Planning for ERP systems: analysis and future trend

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Abstract The successful implementation of various enterprise resource planning (ERP) systems has provoked considerable interest over the last few years. Management has recently been enticed to look toward these new information technologies and philosophies of manufacturing for the key to survival or competitive edges. Although there is no shortage of glowing reports on the success of ERP installations, many companies have tossed millions of dollars in this direction with little to show for it. Since many of the ERP failures today can be attributed to inadequate planning prior to installation, we choose to analyze several critical planning issues including needs assessment and choosing a right ERP system, matching business process with the ERP system, understanding the organizational requirements, and economic and strategic justification. In addition, this study also identifies new windows of opportunity as well as challenges facing companies today as enterprise systems continue to evolve and expand.

Introduction

Enterprise resource planning (ERP), when successfully implemented, links all areas of a company including order management, manufacturing, human resources, financial systems, and distribution with external suppliers and customers into a tightly integrated system with shared data and visibility. Potential benefits include drastic declines in inventory, breakthrough reductions in working capital, abundant information about customer wants and needs, along with the ability to view and manage the extended enterprise of suppliers, alliances, and customers as an integrated whole (Escalle et al., 1999).

While companies such as Cisco Systems, Eastman Kodak, and Tektronix have reaped the expected benefits of ERP systems, many businesses are discovering that their ERP implementation is a nightmare. For example, FoxMeyer Drug, a $5 billion pharmaceutical company, recently filed for bankruptcy. FoxMeyer argued that major problems were generated by a failed ERP system, which created excess shipments resulting from incorrect orders and costing FoxMeyer millions of dollars (Bicknell, 1998; Boudette, 1999). Dell Computer spent tens of millions of dollars on an ERP system only to scrap it because the system was too rigid for their expanding global operations. Recent ERP failures also include Boeing, Dow Chemical, Mobil Europe, Applied Materials, Hershey, and Kellogg’s. A recent study indicates that 40 percent of all ERP installations only achieve partial implementation and 20 percent of attempted ERP adoptions are scrapped as total failures (Trunick, 1999). Depending on the definition of failure, other studies have suggested that ERP failure rate may even be greater than 50 percent (Escalle et al., 1999). Ptak and
Schragenheim (1999) also report that between 60 and 90 percent of ERP implementations do not achieve the return on investment identified in the project approval phase.

Since the technical capabilities of these ERP systems are relatively well proven, there is a growing consensus that planning issues are the major barriers to employing these systems effectively. The focus of this study is, therefore, on the activities prior to the ERP adoption decision. The pressing need for study on planning issues has recently been emphasized in literature (e.g. Chen and Small, 1996).

ERP traces its roots to material requirements planning (MRP) and manufacturing resource planning (MRP II). To better comprehend the ERP planning and implementation issues, therefore, a fundamental understanding of the MRP and MRP II mechanisms is essential. Thus, the evolution of ERP is described in the next section. Planning for ERP adoption generally occurs when an organization recognizes that current business processes and procedures are inadequate for their current and/or future strategic needs. The following section points out the need for careful planning and justification of ERP projects. It discusses the importance of creating a vision for the project and the essential prerequisite of reengineering business processes and understanding the new organizational requirements before implementing an ERP system. While this article is current, the environment of ERP systems is constantly shifting with the development of new information technologies and the formation of new partnerships. These recent developments and future trends are discussed in the penultimate section. Finally, conclusions are drawn.

**The ERP evolution**

In a typical manufacturing environment, the master production schedule (MPS) specifies the quantity of each finished product required in each planning period; it is a set of time-phased requirements for end items. The firm, however, also needs a set of time-phased requirements for the parts and raw materials that make up those end items. Therefore, MRP is a production planning and control technique in which the MPS is used to create production and purchase orders for lower-level components. In the 1970s, manufacturers began to use techniques such as MRP in recognition of the importance of the distinction between independent- and dependent-demand items.

MRP is continually evolving and expanding to include more business functions. In the early 1980s, MRP expanded from a material planning and control system to a company-wide system capable of planning and controlling virtually all the firm’s resources. This expanded approach was so fundamentally different from the original concepts of MRP that Wight (1984) coined the term MRP II, which refers to manufacturing resource planning. A major purpose of MRP II is to integrate primary functions (i.e. production, marketing, and finance) and other functions such as personnel, engineering, and purchasing into the planning process. Since it is a company-wide system,
MRP II often has a built-in simulation capability that allows the firm to ask “what-if” questions. An overview of MRP II is provided in Figure 1.

