Corporate Applications Integration: Challenges, Opportunities, and Implementation Strategies

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In recent years, corporate applications such as enterprise resource planning (ERP) systems, supply chain management (SCM) systems, customer relationship management (CRM) systems, sales force automation (SFA), and other corporate-level information systems have received a great deal of attention from large business enterprises. These applications have been around for about a decade now, and in that time their producers have refined them and perfected them to the point where they can be considered developmentally mature. At the same time, vendors have continued to introduce new products that have moved corporate applications toward a higher level of integration, both technically and organizationally. However, these higher levels of integration have brought with them complex technical, organizational, cultural, political, and legal issues that have made the integration process a very challenging task. This paper reviews relevant current literature, discusses several perspectives of corporate application integration, and points out potential opportunities and challenges inherent in the integration process. Risk reduction strategies and opportunities provided by some newly developed technologies (e.g., software agents) are also discussed.

INTRODUCTION

Ever since the early days of business computing, application integration has been a top priority for management information systems (MIS) professionals. In recent years, corporate applications such as ERP, SCM, and CRM have played an important role in both information system and business process integration despite some negative comments and failed experiments (Dempsey, 1999; Stein, 1999; Willcocks & Sykes, 2000). Currently, there are several major categories of corporate applications—including ERP, SCM, CRM, and others. These applications are designed to ensure an efficient, effective, and integrated information flow for modern businesses. Working in conjunction with one another, corporate applications allow business organizations to minimize redundancy and inefficiency in information processing while improving effectiveness and customer satisfaction. As their technologies gradually mature, corporate applications are gaining acceptance as necessary components of successful, competitive business in the e-commerce era, despite their high costs, and in some cases, risk (Kumar & Hillegersberg, 2000).

Of the corporate applications available at present, ERP systems were among the first to receive widespread attention from large business organizations. ERP systems emerged as information technology implementations of business process reengineering (BPR), with the

goal of achieving a more effective and efficient workflow within an enterprise. ERP integrates data processed by various functional areas including sales, purchasing, and others to provide faster response times and reactions. Consequently, ERP can improve communication both between and within business units or organizations. However, in actual practice, ERP applications are normally limited to intra-organizational business units and typically do not address issues related to external entities like suppliers or customers. As a result, vendors have attempted to fill this gap by introducing SCM applications to handle information exchange between trading partners along the supply chain. SCM applications are automated systems that integrate all sorts of data processing, from customer requests to supplier specifications. SCM systems provide real-time reports and manage the flow of information at each point along the value-adding process. The benefit of an SCM application is that it can quickly and accurately respond to customers' requests and lower overall costs imposed by supply chain operations. Although their objectives are different, ERP and SCM are dependent on each other to work well. An ERP information processing system will count on an SCM system for accurate data input, such as customer demands. Conversely, an SCM system will depend on accurate output from an ERP system, such as product specifications that can be transmitted to upstream suppliers.

In recent years, all these corporate applications have undergone a great deal of change, with their focus shifting from internal to external processes, and their emphasis shifting from being supply-driven to demand-driven. Their objective has changed from maximizing efficiency to increasing customer satisfaction. Their technology has evolved from proprietary and heterogeneous to increasingly standardized or compatible platforms. Communication channels between corporate applications have switched from being private or leased networks to being public networks (e.g., internet). In addition, single-vendor product lines are generally regarded as insufficient to satisfy business needs, and multi-vendor solutions are now preferred (Technology Forecast, 2000).

DEVELOPMENT OF CORPORATE APPLICATIONS

In the early days, manufacturing information systems focused mainly on inventory control. Software packages were designed to manage inventories based on traditional inventory concepts such as optimal reorder point calculation (Blumenthal, 1969). In the 1970s, a more sophisticated method, the material requirement planning (MRP) models, emerged. MRPs were more efficient in that they determined optimal material quantity levels at various stages in the manufacturing process, and so, many software developers wrote applications that were based on the MRP model. But the weakness of the original MRP was its inability to take into account other important factors such as capacity, space, capital, engineering changes, and cost. MRP-II emerged in the 1980s with extended functionalities; with its ability to constantly monitor the manufacturing process, the data feedback of the MRP-II system further improved productivity (Kumar & Hillegersberg, 2000).

