be the most significant shift in the organisational use of IT in the 1990s (Davenport, 1998a,b; Holsapple and Sena, 1999). In the software market, the ERP software is the fastest growing market, as its growth is expected to increase from \$15 billion to \$50 billion in the coming five years (Bingi et al., 1999). By the year 2002, AMR Research expects the ERP systems market to jump from \$15.68 billion (in 1997) to \$72.63 billion (Holland and Light, 1999). This is comparable to the predication of some industry analysts that the worldwide ERP systems market is expected to reach \$50 billion by 2002 (Computer Technology Research Corporation, 1990).

An important feature of ERP is that it is the first approach that integrally combines business management and IT concepts. (Slooten and Yap, 1999). Its strength stems from its ability to provide a comprehensive business functionality in an integrated way using a state-of-the-art IT infrastructure (Waston et al., 1999). In one example, SAP's client/server software package, R/3, offers the potential to integrate the complete range of an organisation's operations in order to present a holistic view of the business functions from a single information and IT architecture perspective (Gable et al., 1998). Indeed, enterprise systems have improved the organisational information flow through the supply chain to such a degree that they have become an effective operating standard (Davenport, 1998a,b). One significant feature of an ERP software is that core corporate activities, such as manufacturing, human resources, finance, and supply chain management are automated and improved considerably by incorporating best practices, so as to facilitate

greater managerial control, speedy decision-making and huge reduction of business operational cost (Bancroft et al., 1998; Holland and Light, 1999).

The basic architecture of an ERP system builds upon one database, one application, and a unified interface across the entire enterprise. An entire organisation is therefore able to operate under one application standard where all applications serving human resources, accounting, sales, manufacturing, distribution, and supply-chain management aspects are firmly integrated. An ERP software is also beneficial in that it can speed decision-making, reduce costs and give managers control over a globally distributed business operations (Gibson et al., 1999; Holsapple and Sena, 1999). A study by Benchmarking Partners for Deloitte & Touche Consulting (Computer Technology Research Corporation, 1999) classifies companies' motivations for ERP implementation into two groups, technological and operational. Technological drivers relate mainly to the Year 2000 (Y2K) compliance requirements, replacement of disparate system, improvement of quality and visibility of information, integration of business processes and systems, simplification of integration of business acquisitions into the existing technology infrastructure, replacement of older, obsolete systems, and the acquirement of system that can support business growth. Operational drivers, on the other hand, are related to improving inadequate business performance, reducing high-cost structures, improving responsiveness to customers, simplifying ineffective, complex business processes, supporting new business strategies, expanding business globally, and standardising business process throughout the enterprise.

### **3. ERP cost and impact**

The contribution that ERP packages, including those from SAP AG, PeopleSoft, Oracle, and Baan, have made to the business world has been remarkable. ERP systems have increased the efficiency of a wide range of businesses by providing them with seamless access to much of the information they need (Li, 1999). An ERP system can

be thought of as a business-wide integration mechanism of all organisational IS (Bingi et al., 1999). This integration makes organisations able (Bingi et al., 1999) to take quick reaction to competitive pressures and market opportunities, be more flexible product configurations, achieve reduced inventory, and maintain tightened supply-chain links. The study also identifies the various benefits of ERP implementation as perceived by the companies surveyed. ERP benefits can be classified into tangible and intangible. According to the Deloitte & Touche's survey (Computer Technology Research Corporation, 1999), tangible benefits refer to inventory reduction, reduction of personnel, increased productivity, improvements in order management, more rapid closing of financial cycles, reduction in IT and procurement costs, improvement of cash flow management, increase of revenue and profits, reduction in transportation and logistics costs, reduction in the need for system maintenance, and improvement in on-time delivery performance. Intangibles refer to the increased visibility of corporate data, new or improved business processes, improved responsiveness to customers, unanticipated reduction in cost, tighter integration between systems, standardization of computing platforms, increased flexibility, global sharing of information, Y2K compliance, improved business performance, and improved visibility into SCM process. However, a study of 63 companies shows that it took eight months after the new system was in to see any benefits. However, the median annual savings from the new ERP system was \$1.6 million (Koch et al., 1999).