In the 1990s, MRP II was further expanded into ERP, a term coined by the Gartner Group of Stamford, Connecticut, USA. It is intended to improve resource planning by extending the scope of planning to include more of the supply chain than MRP II. Thus, a key difference between MRP II and ERP is that while MRP II has traditionally focused on the planning and scheduling of internal resources, ERP strives to plan and schedule supplier resources as well, based on the dynamic customer demands and schedules.

The popularity of ERP systems started to soar in 1994 when SAP, a German-based company, released its next-generation software known as R/3. In the following years, companies began to pour billions into ERP systems offered by SAP and its major competitors such as Oracle, Baan, J.D. Edwards, etc. By the late 1990s, industry prognosticators were forecasting that the ERP market...
would sustain an industry growth rate of 30 to 40 percent, and that the market would exceed $50 billion by 2002. An overview of ERP systems including some of the most popular functions within each module is presented in Figure 2. While the names and numbers of modules in an ERP system provided by various software vendors may differ, a typical system integrates all these functions by allowing its modules to share and transfer information freely and centralizing all information in a single database accessible by all modules.

In summary, traditional MRP and MRP II applications may not be up to the challenge presented by manufacturers seeking to capitalize on the competitive advantage offered by an integrated supply chain. ERP, therefore, has evolved from its predecessors to play an integrated supporting role in the creation of a value chain.

**The planning issues**

Facing depressed demand and rising costs in its core business, the manufacture and distribution of particleboard and fiberboard products, CSR Wood Panels in Australia sought ERP as a solution. The company reviewed 95 software packages and implemented QAD’s enterprise resource planning MFG/PRO module across 43 distribution centers and factories. Wherever CSR’s business practices did not meet the requirements of the software, the company adapted its practices to meet the requirements of the ERP system. While CSR was able to reduce total inventory by $37 million a year after the implementation, the company observes that the real value of ERP is a streamlined delivery process, structural organizational change, the ripple effect of easily accessible information, and heightened customer satisfaction (Aubrey, 1999).

The case of CSR Wood Panels illustrates the importance of thorough planning necessary for a successful ERP implementation. The rest of this section addresses the issues of needs assessment and choosing the right ERP system, matching

![Figure 2. An overview to ERP systems](image-url)
business process with the ERP system, understanding new organizational requirements, and the economic and strategic justification of ERP projects.

Assessing needs and choosing the “right” ERP system
Planning for ERP adoption generally occurs when an organization realizes that current business processes and procedures are incompetent for their current and/or future strategic needs. The first step in planning, therefore, is an internal needs assessment. Since the total ERP implementation costs including software, hardware, consulting, and internal personnel can easily run as high as 2 percent or 3 percent of a company’s revenues, the needs assessment can help determine whether a company should maintain and enhance a legacy system or implement a new ERP system. Convincing reasons for a new ERP system may include:

- the use of multiple points of input with duplicated effort in the existing system;
- the inability of the existing system to support organizational needs;
- the requirement of extensive resources for maintenance and support;
- the consideration of an enterprise to reengineer its business process;
- the growth of the enterprise and subsequent incompatibility of several information systems;
- the inability of employees to respond easily to questions or information requested by key customers or suppliers.

For many companies today, the question is not whether an ERP system is needed but rather what kind of system is needed? Thus, once the company decides to implement a new ERP system, the next step is defining a “should-be-state” and envisioning life at the end of the ERP project. Developing a vision of life after implementation clarifies the goals of the project. It helps determine the appropriate modules and functions to be included in the system, which in turn facilitates identification of all the benefits that can be gained and therefore provides an effective sales tool for enlisting project support. More importantly, it is the yardstick of performance against which implementation progress is measured.

The primary motive for ERP installation is the potential for enhancing the firm’s competitiveness. Since different firms have varying competitive objectives, their expectations of ERP also vary. Top management, therefore, must examine the firm’s current competitive position in relation to its desired position before deciding on a particular ERP system or various modules within a system. Competitive strategy, targeted market segments, customer requirements, manufacturing environment, characteristics of the manufacturing process, supply chain strategy, and available resources all enter into the decision. Compaq Computer is a good example of a company that realized the importance of manufacturing environment and competitive strategy. Pressed by the profound success of some build-to-order personal computer companies such as Dell and Gateway, Compaq decided to shift from build-to-stock to build-to-order. It understood, however, that superior
Capabilities in demand forecasting and order management are key for a competitive advantage in the build-to-order environment. Compaq therefore decided to write its own proprietary applications to support the forecasting and order processing processes. To ensure compatibility, the two applications were written using the same computer language used by its ERP vendor.