In the early 1990s, the functionality of manufacturing systems was further extended to encompass other areas within the business organization, including such areas as finance, engineering, human resources, and others (Markus, Tannis, & Van Fenema, 2000). At this point, the term MRP came to be viewed as a misnomer that did not convey the scale and comprehensiveness of the system, and so ERP became the phrase to describe such systems

or concepts. The most significant period for ERP implementation was the mid to the late 1990s, and by early 2000, ERP had generated an estimated $20 billion dollars for consulting firms and vendors (Willcocks & Sykes, 2000).

From a functionality perspective, ERP is a comprehensive system that carries out all sorts of operations from customer orders to post-sales service. It is designed to flawlessly integrate into a single system the processes and information it receives from a number of functional areas within an organization. This integrated system can then serve the information processing needs of various units in that organization that traditionally used proprietary specialty systems. Consequently, the implementation of ERP often faces some degree of organizational resistance and technical difficulty. For successful implementation, ERP needs to break departmental barriers and combine heterogeneous platforms into a single, integrated system that uses a single, centralized, enterprise-wide database.

A complete ERP system includes numerous specialized subcomponents. Each subcomponent automates and mechanizes a portion of the business processes of an organization. In addition to general-purpose functional components such as accounting or human resources, some ERP vendors also provide industry-specific applications that are designed for various vertical markets. For example, specialty ERP applications are available for governments, financial service organizations, and retail industries.

From the information resource management (IRM) perspective, ERP implementation creates a centralized data resource that the entire enterprise can use to facilitate the flow and exchange of information. An enterprise-wide database system becomes a critical nerve center for ERP by providing real-time data access to a number of authorized users at the same time. Such real-time data access enables businesses to achieve incredible efficiency while reducing the cost and time required for order fulfillment, and eliminates redundant operations. Manufacturers with fully functional ERP systems enjoy such benefits as reduced inventories, decreased order-cycle times, increased production capacity, lower total logistics costs, decreased procurement costs, and reduced manufacturing waste.

Unlike ERP systems that focus on internal operations, SCM applications are designed to exchange information between trading partners on the supply chain. Mentzer et al., (1999), defines supply chain management as:

> the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain (that consists of multiple firms), for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole...

Speaking simply, SCM is the process of making both the supply chain and individual companies on the supply chain more efficient and effective. SCM covers a company's internal operations and its interfaces with its suppliers and customers. A company can enjoy significant competitive advantages and can assume an industry leadership role if it can maneuver itself into a position where it can control the supply chain. For example, Wal-Mart has successfully demonstrated this strategy by forming partnerships with suppliers such as Procter and Gamble,

3M, and Philips Consumer Electronics, thereby reducing its inventory and its overall logistics cost (Mentzer, Min, & Zacharia, 2000).

Like ERP, the foundations for modern SCM were laid in 1970s. At the beginning, the objective of SCM systems was to achieve an elementary level of manufacturing control. Early systems were not very user-friendly and typically required in-depth programming and system knowledge. End-users had to employ IT specialists to get information from the system. In the 1990s, the focus of supply chain management was shifted to interdependence among organizations on the chain. The idea was not just to make each functional unit a part of the enterprise, but to interconnect the entire supply chain by pursuing inter-organizational information sharing. This necessitated high-level planning that took into account the entire supply chain. (A complete SCM system normally contains several component modules, including a demand management module, a replenishment management module, and a category management module. The demand management module analyzes and forecasts market and customer demands. The replenishment module manages inventory levels. The category management module helps make strategic decisions on categorizing and promotion strategies.)

ERP and SCM have some similarities and some differences. On the similarity side, both ERP and SCM have common objectives—to facilitate efficient use of resources and to achieve optimal levels of customer satisfaction. They both emphasize system integration, process collaboration, and data sharing among relevant entities. In addition, they both stress the importance of online data accessibility and real-time data updates. But there significant differences in focus: ERP puts heavy emphasis on synergy within an organization, because ERP applications are not designed to optimize individual processes, but are designed to incorporate and coordinate various processes within an organization. ERP implementation often requires organizational restructuring, or BPR, which leads to the establishment of new standards and compatibility within an organization. On the other hand, SCM focuses more on achieving the sometimes-conflicting objectives of various business units. The objective of SCM is to optimize and integrate various planning and production operations across the supply chain. By using sophisticated algorithms and scenarios, SCM applications allow managers to restructure the supply chain to become more efficient. A bonus is that SCM can help managers understand the effects of their strategic decisions and thus make better decisions.