Despite these significant benefits that ERP systems can provide, they are very expensive even under ideal circumstances. The cost of an ERP software itself can range from hundreds of thousands of dollars to several million dollars. This cost can further be escalated when considering hiring consultants to help in the selection, configuration, and implementation of the system. According to an IT research firm, Gartner Group, companies may spend up to three times as much money on consultants as they do on the ERP system itself (Computer Technology Research Corporation, 1999). Other costs may include the

human resources needed to work full time on the implementation project. Additionally, an organisation may need to install new hardware to run the ERP software, and a new database to store the ERP data. Furthermore, integrating the ERP system with other types of applications is usually a necessity. It is also important that end-user training and change management costs are considered in the equation (Computer Technology Research Corporation, 1999). In fact, every company that implements an ERP system is faced with its cost and complexity. However, the disastrous problems are usually those which relate to implementing an ERP system without thinking through its full business implications (Davenport, 1998a,b).

#### **4. Taxonomy of critical factors**

One major benefit of ERP comes from its enabling role in reengineering the company's existing way of doing business. All the processes in a company must conform to the ERP model. Organisations that do not adopt this philosophy are likely to face major difficulties (Gibson et al., 1999). This entails that the costs of aligning with an ERP model could be very high, especially when a company plans to roll out the system worldwide. However, ERP implementation results in significant benefits engendered from the integrated nature of the system as well as from reengineering business processes and the change in business culture (Bingi et al., 1999). This however results in the scale of business process reengineering (BPR) and customisation tasks involved in the software implementation process being the major reasons for ERP dissatisfaction (Scheer and Habermann, 2000).

One useful approach to adopt when trying to answer the question on whether/how ERP systems implementation impact on business performance is to consider the levels of ambition of the organisations concerned and what it is that they aspire to achieve in terms of competitive results (Al-Mashari et al., 2001). It is often the case that well deployed visions and missions are the ones that are translated into critical factors of success that get communicated at all levels within the organisation.

In a sense, one major condition for ERP systems to yield to the desired benefits is how well they serve the delivery of CFs. In light of Lyytinen and Hirschheim's (1987) definition of failure, success in IT projects can be seen as:

- *Correspondence success*, where there is a match between IT systems and the specific planned objectives.
- *Process success*, when IT project is completed within time and budget.
- *Interaction success*, when users' attitudes towards IT are positive.
- *Expectation success*, where IT systems match users' expectations.

The link between ERP benefits and strategic goals, objectives or CFs is therefore a relative one rather than absolute in terms of what specifically can be expected. Shang and Seddon (2000) classify ERP benefits into five groups as follows:

- *Operational*, relating to cost reduction, cycle time reduction, productivity improvement, quality improvement, and customer services improvement.
- *Managerial*, relating to better resource management, improved decision making and planning, and performance improvement.
- *Strategic*, concerning supporting business growth, supporting business alliance, building business innovations, building cost leadership, generating product differentiation, and building external linkages.
- *IT infrastructure*, involving building business flexibility, IT cost reduction, and increased IT infrastructure capability.
- *Organisational*, relating to supporting organizational changes, facilitating business learning, empowering, and building common visions.

In a sense, a balanced strategy will have CFs of a strategic, organisational and operational nature. The implementation of ERP systems will therefore be carried out to serve that particular purpose and to support the accomplishment of the various, multi-level CFs. Furthermore, ERP systems can yield to many intangible benefits such as flexibil-

ity, integration, process orientation and synergy building. These very often-unexpected benefits can therefore provide organisations with added capability and will ultimately enhance the latter's strategic planning efforts and can boost future competitive results.

The taxonomy represented in Fig. 1 is a means for illustrating on the one hand the inter-relationship between core business strategy aspects, and on the other, the role of IT and associated systems can play in supporting the effective deployment of key business imperatives through process improvement and management and through regular performance monitoring and review.

## 5. Setting-up

### 5.1. Management and leadership

A review of successful ERP implementations has shown that leadership and top management commitment are the most critical factors in organizations embarking on ERP implementation, as they ensure a smooth change management and system rollout (Bingi et al., 1999). Not only is the requirement for setting the vision and the direction for the business, it is also for harnessing the energy and creativity of employees, for enabling the business to perform, for implementing modern concepts such as BPM and for exploiting the technology capabilities of an ERP system. Furthermore, leadership is a propagated approach of individuals and champions who can effectively implement change programs such as ERP systems and who are not averse to modern ideas, learning and growing the business through innovation and best practices (Al-Mashari et al., 2001).

