Implementation Management of an E-Commerce-Enabled Enterprise Information System: A Case Study at Texas Instruments

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Implementation Management of an E-Commerce-Enabled Enterprise Information System: A Case Study at Texas Instruments

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This chapter presents a case study of an overview of the efforts of Texas Instrument's (TI's) internal and external ERP implementation, with a focus on linking its ERP system in a global e-commerce setting. This linkage is especially important since it had been stated in TI's strategic plan as an objective of this project to provide visibility of the ERP system to external constituents via Web linkages along with the objective of standardizing internal processes and important information technology systems to support market needs. Thus, its ERP system is central to managing its supply chain and B2B e-commerce linkages from both a customer and supplier perspective. Issues faced by TI are clearly outlined with future questions also posed in the final section.

INTRODUCTION

The integration of enterprise systems and the supply chain to an organization is becoming more critical in an ever-changing, globally competitive environment. As markets mature and customer preferences become more diverse and specific, quick response to those needs is required to maintain competitive advantage. This quick response will require close relationships, especially communications and information sharing among integrated internal functional groups, as well as the suppliers and customers of an organization. Texas Instruments (TI), headquartered in Dallas, Texas, is one organization that has come to realize this requirement for building and maintaining its competitive edge. One strategic decision made by the organization was to implement an enterprise resource planning (ERP) system with a focus on linking it with a global electronic commerce (e-commerce) setting.

This case study provides an overview of the efforts of TI's internal and external ERP implementation that led to over 70% of the transactions being conducted in a global e-commerce setting. TI's strategic goals include providing visibility of the ERP system to external constituents via Web linkages and standardizing internal processes and information technology to support market need. The e-commerce linkage is especially important in achieving these goals. Thus, TI's ERP system is central to managing its supply chain and Web e-commerce linkages from both a customer and supplier perspective.

In this situation there were a number of major players, including project management direction from Andersen Consulting Services, software vendors such as SAP and i2 Technologies, hardware vendors such as Sun Microsystems, and various suppliers and customers of TI. Part of the process involved outsourcing some of TI's internal information systems capabilities to these vendors, especially Andersen Consulting.

The various stages of implementation from adoption to preparation and operation are detailed as separate sections. At each stage of the implementation TI used performance metrics to manage the process. We also provide an overview of how these performance metrics played a role in the implementation.

STRATEGIC SYSTEMS IMPLEMENTATION BACKGROUND

Much research has been undertaken to develop a better understanding of IT implementation and to assess its contribution to improving organizational efficiency. A meta-analysis of IT implementation research (Lai &

Mahapatra, 1997) indicates that there is shift in emphasis from studying individual IT to organizational and inter-organizational systems. Since an ERP system has long-term and broad organizational implications, strategic planning is key to the successful management of such systems. There is an extensive body of literature related to strategic planning. Critical antecedents to developing a successful strategic plan are (Lederer & Salmela, 1996; Lederer & Sethi, 1992):

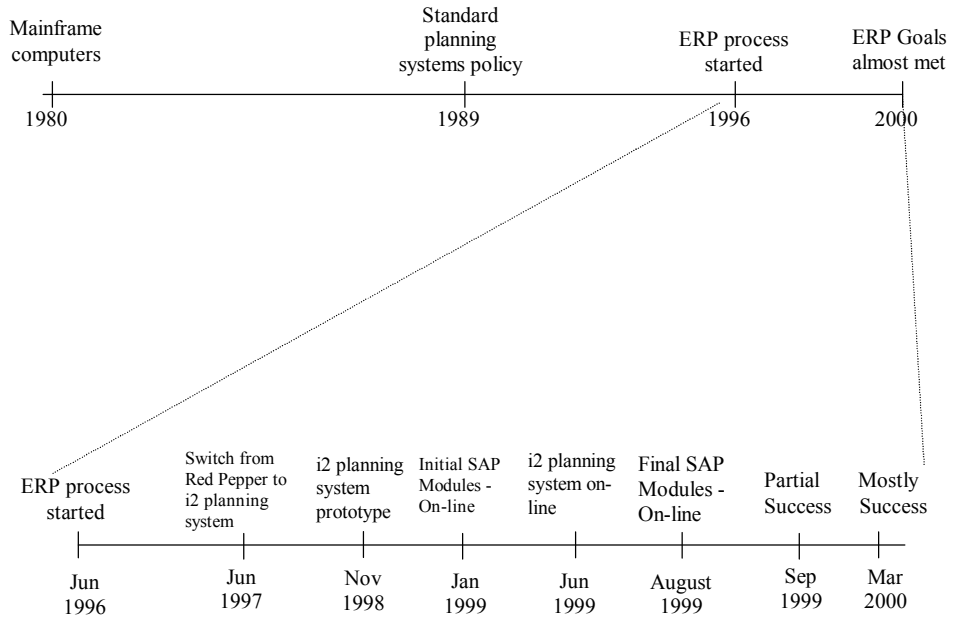
(1) external and internal environments,
(2) planning resources and processes, and
(3) an information plan that actually gets implemented.

These constructs provide a theory of strategic information systems planning and are important to both researchers and practitioners involved with planning.