ERP applications manage functions within a single enterprise and do not focus on external issues such as coordinating and managing the activities of trading partners. In contrast, SCM aims to eliminate barriers between trading partners by resolving supply issues in multiple organizations on the chain. With ERP, all processes and functions within an organization are integrated. With SCM, only functions relevant to the supply chain are considered. In other words, ERP has a wider and shorter scope that extends across various functional areas in one organization, whereas SCM has a narrower but longer focus that extends over multiple organizations.

ERP and SCM also differ in the way they manage information resources. The centralized database for ERP eliminates data redundancy and improves data integrity within an enterprise, thus assisting individual departments in achieving overall corporate goals. In the case of

SCM, there is no centralized database; the data is scattered among various organizations on the supply chain.

The following section examines the possibility of integrating ERP and SCM. The possibility of including sales force automation (SFA), CRM, and other corporate applications in the integrated system is examined later.

INTEGRATING ERP AND SCM

Both ERP and SCM integrate previously scattered systems. ERP integrates systems within an organization, while SCM integrates systems among organizations. As ERP and SCM programming gradually becomes more mature, it is logical to suppose that further integration of the two systems will take place. There are practical reasons to pursue integrating ERP and SCM. From the market forces perspective, corporate mergers, fierce global competition, and the e-commerce movement are forcing companies to be more efficient and effective. Due to the complementary focuses and data dependencies between ERP and SCM, pursuing a higher level of integration is worthwhile.

The integration of ERP and SCM promises a number of benefits, the first of which is improved efficiency. By integrating the two systems, manual information exchange between the two systems may be greatly reduced. The second benefit would be extended data accessibility. By giving partners on the supply chain access to certain ERP information, the value chain would be more responsive to the end-consumers. The third benefit would be cost shifting, where an ERP system linked with SCM system would enable customers to directly check supplier capacities and reserve inventory. In this way, the need for customers to carry inventory would be reduced. As the responsibility of inventory management would transfer from customer to supplier, inventory cost would also shift to supplier. Such a shift could reduce the overall cost of inventory by economy of scale.

To actually integrate ERP and SCM will not be an easy task, however. It is a well-known fact that successful implementation of ERP in just one organization is a challenge (Dempsey, 1999; Stein, 1999; Willcocks & Sykes, 2000). To further extend an ERP system to include an SCM system that ties it to multiple trading partners, in multiple locations, in multiple countries, is bound to significantly increase the level of complexity (Markus et al., 2000). So, there will be many obstacles to overcome; some of these are described below.

Cost and Resource Continuity

In actual practice, integrated enterprise systems have been difficult to create because the process is so expensive. For example, one U.S. corporation invested an estimated $500 million during a four-year ERP implementation effort (Willcocks & Sykes, 2000). Another difficulty is the lack of resource continuity over the extended time horizon needed to bring the project to completion (Kumar & Hillegersberg, 2000). Some organizations may invest a large amount initially, but fail to follow up by allocating resources later. When integrating ERP with SCM, multiple organizations must be brought into the mix, with the implementation time projected to take even longer. Therefore, the likelihood for resource continuity is significantly reduced, and a participating organization's decision to withdraw from the project,

either voluntarily or involuntarily, could have a devastating effect on the business entities that do want to continue the integration process.

Organizational Conflicts and Resistance

Installation of corporate applications is often seen as an IT project, instead of a business-IT joint effort, and this view is often cited as a contributing factor in the failure of ERP implementation (Willcocks & Sykes, 2000). Large projects like these often require sweeping changes that subsequently create conflicts and political problems within organizations (Markus et al., 2000). To successfully adopt corporate applications, the organization as a whole must recognize the need to reengineer its existing business processes. When integrating SCM and ERP, the reengineering process will be more volatile due to the involvement of multiple organizations, which may well cause resistance and conflict to increase exponentially because multiple organizations will be involved.