The experience of Microsoft highlights the importance of having top management directly involved in planning and implementing an ERP system. Microsoft's top management was instrumental in overseeing its ERP project, and the entire board reviewed and approved the plans (Deloitte Consulting, 2000). At ALEVO, the decision to implement an ERP system was also made at the board level, and the senior management team input was very important when selecting a

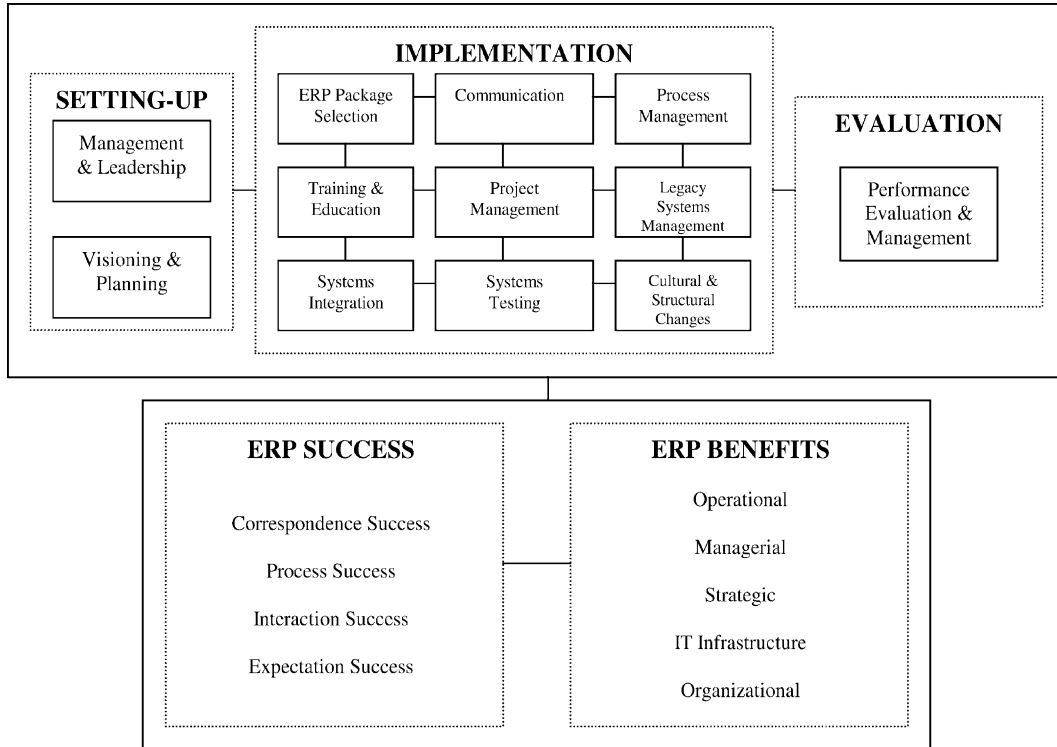


Fig. 1. Taxonomy for ERP critical factors.

suitable vendor (Welti, 1999). Top management support and commitment does not end with initiation and facilitation, but must extend to the full implementation of an ERP system. HP noted that ERP implementation is about people, not processes or technology. The organisation went through a major transformation, and the management of this change was carefully planned (from a strategic viewpoint) and meticulously implemented. All the case studies analysed have shown that the key to a smooth rollout is the effective change management from top. Intervention from management has been necessary to crucial for the adequate resourcing of the project, to taking fast and effective decisions, resolve conflicts and bring everybody to the same thinking, to promote company-wide acceptance of the project, and to build co-operation among the diverse groups in the organisation, and in many times across national borders. Top management needs

to constantly monitor the progress of the project and provide direction to the implementation teams.

### 5.2. Visioning and planning

ERP systems are essentially considered as process-oriented IT tools for improving business performance. One of the most fundamental elements in business improvement is having a clearly defined vision/mission and the formulation of the right policies/strategies that can serve as the blueprint for any organisational success (Mitchell and Zmud, 1995). It is also important to emphasise at this juncture that successful visions/missions are those that are translated into measurable goals and targets. The visioning and planning stage can then serve as ‘the precursor’ for putting in place an enabling IT strategy, based on mapping and determining the key requirements that can support

the effective deployment and delivery of the key business imperatives (Al-Mashari et al., 2001). In fact, an IT vision/mission process is developed as a sub-set of the business strategic formulation process (Henderson and Venkatraman, 1993). It addresses similar issues that are considered from a technical, enabling and supporting perspective (Al-Mashari et al., 2001), and be shaped through a comprehensive gap analysis as well as capturing leading practices from similar competent organizations (Al-Mashari and Zairi, 1999).