Matching business process with the ERP system
To better understand the attraction and potential dangers of ERP systems, we need to realize the problem they are designed to solve: the fragmentation of information over many legacy systems in large business organizations. When developing information systems in the past, companies would first decide how they wanted to do business and then choose a software package that best supported their proprietary business process. The sequence is, however, reversed with ERP systems (Davenport, 1998). Therefore, the business process must often be modified to fit the system.

While firms can choose to customize their ERP installation to a certain degree because the systems are modular, major modifications are complex, impractical, and extremely costly. Modifications can also jeopardize the key benefits of integration as well. As a result, most companies that succeed in installing ERP systems reengineer their business processes to fit the system requirements. IBM’s answer to Dell Computer’s build-to-order business model is a case in point. Before IBM reengineered its business process, it had 12 weeks of PC inventory in the supply chain system. Twelve weeks of inventory in a system with a 12 to 18 month product life cycle proved to be fatal. The reengineering team examined the entire fulfillment process and found that distributors often had to disassemble the PCs they received to modify them to meet the customer’s requirements. Thus, IBM changed its practice and started delivering components instead of assembled PCs to its distributors. The team also discovered that IBM was better at managing the distributor’s inventory of components than the distributors themselves. IBM therefore started to manage its distributors’ inventories. As a result of the reengineering process, IBM and its distributors were able to cut inventory from 12 weeks to 2 and eliminate various non-value-adding activities.

The peculiar feature characteristics of ERP as a complex organizational initiative brings about the question of whether or not a competitive advantage can be gained from a standardized software package when a firm’s competitors also have the opportunity to implement the same or a similar package. As the Fortune 1000 ERP market begins to saturate, more and more vendors begin to target hundreds and thousands of midsize and small companies. The real competitive advantage brought by the ERP systems for these companies appears to hinge on who can achieve a tighter, smoother fit between its business process and the ERP system. Recent thoughts on business process reengineering can be found in Davenport (1993), Hammer and Champy (1993), Altinkemer et al. (1998), and Hammer and Stanton (1999).
Understanding the organizational requirements

Many companies fail to realize the full benefits of ERP systems because they are not organized in such a way to benefit from the new information tools provided by, and the new disciplines required of, the enterprise systems. Their organizations are not positioned for integration. Departments work toward their own sets of objectives. Performance measurement and rewards are functional and not global. Information is spread out on many fragmented systems and there are few people who have an enterprise-wide view of the organization. Top management must provide leadership for all these changes.

Top management commitment, however, is much more than a CEO giving his or her blessing to the ERP system. This commitment must not be limited to the conception of the project but should continue through its completion. Management commitment should look beyond the technical aspects of the project to the organizational requirements for a successful implementation. In addition to providing the necessary funding, top management must recognize that ERP implementations require the use of some of the best and brightest people in the organization for a notable period of time. Top management must identify these people, free them from present responsibilities, organize them into an interdisciplinary team, and empower them for the responsibility of the project. Commitment also implies that they are willing to spend significant amounts of time serving on the steering or executive committee overseeing the implementation team. Management should also show its commitment to an ongoing company-wide education program, beginning with top management. Successful implementation of ERP systems means that some jobs will be significantly changed. Management, therefore, must ensure that job evaluations, compensation programs, and reward systems are modified on a basis consistent with business transactions and system performance measures. After all, the way people are measured will influence their behavior.

As in many major change efforts, objections and disagreements arise in the process of reengineering and ERP implementation can only be solved through personal intervention by top management. Top management, therefore, must endorse, for example, that marketing decisions such as customer order promising will be made out of the master production schedule within the system and that accounting and financial data would be shared by all authorized users in a common format no matter where it originated. Furthermore, this formal system will be used to manage the extended enterprise of suppliers, alliances, and customers as an integrated whole.

Economic and strategic justification

An ERP system effort represents a substantial investment for the firm. A new ERP implementation can range anywhere from $2 to $4 million for a small firm to over $1 billion for a large company. The huge investment required to implement an ERP system needs to be weighed carefully against the eventual savings and benefits the system will produce. In fact, some companies have
found that by forgoing an ERP system they can actually gain a cost advantage over competitors that are embracing the system.

Many large ERP systems proceed without sufficient analysis of costs and benefits. The costs of an ERP implementation are generally quantifiable, though the biggest opportunity cost for some firms can be the cost of not investing in an ERP system. For example, with respect to Cisco Systems, Inc. Cotteller et al. (1998) reported a breakdown of the implementation costs for its ERP system installation as follows: software, 16 percent; hardware, 32 percent; system integration, 38 percent; and headcount, 14 percent. Unlike the costs, many benefits are often very difficult to quantify. Major strategic benefits such as improved response to customer demands, streamlined communication provided by universal, real-time access to operating and financial data, and strengthened supplier relationships through information sharing, are all extremely critical for the survival and growth of many firms, yet cannot be readily converted to cash values. Justification of ERP systems, therefore, should encompass not only economic but also strategic benefits. The fact that data is difficult to estimate precisely shouldn’t preclude rigorous analysis.