Technical Difficulties

Most ERP and SCM applications are customizable-package software, which means they can be configured to meet the unique requirements of specific business processes. How they are configured is often a highly technical process that requires both domain knowledge and technical skill. Besides, corporate application technologies are continuously evolving in terms of technology and functionality, and application vendors keep introducing new products or patches. User modification and configuration further complicate the issue (Kremers & van Dissel, 2000.) In addition, many organizations need to retain their legacy system as a part of their ERP system. So, it naturally happens with ERP and SCM integration that the organizations involved will likely have, not only different business processes, but also different legacy systems; and integrating these multiple legacy systems will dramatically increase the difficulty of the project—success will require both tremendous domain knowledge and technical skill.

TYPES OF INTEGRATION AND STRATEGIES

Despite the potential challenges pointed out above, corporate application vendors have begun to roll out products that integrate ERP and SCM functions, or middleware applications to bridge them (Technology Forecast, 2000). The trend toward more integration seems to be inevitable. Therefore, companies need to have well-thought-out implementation strategies to minimize the risk of failure. In addition, ERP and SCM are mission-critical corporate applications, so any improvement or modification to these systems needs to be performed with minimal interruption to business operations. In the following section, we discuss different levels of corporate application integration and propose several integration strategies for management consideration.

Data Integration

The sheer scale of corporate application integration and implementation encourages organizations to deal with the task one level at a time (Markus & Tanis, 2000). At each level, there are challenges and choices to make (Markus et al., 2000), but each level also comes with unique opportunities for business process improvements.

The most basic level of integration is data integration. Data-level integration requires compatibility of data definitions and encoding formats between the systems to be integrated. Data-level integration is similar to electronic document interchange (EDI), in which heterogeneous systems are able to exchange transactions by following a common set of data and communication protocols. With data-level integration, ERP and SCM will be able to exchange transactions electronically while retaining their own heterogeneous platforms and databases. But because of its simplicity, data-level integration has limited benefits. First, the information exchange may not be real-time, but may be done in batch formats. Second, redundancy of information remains since each system maintains its own database. Third, long-term costs may be higher due to the need for maintaining two separate systems.

Application Integration

Application-level integration is the next level after data-level integration. With application-level integration, ERP systems and SCM systems are integrated at the program (code) level. In other words, the two systems can conduct procedure calls directly on each other. For example, an ERP system may trigger the launch of a purchasing module on an SCM system to place an order; an SCM system may call the personnel module on an ERP system to schedule more workers to meet higher demands.

The main challenge of application-level integration is technology complexity. First, ERP applications are customized to meet companies' internal data processing needs, so many firms have unique ERP reference models. Consequently, the objects in one ERP system will likely be entirely different from objects in another system. In addition, each firm has likely adopted its own set of performance measures, such as inventory turnover, on-time delivery, order fulfillment, data accuracy, customs clearance, proactive communications, and so on. Such customization becomes an obstacle for integration. Furthermore, a large variety of corporate applications are currently in use. According to a Meta Group survey, it is estimated that large business organizations have an average of forty-nine different corporate applications (Technology Forecast, 2000). Each of these applications may use a different computing platform, data format, and communication protocols. Consequently, a great deal of custom programming will be needed for integration. The use of middleware applications is often necessary. Based on their prior experiences with EDI and computer-aided design (CAD), it is usually difficult for customers and suppliers to agree on a common solution. It proves even more challenging to integrate multiple companies on the supply chain simultaneously, which in turn increases the integration cost (Markus et al., 2000).

Another challenge of application-level integration is the need for mutual trust between trading partners. SCM, by definition, allows data sharing with external organizations. Integrating ERP and SCM at the application level gives trading partners access to each other's ERP systems. Some companies may not feel comfortable sharing certain information except with long-time trading partners. Thus, a partnership between two companies on the supply chain cannot be purely technology-based—it also requires the creation of extensive social, economic, service, and technical alliances built over an extended period of time; it also requires that the partners have mutual commitment, trust, and common goals (Morgan & Hunt, 1994; Mentzer et al., 2000).

Potential liability from incorrect data is another issue. Once integrated, SCM will become dependent on the performance of ERP systems. Without human monitoring, erroneous data from one partner's ERP system could contaminate the SCM system and subsequently affect the operation of the entire supply chain. System security is also a concern. Business organizations need to protect their own interests, even on the same supply chain. The scope of the information that will be available on the system needs to be agreed upon by all the parties in advance. If these parameters are not carefully and clearly defined, sharing information may hurt, rather than help, the relationship between business partners. For instance, from the technical perspective, each company likely has its own security policies implemented on its system. By integrating its ERP system with SCM, the company with the weaker security protocol may create security loopholes, and this breach could put the entire supply chain in jeopardy. So, a common set of security protocols will need to be developed for all participating organizations.