Luftman and Brier (1999) point out that IT managers must be knowledgeable about how new technologies (such as ERP systems) can be integrated into every component of their business, including tactical and strategic plans, management systems, culture, human resources, organisational structure, current technologies and business architecture. It is therefore imperative that business strategy formulation process be conducted with the presence of both IT and business executives. Alignment of IT strategy with the organization's business strategy is also considered a fundamental principle that has been advocated for over a decade (Rockart et al., 1996). Luftman and Brier (1999) find out that the IT/Business strategic alignment process is enabled by senior executive support for IT, involvement of IT people in strategy development and the level of IT people's understanding of the business. He also recommends that maximizing the role of alignment enablers can be achieved through setting clear goals and establishing strong teams, establishing strong communication plans, understanding the business–IT linkage, analysing and prioritising performance gaps, specifying actions and defining project-management infrastructure, choosing and evaluating success criteria, and sustaining alignment through continuous improvement. In ERP implementation, the same principles of IT strategic alignment apply. If an organization strives to install a system without establishing a clear vision and understanding of the business propositions, the integration efforts can quickly turn into a disaster, no matter how competent is the software package selected (Davenport, 1998a,b).

Indeed, without a clear direction and meticulous strategic planning, the ERP implementation

initiative can suffer a huge failure (Deloitte Consulting, 2000). Well-defined strategic targets help to keep the project team on track throughout the entire implementation process (Welti, 1999). Project frameworking through planning is important as it identifies the extent and type of benefits that can be derived from an ERP systems (Markus et al., 2000). In reality, the logic of an ERP system may conflict with the logic of the business, and either of two results will come out, an implementation failure, or a weakened competitive position (Davenport, 1998a,b). In the past, ERP projects' failures are found to be the result of inadequately defined business goals and the lack of strong and adequate sponsorship (Deloitte Consulting, 2000).

## **6. Deployment**

This group of factors concerns moving from the what to the how issue of implementation, and converting the 'blueprints' into real actions that focus on the value chain aspects. From a business perspective, the deployment stage includes the definition of the documentation, analysis, improvement, control and redesign/reengineering opportunities of all the most critical processes and core activities. These activities are coupled with the management of the people (skills, competencies, etc.); the change management (preparing the organisation for change, dealing with resistance, for putting in communication, awareness, etc.); teambuilding (training briefing, reward, recognition, etc.); the use of tools and techniques (problem-solving tools, measurement tools, need analysis tools, etc.); and project-management competencies (Al-Mashari et al., 2001).

In fact, ERP systems are a natural progression from the logic described hitherto (Al-Mashari et al., 2001). They are derived from a true business need and requirement, their purpose is clearly defined through the IT vision/mission, their role is fundamentally to support all aspects of process management. The role itself is very encompassing and will cover strategic, tactical and operational aspects and the benefits to be accrued will therefore be very diverse.

### 6.1. ERP package selection

Companies often fail to consider whether the system they are evaluating will match their overall business strategy (Davenport, 1998a,b). It is therefore prudent that the characteristics of an ERP software are matching the criteria used by an organisation to select an IS. The results of a survey of the criteria used by organisations in selecting their current IS shows that the best fit with current business procedures is the most important one (Everdingen et al., 2000). Clarkston Potomac (Computer Technology Research Corporation, 1999) suggests several practices to ensure a successful ERP selection process, including staying on schedule, including human resources representatives in the assessment of IT capabilities, not allowing vendors to drive the presentations of demos, entering product presentations or demos with a clear agenda and communicate that agenda to the providers, ensuring that test scenarios represent a variety of departments, building test scenarios that represent current and future processes, documenting assumptions about what the ERP system will accomplish, recording all conclusions reached about each vendor and system, respecting dissenting options, scheduling breaks between product reviews, resisting the temptation to rank candidates, eliminating clear losers immediately, using experienced negotiators, and maintaining site of original plans. On the other hand, Rao (2000a,b) believes that small and medium enterprises should check for five important criteria when selecting an ERP package. These are affordability, domain knowledge of suppliers, level of local support, software upgradability and use of latest technology.

### 6.2. Communication

Indeed, communication is one of most challenging and difficult tasks in any ERP project (Wolti, 1999). The communication plan has to detail several areas including the rationale for the ERP implementation, details of the business process management change, demonstration of applicable software modules, briefings of change management strategies and tactics and establish-

ment of contact points (Bancroft et al., 1998). Communication has to cover the scope, objectives, and tasks of an ERP implementation project (Sumner, 1999). In a way to avoid the various communication failures, an open information policy has to be maintained for the project. For example, a good e-mailer system can help promote this policy, but serious problems need to be discussed by telephone or, preferably, face to face (Wolti, 1999).