Economic and strategic justifications for an ERP project prior to installation are necessary not only because of the enormous investment and risk involved; the justification process helps identify all the potential benefits that can be accrued with the ERP implementation, which later become yardsticks for performance evaluation. Companies, however, need to realize that justification and delineation of benefits from implementing an ERP system depend on which modules or functions are involved. For example, when the sales and marketing modules are integrated in concert with the financial reporting function, management is able to make important decisions based on a detailed understanding of product and customer profitability rather than instinct. Managers and researchers who are interested in economic and strategic justification are referred to a comprehensive study by Small and Chen (1997).

The future trend and challenges
While many business processes, including finance/accounting and human resource management, are well supported by most installed ERP systems, these systems currently provide weak support in less data-intensive areas such as supply chain planning, customer management, and marketing and sales. Fortunately, enterprise system developers have begun to provide solutions that overcome such weaknesses. They have recently developed supply chain optimization (SCO) and customer relationship management (CRM) strategies and systems in an attempt to seamlessly link front office (e.g. sales, marketing, customer services) and back office (e.g. operations, logistics, financials, human resources) applications to enhance competitive advantages. Figure 3 depicts the future trend in this direction.
Advanced planning in supply chain management

The majority of existing ERP systems are still transaction-oriented, enabling transaction-oriented business processes such as order entry and collection of transactional data. Thus, they offer very limited planning and decision support capabilities. Advanced planning systems (APS) employ sophisticated mathematical algorithms to model and analyze supply chain constraints to develop plans that provide optimal or near-optimal solutions. Due to the application of optimization or heuristics techniques, these cutting-edge systems are also referred to as SCO by such leading vendors as i2 Technologies and Manugistics Inc. Since APS do not generate their own data, they can be integrated with ERP systems to draw upon massive amounts of transactional data, though the data can be drawn from other data repositories as well. Thus, for companies that already have their ERP up and running well, APS can bring additional and substantial benefits and thus allow them to better utilize the investment in their ERP systems.

Companies that have implemented APS have reported staggering benefits such as an improved fill rate and on-time delivery (30 percent), reduced order cycle time (50 percent), and reduced inventory (50 percent) (Kilpatrick, 1999). A recent study by AMR Research also confirmed that many companies have achieved payback on their investment in SCO in one year – some by as much as 300 percent (Latamore, 2000). Nevertheless, the implementation of APS or SCO, especially when integrated with ERP systems, cannot be successful without significant changes to business processes and organization. In addition to the planning requirements for successful ERP implementations prescribed in their previous section, top management must fully understand the degree of the changes and supports needed for the new project and be comfortable with the fact that the decisions their planners make will have a profound impact on the entire supply chain. Companies must be prepared to realign their internal supply chain processes and, if necessary, adjust their relationships with suppliers. The integration of APS or SCO with ERP also requires a higher level of mutual trust and openness among trading partners. Equally importantly, top management needs to change traditional performance measures such as units produced or unit costs to encourage a more balanced and global perspective that recognizes the contribution of all supply chain partners involved.

Figure 3.
The future trend of ERP systems
Customer relationship management

Increased power among buyers and decreased market entry barriers, along with an ever-expanding palette of products and services, have forced firms to rethink ways of keeping their customers loyal and protecting profit margins. It is no secret that developing a long-term relationship with a customer is more profitable than acquiring a new customer. A recent survey also reveals that firms striving to improve customer loyalty are 60 percent more profitable than those who aren’t (Saunders, 1999).

Customer relationship management (CRM) is a customer-centric business model. An outgrowth of sales force automation (SFA) tools, CRM systems are also referred to as one-to-one marketing. They can utilize the data mining capabilities of ERP systems and data warehousing to uncover profiles of key customers, customer profitability, and purchasing patterns (Conlon, 1999). The result of harnessed technology, integrated customer touch points, and a complete view of customers’ needs and wants is superior customer loyalty, reduced cost of sales and services, and ultimately, improved bottom line profits.