Business Process Integration

The internal business processes of an organization determine how corporate applications are configured (Markus et al., 2000). With multiple trading partners each having its own unique way of doing business within its own organization, it is almost impossible to fully integrate corporate applications across the supply chain. Therefore, the next logical step of integration is business process integration (BPI). BPI goes beyond data and systems. It is an alignment of business workflow, success criteria, data definition, and standards. The goal of BPI is to create frictionless information and material flow on the supply chain. BPI can be described in four layers of compatibility.

1. The first layer is technical compatibility. At this level, BPI requires companies to adopt compatible technology, including data formats, communication protocols, network infrastructures, security policies, applications, and computing platforms.

2. The second layer is operational compatibility. At this layer, partner companies need to adopt compatible workflow and business processes to facilitate operational integration. For example, partners may develop a common procedure for handling customer complaints. When a retail customer files a complaint regarding product quality, the manufacturer and up-stream component suppliers will be able to handle it using compatible procedures.

3. The third layer is strategic compatibility. At this layer, partner organizations need to develop a common set of goals, cultures, and objectives. Numerous studies have shown that compatible corporate culture is essential in long-term business relationships (Bowersox, 1990; Bucklin & Sengupta, 1993; Mentzer et al., 2000). A recent study of two large auto manufacturers in the U.S. concluded that balanced power, mutual dependence, target costing, and personal alliance are essential factors for SCM success (Landry, 1998). Currently, many supply chain relationships are simply transactional. In other words, the relationship is a tactical buyer-seller relationship rather than a real partnering relationship that depends on mutual trust or social ties (Mentzer et al., 2000). Studies have shown that organizational incompatibilities between allied firms, in terms of reputation, job stability, strategic horizons, control systems, and goals, often lead to the creation of fewer strategic partnerships (Brock Smith & Barclay, 1997). Comparable

strategic vision and capability beyond the involvement of the IS department and the CIO are required to achieve high-level integration like BPI (Welty & Becerra-Fernandez, 2001).

4. The fourth layer is political and legal environment compatibility. Business partners often face different legal environments, due to different local laws and industry-specific regulations. For example, material suppliers may face labor regulations that are different from retailers. In addition, supply chains often connect business organizations in multiple countries (Markus et al., 2000). Particularly since the creation of the World Trade Organization (WTO), multinational supply chains have become common. Consequently, the proper management of cross-border information flow is essential to the operation of successful SCM systems. For example, a supply chain in the garment industry may include hundreds of suppliers located in multiple countries with very different political and legal environments (Magretta, 1998). Currently, the reference model used by most corporate applications implies a standardized business model that may not fit the actual business practices in many countries (Soh, Kien, & Tay-Yap, 2000). To facilitate a smooth and legal information flow, the integrated corporate application system needs to consider factors such as quotas, tariffs, environmental regulations, labor laws, embargos, privacy laws, and many other legal issues (Hofstede, 1997; Kale, 1995).

TABLE 1
Levels of Integration and Challenges

Levels	Capability
1. Data Integration	Data exchange between corporate applications
2. Application Integration	Technical integration, procedural calls between applications
3. Business Process Integration	Total integrations, all aspects

Strategies for Corporate Application Integration

Companies may employ a number of implementation strategies to integrate such applications. In general, three integration strategies are used to cover these situations.

1. The first strategy might be called the "closest-fit" approach, and is employed when a company has no existing corporate applications. Despite the rapid growth in the past decade, this is still the case for many business organizations. Although the high-end market is nearly saturated, most midsize organizations in the U.S. and organizations of all sizes in many parts of world such as India, China, Singapore, Japan, United Kingdom, and Spain are not users of ERP, SCM, or other corporate applications (Everdingen, Hillegersbert, & Waarts, 2000). The strategy for this situation is to select an application vendor who provides integrated solutions. Compatibility with existing business processes is the top priority for selecting the vendor because a fundamental concept of using corporate applications is not to waste time "reinventing the wheel" (Willcocks & Sykes, 2000). The problem is that most ERP, SCM, or other corporate applications use generic

reference models, and these generic models do not come close to fitting every organization perfectly, so some degree of reconfiguration or modification will always be necessary, and could also be a costly process (Everdingen et al., 2000). So, the closest compatibility between the selected system and the existing business process would mean less costly customization. An example of such integrated solutions is the Supply Chain Collaboration Suite (CPFR) offered by GlobalNetXchange (GNX). CPFR allows retailers and manufacturers to collaborate without large infrastructure investments.