### 6.3. Process management

To take full advantage of an ERP software, business process redesign is a prerequisite (Holland and Light, 1999). Because ERP systems are essentially developed as instruments for improving business processes such as manufacturing, purchasing, or distribution, ERP implementation and BPR activities should be closely connected (Al-Mashari and Zairi, 1999). This is achieved through an exhaustive analysis of current business processes to identify the potential chances of reengineering, rather than designing an application system that makes only the best of bad processes (Scheer and Habermann, 2000).

### 6.4. Training and education

Inadequate training has been one of the significant reasons of many ERP systems failure (Gupta, 2000). In ERP implementation projects, despite millions of dollars and hundreds of deployment hours, many projects fail because of the lack of adequate training (Kelley et al., 1999). A particular challenge in ERP implementation is to select an appropriate plan for end-user training and education. It is however important to stress that the main goal of ERP training should be the effective understanding of the various business processes behind the ERP applications (Gupta, 2000). ERP training should address all aspects of the system, be continuous and based on knowledge transfer principles wherever consultants are involved (Davenport, 1998a,b).



### 6.5. Project management

Approximately 90% of ERP implementations are late or over budget (Martin, 1998), which may be due to poor cost and schedule estimations or changes in project scope, rather than project-management failure (Holland et al., 1998). Slevin and Pinto (1987) argue that in order to manage a project successfully, project managers must be capable both in strategic and tactical project-management activities. They propose ten project-management critical success factors that fall in either the strategic or tactical phases of a project. The strategic factors are: project mission, top management support and project schedule/plan; while tactical factors are: client consultation, personnel recruitment, technical task, client acceptance, monitoring and feedback, communication, and troubleshooting (Slevin and Pinto, 1987).

With new technology, it is often critical to acquire external expertise, including vendor support, to facilitate successful implementation. (Sumner, 1999). Hundreds of companies provide ERP services, which may include all or some combination of ERP selection, business process planning or reengineering, ERP implementation, End-user training and ERP maintenance and support. With the growth of the ERP market being fast and huge, there has been a lack of competent consultants. One of the challenges with ERP implementation is that it demands multiple skills covering functional, technical, and inter-personal areas. If these skills are found in a consulting firm, it is another challenge for an organisation to manage such a consultant (Bingi et al., 1999). However, an important success factor here is for the organisation to establish a knowledge transfer mechanism by which consultants' role is defined clearly and their skills and expertise are acquired and transferred adequately.

### 6.6. Legacy systems management

Roberts and Barrar (1992) and Adolph (1996) note that legacy systems include the existing information technology infrastructure (hardware and software), business processes, organisational structure and culture. In ERP implementation,

existing legacy systems have to be carefully defined and evaluated to determine the nature and scale of problems that an organisation may encounter during implementation (Holland and Light, 1999). As it is important that an adequate infrastructure should be planned for so that it becomes reliably available and well in time (Rao, 2000a,b); Holland and Light (1999) stress the need to carefully manage legacy systems in ERP implementation. They suggest that if organizational legacy systems are very complex (with multiple platforms and a variety of procedures to manage processes), then the amount of technical and organisational changes required is likely to be high, and vice versa. Indeed, the problem of legacy systems centers on the fact that in most companies, data are not kept in a single repository, but rather spread across dozens or even hundreds of separate computer systems, each housed in an individual function, business unit, region, factory, or office. Each of these legacy systems may provide valuable support for a particular business task. However, when they are considered in combination, they represent one of the heaviest hindrances on business productivity and performance (Davenport, 1998a,b). It is important, therefore, that an organisation approaches the transition of legacy system carefully and with a comprehensive plan.

### 6.7. System integration

One of the complexities associated with ERP implementation is related to the cross-module integration nature of the system (Soh et al., 2000). Though there are middleware technologies that can be used to integrate software applications from several vendors to the ERP backbone, they are not available for all ERP systems (Bingi et al., 1999). Moreover, middleware vendors often tend to focus on the technical aspects of application inter-operability rather than linking business processes together, and, in many times, organisations have to develop their own interfaces for commercial software applications. Even maintaining the integration mix requires an excessive and ongoing expenditure of resources (Bingi et al., 1999). It is found that organisations spend up to 50 percent of their IT budgets on application integration (Rad-

ding, 1998). When it comes to maintaining the system, IS personnel are faced with the challenge of managing and keeping it integrated with other organizational systems (Bingi et al., 1999).