Major ERP vendors are gearing up for these growing needs by aggressively forming alliances with or taking over other software companies that have been operating in the CRM market. For instance, J.D. Edwards entered into a deal with Seibel, a leading CRM company, in May of 1999 and subsequently shut down its in-house SFA team. Peoplesoft acquired Vantive’s CRM software in October of 1999 to integrate with its own ERP systems. Through mySAP initiatives, users of SAP R/3 system can add Web-based CRM and supply chain management (SCM) functions while leaving the core R/3 system intact (Xenakis, 2000). Oracle has taken the most drastic steps in forming a new bond between ERP and CRM. The new flagship ERP/CRM software package, called 11i, is heavily Internet oriented and allows users to seamlessly implement modules of CRM with a smaller ERP suite (Sweat, 2000). A recent AMR Research report predicts that the CRM market will exceed $16 billion by 2003.

While firms can benefit from lessons learned from ERP implementations, the implementation of CRM systems as either bolt-on or new generation CRM/ERP systems may not be any easier. Like many enterprise systems, successful CRM implementation requires significant changes, especially when integrated with ERP systems, because the combined impact on business processes and organization will be astronomically profound. It requires redesigning core business processes around customers, as the goal of a customer-centric approach is finding products or services to fit customer needs as opposed to finding customers to fit the products. In fact, Dickie (1999) recommends not initiating a CRM project if senior management does not fundamentally believe in reengineering to a customer-driven model. Employee resistance will not be a surprise, as their positions will be reassigned or eliminated. Culture change is also expected as customer touch points will be linked and the sales department will no longer be the sole owner of customer data. Instead, customer data will be shared across the enterprise or the entire supply chain.
Continuous improvement with ERP-enabled processes

More and more companies today are recognizing that “going live” with ERP is just the beginning of a much more rewarding journey, and thus have already begun to undertake actions that can help achieve the full capabilities and benefits of ERP-enabled processes. Although many benefits such as inventory reduction, improved productivity, and reduced financial close cycle do result soon after the go-live date, the most significant and “unanticipated” benefits brought by the new capabilities won’t be realized until sometime after “going live” as people in organizations continue to learn and grow to understand and work with redesigned processes. The synergy created and manifested by new technology and business processes, along with new employee energy can provide organizations with unprecedented capabilities they never envisioned prior to ERP implementations.

The more organizations continue to learn about enterprise systems and new business processes, the more they will recognize that the benefits will continue to be realized long into the future. Therefore, those characterized as “learning organizations” will unquestionably be better positioned to develop the unprecedented competencies provided by ERP systems. This argument is supported by a recent study that reveals that business process change efforts of the last several years seem to have had an immediate effect on sales by employee, but no significant effect on other strategic performance measures such as return on sales and revenue growth (Altinkemer et al., 1998). Ahmed (1999) also point out that evidence of practical experiences of success of business process change related programs require ongoing effort for at least three to five years, even reaching time frames of around 10-20 years for realization of full potential.

Business organizations today are reasonably skilled in creating and acquiring knowledge. It is, however, the behavior change needed to support the new way of doing business that is most critical to provide ERP firms with unprecedented competencies. After all, ERP-enabled business processes are designed to evolve and grow in power for those organizations that take the time and effort to grow with them. The race of first wave ERP implementations hinges on companies that can achieve a smoother and tighter fit between their business processes and the ERP systems. The key to second wave success appears to rest on organizations that can learn quickly and continually to fully capitalize on the new ERP-enabled capabilities and benefits.

Conclusion

While ERP systems have the “magic touch” to dramatically enhance the performance of many companies’ business operations, they are also expensive, profoundly complex, and notoriously difficult to implement. The chance of failure, therefore, has always been high. In order to reap the potential benefits and avoid serious pitfalls, firms must truly understand and address the planning issues.

Unlike the implementation of less sophisticated technological innovations such as computer-aided design/manufacturing and manufacturing resource
planning (MRP II), business process reengineering is a unique planning activity in ERP projects. Unsuccessful companies start their ERP implementation effort with automation, bypassing the critical steps of understanding its business implications and simplifying or reengineering their processes. There are many reasons for ERP implementation failure. Some lay heavy blame on unreasonable expectations; others point to the lack of support from software and hardware vendors. These and other issues such as vendor selection and vendor commitment have been purposely omitted in this study, as they are well documented in many trade magazines. The present study has chosen instead to focus on less explored and more intricate planning issues.

The more that organizations learn about new business processes and enterprise systems, the more they will recognize that the behavior changes needed to support the new way of doing business are the most critical in providing ERP firms with unprecedented competencies. After all, ERP-enabled business processes are designed to evolve and grow in power for those organizations that take the time and effort to grow with them. The rate at which organizations can continue to learn and modify their behavior as needed may become the only sustainable source of competitive advantage in the near future.

References