2. The second strategy might be called the "minimalist" approach. This strategy depends on building the entire system from small independent, but compatible, components (Kumar & Hillegersberg, 2000). The prerequisite of this approach is to have a scalable backbone system that allows for expansion using plug-in modules. This strategy allows firms to extend the system gradually, as resources and organizational constraints allow. This approach also reduces the possibility of system mismatch and total project failure. This strategy is especially suitable for small to midsize organizations with limited up-front money to invest (Everdingen et al., 2000; Kumar & Hillegersberg, 2000). Such a phased implementation approach is also beneficial for cross-border integration of ERP and SCM. In an international environment where each country has a unique political and technological environment, the component strategy is the least risky. Another application of the "minimalist" approach would be for companies who have some corporate applications but want to add more. In this situation, an ideal strategy would be to look for additional systems that are compatible with the existing systems, or to look for systems that have middleware applications available from enterprise application integration (EAI) vendors. For example, Software Technologies Corporation has released an out-of-shell product that integrates SAP's R/3 ERP application and Siebel's CRM suite. Most major vendors also provide EAI products to help smooth out the bumps in the integration process.

3. The third strategy, which might be called "bridging," is employed where existing corporate applications lack compatible middleware to interface with new applications. In this situation, the integration strategy would be to use custom programming to "bridge" the gap. Most ERP systems publish application-programming interface (API) that makes low-level integration possible. The advantage of this strategy is that companies can customize the integration to whatever level they want. The downside is that this approach probably will be the most time consuming and most costly (Technology Forecast, 2000).

TABLE 2
Integration Strategies

Situation	Integration Strategy
1. Starting from scratch	1. Select vendors with integrated solutions
2. Expanding existing corporate applications with available compatible products	2. Minimalist approach 3. Select compatible products
3. Expanding existing corporate applications without compatible products	4. Use middleware 5. Custom programming

Expanding the Integration to CRM

Achieving customer satisfaction is an important goal for most businesses. Companies used to work hard to improve the satisfaction of all customers, whether they were desirable and profitable customers, or undesirable and problematical. There was no other way to address the goal of customer satisfaction because information and methods of identifying desirable customers were unavailable. With the development of CRM (customer relationship management) software that included data warehousing and sophisticated data-mining techniques, businesses learned to profile customers based on historical data and patterns. The goal of CRM has not been blanket improvement of customer satisfaction, but to ensure that only the best customers become repeat customers. In other words, CRM allows companies to find their best customers and then concentrate their efforts to provide them with better services.

The history of CRM systems is relatively short compared to that of ERP and SCM, having only debuted in the late 1990s. A complete CRM application may include several sub-systems, including sales forces automation (SFA), marketing automation, and customer care automation. Together, CRM systems make the process of selling more efficient and effective while improving satisfaction to targeted customers. In large business organizations, sales, marketing, and services are often separate units with strong boundaries. An integrated CRM helps break down the barriers between these departments and allows the sales force to be more aware of everything that is happening to the customer.

There are some potential benefits to integrating CRM with ERP and SCM. For example, integration between CRM and ERP allows the sales force to access ERP information such as sales volumes, credit ratings, payment status, available human resources (e.g., to make products or technical support more easily available to customers), and so on. Production managers are able to stay better informed about customers' reactions to products, promotional activities, and other customer-related issues. In addition, CRM may provide information to ERP that will help it to prioritize work processes to optimize services to preferred customers, further enhancing the relationships with these customers and thus contributing to the bottom line. CRM is a system designed to handle marketing, sales, and service in one organization. It normally does not involve the systems of multiple trading partners. Consequently, the integration of CRM with ERP is not likely to be as problematic as the integration of SCM and ERP.