### 6.8. System testing

As the implementation of any application system cannot be realised in a single step, the new functionalities are better tested both alone and in conjunction with the existing functionalities (Apperlath and Ritter, 2000). In ERP implementation, going live on the system without adequate and planned testing is a recipe for an organisational disaster (Computer Technology Research Corporation, 1999). The testing and validation of an ERP system is important to ensure that the software works technically and that the business process configurations are practical. When business processes are up and running, an important test is of whether the processes described and represented in the application system actually match with the processes taking place in the organisation (Apperlath and Ritter, 2000). In the case of Guilbert, testing was considered important because the new system were found not working in parallel with the company's old systems. A testing process was undertaken as the system was configured, and then the entire system was tested by user trials (Gibson et al., 1999).

### 6.9. Cultural and structural changes

It is estimated that about half of enterprise system projects fail to achieve hoped-for benefits, because managers significantly underestimate the efforts required to manage effectively the wide range of changes involved (Pawlowski and Boudreau, 1999). ERP systems are designed such that they support a variety of logical organisational structures. Consequently, customising and configuring an ERP software involves creating a logical structure that in turn involves one or more financial entities and one or more operational entities (manufacturing and/or sales and distribution units) (Markus et al., 2000). This requires a massive change in an organization's structure and affects the way people use to do work and interact.

Therefore, it is important that an organisation goes through a carefully planned transformation that is based on adequate strategy and well-defined methodology of implementation (Bingi et al., 1999).

## 7. Evaluation

For the purpose of measuring and improving business performance, several costing techniques have been developed to provide more accurate cost information, primarily by cutting the link between internal management reporting and the demands of external regulations (Dixon et al., 1990). However, several authors such as McKinnon and Bruns (1992) suggest that management accountants must pass responsibility for performance measurement to those responsible for achieving the performance (i.e., process owners). This led to the development of non-financial measures of performance to achieve a balanced between both financial and operational measures. Grady (1991) supports this balanced perspective and Kaplan and Norton (1992) propose a "Balanced Scorecard" of measures along five perspectives, namely strategic planning, financial, customer, internal business, and innovation and learning. This approach appears to become more popular as its applicability continues to spread across different fields.

### 7.1. Performance evaluation and management

Measuring and evaluating performance is a very critical factor for ensuring the success of any business organisation and indeed for making IT systems such as ERP pay back. Performance management in this context is therefore an integrated holistic concept. It has to embody the whole organisation and capture tangible and intangible aspects, cover soft and hard elements and include aspects of synergy through integration. Sinclair and Zairi (2000) argue that such measurement is not widely pervasive as an integrated practice and its implementation is not a straightforward process. It is suggested in the taxonomy that measurement takes place in a balanced perspective and for the purpose of providing useful information

that can enable the decision making process and, which can help deliver the corporate objectives and therefore lead the business competitively forward.

In ERP contexts, the performance management has got to reflect a holistic and balanced perspective. In addition to technical performance such as reliability of the system, other aspects on flexibility, speed, timeliness, costs, etc. can also be added on. The value-added contribution is in the form of the tangible and intangible benefits, covering the strategic and operational aspects of business organizations (Al-Mashari, 2000). Furthermore, competitive measurement could cover the added capability provided by ERP systems to the business for 'stretching' the competitive and strategic agenda.

To complement this system, it is advisable that regular auditing and benchmarking are considered for optimisation of the potential available to businesses in all aspects. Furthermore, external benchmarking can bring in new ideas, knowledge and best practices on dealing with deficiencies in ERP systems, de-bottlenecking, streamlining process, optimising and redesigning for more extensive benefits (Al-Mashari, 2002). Such audits can take advantage of an array of existing tools that can be applied to 'scan' both the organisational, managerial and technical sides of the business.

## 8. Conclusion

This paper has presented a novel taxonomy of realising and maximising ERP benefits through a critical factor approach. The paper argues that ERP benefits are realised when a tight link is established between implementation approach and business-wide performance measures.

The paper has discussed the concept of ERP as a pioneering, enabling and support system that is compatible with the requirements of modules business and that can help the effective implementation of the business process management principles. The paper agreed the ERP systems can yield to a wide array of benefits that are of a tangible and intangible nature. These are, however, heavily dependant on the approach adopted for the evaluation, selection and project manage-

ment of ERP systems. To this end, a several critical factors have been identified and have been eluded to individually, within the paper.

The taxonomy presented in this paper emphasizes that a clear vision and business director is fundamental for the success of ERP system implementation. It also considers IT strategic process a sub-set of the business strategy planning process where it sets the architecture and requirement for the short, medium and long-term requirements. The taxonomy also focuses on the business process management as a core requirement for business success in the creation of a value chain approach. The ERP system strategic is then become out of a clear IT strategy, which in turn, is supporting the core business strategy.

A stage of performance review and evaluation is based on the premise that the evaluation and performance monitoring of ERP system's implementation can in turn lead to the achievement of all the business desired goal and objectives. The proposed taxonomy puts forward the idea that regular audits and benchmarking exercise can bring with them new learning, idea, and innovation that will make the organisation more adaptable to change programs and will also, provide them with the opportunity to derive maximum benefits from investing in complex system such as ERP. Finally, the taxonomy has also suggested that the most essential element of successes and the pre-requisite for successful and effective ERP implementation is leadership and commitment.

## References

- Adolph, W., 1996. Cash cow in the tar pit: Reengineering a legacy system. *IEEE Software*, 41–47.
- Al-Mashari, M., 2000. A proposed integrative framework for effective SAP R/3 deployment. In: *Proceedings of GITM'2000*, pp. 39–42.
- Al-Mashari, M., 2002. Implementing ERP through SAP R/3: A process change management (PCM) perspective. *King Saud University Journal—Computer & Information Sciences Division* 14, 25–37.
- Al-Mashari, M., Zairi, M., 1999. Standardisation through SAP R/3: A proposed model for effective implementation. In: *Proceedings of the IEEE Conference on SIIT*, pp. 19–24.
- Al-Mashari, M., Al-Mudimigh, A., Zairi, M., 2001. Realizing IT value: The case of enterprise resource planning. In: *Proceedings of IRMA'2001*.

- Apperlath, H., Ritter, J., 2000. *SAP R/3 Implementation: Method and Tools*. Springer, Berlin.
- Bancroft, N., Seip, H., Sprengel, A., 1998. *Implementing SAP R/3: How to Introduce a Large System into a Large Organization*. Manning Publication Co., Greenwich, CT.
- Bingi, P., Sharma, M., Godla, J., 1999. Critical issues affecting an ERP implementation. *Information Systems Management*, 7–14.
- Blumenthal, S., 1969. *Management Information Systems: A Framework for Planning and development*. Prentice-Hall, Englewood Cliffs, NJ.
- Chung, S., Snyder, C., 1999. ERP Initiation—A historical perspective. In: *Proceedings of AMCIS*.
- Computer Technology Research Corporation, 1999. *Enterprise resource Planning: Integrating Applications and Business Process Across the Enterprise*. Computer technology Research Corporation, USA.
- Deloitte Consulting, 2000. *Success File*, Deloitte Consulting.
- Davenport, T., 1998a. Living with ERP. *CIO Magazine* (1).
- Davenport, T., 1998b. Putting the enterprise into the enterprise system. *Harvard Business Review*, 121–131.
- Dixon, J., Nanni, A., Vollmann, T., 1990. *The New Performance Challenge: Measuring Operations for World-Class Competition*. Business One Irwin, Homewood, IL.
- Everdingen, Y., Hillegersberg, J., Waarts, E., 2000. ERP adoption by European midsize companies. *Communications of the ACM* 43 (4), 27–31.
- Gable, G., 1998. Large package software: A neglected technology. *Journal of Global Information Management* 6 (3), 3–4.
- Gable, G., Scott, J., Davenport, T., 1998. Cooperative ERP life-cycle knowledge management. In: *Proceedings of the 9th Australasian Conference on Information Systems*, Sydney, Australia.
- Gibson, N., Holland, C., Light, B., 1999. A case study of a fast track SAP R/3 implementation at Guilbert. *Electronic Markets* (June), 190–193.
- Grady, M.W., 1991. Performance measurement: Implementing strategy. *Management Accounting (US)* (June), 49–53.
- Gumaer, R., 1996. Beyond ERP and MRP II. *IIE Solutions* 28 (9), 32–35.
- Gupta, A., 2000. Enterprise resource planning: The emerging organizational value systems. *Industrial Management & Data Systems* 100 (3), 114–118.
- Henderson, J., Venkatraman, N., 1993. Strategic alignment: Leveraging information technology for transforming organisations. *IBM Systems Journal* 32 (1), 4–16.
- Holland, C., Light, B., 1999. A critical success factors model for ERP implementation. *IEEE Software* (May/June), 30–35.
- Holland, C., Light, B., Gibson, N., 1998. Global enterprise resource planning implementation. In: *Proceedings of the American Conference On Information Systems*. Global Information Technology and Global Electronic Commerce Mini-Track, Baltimore, August 14–16.
- Holsapple, C., Sena, M., 1999. Enterprise system for organizational decision support: A research agenda. In: *Proceedings of AMCIS*.
- Kaplan, R.S., Norton, D.P., 1992. The balanced scorecard—measures that drive performance. *Harvard Business Review*, 71–79.
- Kelley, H., Compeau, D., Higgins, C., 1999. Attribution analysis of computer self-efficacy. In: *Proceedings of AMCIS*.
- Koch, C., Slater, D., Baatz, E., 1999. The ABCs of ERP. *CIO Magazine*.
- Kumar, K., Hillegersberg, V., 2000. ERP experiences and evolution. *Communications of the ACM* 43 (4), 22–26.
- Li, C., 1999. ERP packages: What's next? *Information Systems Management* 16 (3), 31–35.
- Luftman, J., Brier, T., 1999. Achieving and sustaining business–IT alignment. *California Management Review* 42 (1), 109–121.
- Lyytinen, K., Hirschheim, R., 1987. Information systems failures—a survey and classification of the empirical literature. *Oxford Surveys in Information Technology* 4, 257–309.
- Markus, M., Tanis, C., Fenema, P., 2000. Multisite ERP implementation. *Communications of the ACM* 43 (4), 42–46.
- Martin, M.H., 1998. An ERP strategy. *Fortune* 2, 95–97.
- McKinnon, S.M., Bruns Jr., W.J., 1992. *The Information Mosaic*. Harvard Business School Press, Boston, MA.
- Mitchell, V., Zmud, R., 1995. Strategy congruence and BPR rollout. In: Grover, V., Kettinger, W. (Eds.), *Business Process Change: Reengineering Concepts, Methods and Technologies*. Idea Group Publishing, London, pp. 428–452.
- Pawlowski, S., Boudreau, M., 1999. Constraints and flexibility in enterprise systems: A dialectic of system and job. In: *Proceedings of AMCIS*.
- Radding, A., 1998. The push to integrate-packaged applications promise to speed integration and cut costs. *Information Week* 671.
- Rao, S., 2000a. Enterprise resource planning: Business needs and technologies. *Industrial Management & Data Systems* 100 (2), 81–88.
- Rao, S., 2000b. Enterprise resource planning: Business needs and technologies. *Industrial Management & Data Systems* 100 (2), 81–88.
- Rizzi, A., Zamboni, R., 1999. Efficiency improvement in manual warehouses through ERP systems implementation and redesign of the logistics processes. *Logistics Information Management* 12 (5), 367–377.
- Roberts, H., Barrar, P., 1992. MRP II implementation: Key factors for success. *Computer Integrated Manufacturing System* 5 (1), 31–38.
- Rockart, M., Earl, M., Ross, J., 1996. Eight imperatives for the new IT organization. *Sloan Management Review* 38 (1), 43–55.
- Rosemann, M., 1999. ERP-software-characteristics and consequences. In: *Proceeding of the 7th European Conference on Information Systems, 1999-ECIS'99, Copenhagen, Denmark*.