It is also possible to integrate CRM and SCM to allow a sales force to access such information as supply status, product configuration, assembly process, and delivery status. Consequently, the sales force is more informed about customer problems and able to respond more intelligently. Eventually, they will be more responsive to customer needs and able to provide effective solutions that improve the satisfaction of preferred customers. For production managers, the integrated system allows them to better forecast demand by incorporating factors such as promotion and sales activities. Suppliers may also take advantage of the integration to better schedule the delivery of raw materials and to prioritize material flow to enhance service to profitable customers. Most of the major vendors of ERP, SCM, and CRM provide some levels of integrated solutions (See Table 3).

TABLE 3
Selected ERP & SCM Vendors

Vendors	Products
BAAN	ERP, SCM, CRM, etc.
Oracle	ERP, SCM, Procurement Management, Learning Management, etc.
Peoplesoft	ERP, CRM, SCM, Supplier Relation Management (SRM), etc.
SAP	ERP, SCM, CRM, Product Lifecycle Management, Enterprise Portal, etc.
Great Plains	ERP, SCM, CRM, etc.
J.D. Edwards	ERP, SCM, CRM, SRM, etc.

Incorporating Software Agents with Corporate Applications

Even with the integration of corporate applications, some manual steps are still needed in business processes. In most organizations, the goal of total automation would be unrealistic, as it will always be necessary to employ humans to do ill-defined tasks like collecting and interpreting information, making value judgments about potential suppliers or clients, evaluating products, making price decisions, or entering purchase and payment information to complete a transaction (Maes, Guttman, & Moukas, 1999). These manual processes represent opportunities to cut costs and improve efficiency.

Software agents are applications that perform tasks on the users' behalf. They automate tasks such as filtering information, matching criteria and products, identifying needs, negotiating terms, purchasing, evaluating services, and many others. The main difference between software agents and traditional software is that software agents are personalized, run continuously, and are semiautonomous (Maes, 1994). In other words, software agents proactively monitor and respond to situations, as would a human agent. For example, a restaurant chain that needed to order food supplies could use an inventory-software agent to monitor the quantity and usage patterns of supplies among restaurants within the chain. When the software agent determined a need to replenish an inventory item, it would launch the buying-software agent. The buying-software agent would automatically survey qualified food suppliers that carried the needed product, evaluate the various offerings, make judgments, select the supplier, and place the order. The purchasing-software agent would also notify other software agents (such as the warehouse-software agent and accounting-software agent) to conduct the subsequent tasks of anticipating delivery, verifying shipment, and making payments.

Currently, the use of software agents is limited, but the potential for integrating software agents and existing corporate applications exists in several areas. First, software agents could be used to extend the basic functionality of SCM. A software agent could be built to continuously monitor the material flow along the entire supply chain and could alert companies regarding unusual conditions such as delayed deliveries. Another software agent could be created to gather market intelligence such as competitor pricing information. Information

brought back by the software agent could then be used to adjust production and inventory levels on the supply chain. In addition, software agents could be used to monitor spending patterns within an organization and notify the accounting system of possible internal audits. For CRM, software agents could be used to search for potentially profitable customers, or to track orders and inform the account manager of any event that might dissatisfy the customer. Software agents could also be used to advertise new offerings to customers who might be interested in them.

CONCLUSION

Integration of corporate applications between and among trading partners represents a challenging but promising task. Higher levels of integration can improve efficiency, shorten response time, and improve customer relationships. However, the complexity of system configuration, administration, and maintenance are expected to increase commensurately with the level of integration. Based on previous experiments with ERP and SCM, this paper discusses several strategies for integrating ERP, SCM, and possibly other corporate applications. The approaches suggested take into consideration both the technical features of the applications and organizational constraints in the businesses where they may be used. The purpose of these strategies is to minimize the risk of failure and maximize the utilization of resources.

This paper does not specifically addresses the issue of e-business solutions. The authors fully understand the importance between ERP systems and e-business components such as e-marketing, e-catalogs, and e-procurement systems. We did not omit this important subject due to oversight. Instead, we chose to focus on ERP, SCM, and CRM in this paper. Practitioners and scholars who are interested in corporate applications should pay attention to the following topics in future research efforts.

1. The relationships between the level of integration levels and business outcomes (see Table 1);
2. Cost-benefit analysis of corporate application integration;
3. An examination of issues and opportunities for integrating ERP, SCM, CRM, and e-business applications such as e-catalogs and e-procurement systems.

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