- S, S., 2000. ERP Systems—Using IT to gain a competitive advantage. <http://www.expressindia.com/newads/bsl/advant.htm>.
- Scheer, A., Habermann, F., 2000. Making ERP a success. *Communications of the ACM* 43 (4), 57–61.
- Shang, S., Seddon, P., 2000. A comprehensive framework for classifying the benefits of ERP systems. In: *Proceedings of AMCIS'2000*, vol. II, pp. 1005–1014.
- Shtub, A., 1999. *Enterprise resource planning (ERP): The dynamics of operations management*. Kluwer Academic Publishers, Norwell, MA.
- Sinclair, D., Zairi, M., 2000. Performance measurement: A critical analysis of the literature with respect to total quality management. *International Journal of Management Reviews* 2 (2), 145–168.
- Slevin, D., Pinto, J., 1987. Balancing strategy and tactics in project implementation. *Sloan Management Review*, 33–44.
- Slooten, K., Yap, L., 1999. Implementing ERP information systems using SAP. In: *Proceedings of AMCIS*.
- Soh, C., Kien, S., Tay-Yap, J., 2000. Cultural fits and misfits: Is ERP a universal solution? *Communication of the ACM* 43 (4), 47–51.
- Sumner, M., 1999. Critical success factors in enterprise wide information management systems projects. In: *Proceeding of the SIGCPR'99*, New Orleans, LA.
- Volkoff, O., 1999. Using the structural model of technology to analyze an ERP implementation. In: *Proceedings of AMCIS*, pp. 235–237.
- Waston, E., Rosemann, M., Stewart, G., 1999. An overview of teaching and research using SAP R/3. In: *Proceedings of AMCIS*.
- Welti, N., 1999. *Successful SAP R/3 Implementation: Practical Management of ERP projects*. Addison Wesley, Reading, MA.