By borrowing from the literature on the management of advanced manufacturing technologies (Meredith, 1987; Sarkis & Lin, 1994; Small & Yasin, 1997), a process-oriented framework for ERP management is presented (see Figure 1). As indicated in the figure, the process suggested by this framework is iterative, in the sense that it allows for higher level strategies and processes to be reformulated when they are discovered to be incompatible with lower level systems and configurations, and vice versa.

Strategy Formulation and Integration

Figure 1. Timeline of TI's ERP implementation



Strategic justification frameworks should begin at the upper levels of management. The technology selected should fit within the vision, goals and strategic objectives of the organization. An organization should undergo a SWOT-MOSP process in which it assesses its Strengths and Weaknesses in the light of environmental Opportunities and Threats, then develops its Missions, Objectives, Strategies and Policies. One of the results of this step in the process is determination of an organization's core competencies that need specific technology support.

Process Planning and Systems Design

At the next level is the initiation of process plans that support the organizational competencies identified earlier and that in turn get supported by the chosen system (ERP or otherwise). Also known as the reengineering phase, three studies are usually undertaken at this stage, and they are named AS-IS, SHOULD-BE and TO-BE.

The AS-IS study provides baseline measures for later justification purposes and provides measures for post-implementation auditing. The SHOULD-BE study tries to exhibit how the current system should function after non-automation/non-hard technology improvements (e.g., total quality management) are instituted; a currently disordered system will lead to a disordered ERP system as well. The TO-BE study is used to define the system necessary to meet the objectives set forth by the strategic units.

System Evaluation and Justification

Here, analysis focuses on the economic, technical, and operational feasibility and justification of the system. The justification step should consider many different types of factors—tangible, intangible, financial, quantitative, and qualitative. Since the analysis of tangible factors (e.g., financial) is well-studied using methods such as Return on Investment (ROI), our focus will be on the evaluation of intangible factors.

System Configuration

An ERP system has some of the characteristics of packaged software such as Microsoft Excel and some of those of custom-built ones. It certainly is not designed and programmed for the exclusive use of one organization nor is its implementation and management as easy as that of packaged software. Each ERP software company is likely to have its own business model in the design of its package. As a packaged software system, there are likely to be discrepancies (at the detailed level) between the needs of an organization and the features of the software (Lucas, Walton & Ginzburg, 1988). Hence, a

significant amount of effort can be expected to configure the system or the organizational processes in order to produce an alignment between them.

System Implementation

The implementation stage can be classified into: startup, project management and a migration handling the switchover from the old to the new system. ERP systems force large-scale overhaul of business processes and, therefore, their implementation needs to be supported by appropriate change management approaches (Markus and Benjamin, 1996). Another key concern of implementation is that of systems integration, in which multiple types of subsystems, platforms and interfaces must be integrated over diverse and dispersed geographic locations. Systems implementation involves:

- Acquisition and Procurement–Actual purchase of software, hardware and supporting equipment, and personnel.
- Operational Planning–The project plan necessary to bring up the system.
- Implementation and Installation–This is the actual implementation and startup step.
- Integration–Linking the systems to each other and other organizational systems.

Post-Implementation Audit

This last "feedback" stage, although very important from a continuous improvement perspective, is one of the more neglected steps. According to Gulliver (1987), for example, auditing should:

- encourage realistic preparation of investment proposals;
- help improve the evaluation of future projects as well as the performance of current projects that are not proceeding as planned;
- call attention to projects that should be discontinued.

As can be seen, the process suggested above can be arduous, but this necessary effort must be anticipated for the successful integration of complex and strategic systems into an organization.

IMPLEMENTING A GLOBAL ERP SYSTEM AT TI

Company Background

Texas Instruments Incorporated (TI) is a global semiconductor company and the world's leading designer and supplier of digital signal processing (DSP) solutions and analog technologies (semiconductors represent 84% of TI's rev-

enue base). Headquartered in Dallas, Texas, the company's businesses also include materials and controls, educational and productivity solutions, and digital imaging. The company has manufacturing or sales operations in more than 25 countries and, in 1999, derived in excess of 67% of its revenues from sales to locations outside the United States. In the past few years, TI has sold several non-core businesses to focus on DSP solutions and analog technologies, where TI is the world leader. DSP and analog devices have more than 30,000 customers in commercial, industrial and consumer markets. TI faces intense technological and pricing competition in the markets in which it operates. TI's expectations are that the level of this competition will increase in the future from large, established semiconductor and related product companies, as well as from emerging companies serving niche markets. Prior to the implementation of ERP, TI had a complex suite of stand-alone nonintegrated marketing, sales, logistics and planning systems consisting of thousands of programs that were based on many independent databases and running on proprietary mainframe systems.

Overview

Since the 1980s, TI had used a highly centralized infrastructure utilizing proprietary mainframe computers for meeting its IT requirement. As the first step toward global business processes, certain planning processes and systems were standardized in 1989. However, the systems were independent of one another, and were, therefore, inadequate to meet changing customer demands. Market conditions dictated that TI must operate as a global DSP business, with greater flexibility, shorter lead times and increased productivity to meet customer demand. The company determined the need for dramatic changes in its technological infrastructure and its end-to-end business processes, in order to achieve these business goals. Starting in 1996, TI underwent a company-wide reengineering effort that led to the implementation of a four-year, $250 million ERP system using Sun Microsystems' hardware platform, SAP AG's ERP software, i2's advanced planning tools and Andersen Consulting's implementation process (see Figure 1 for a summarized timeline).

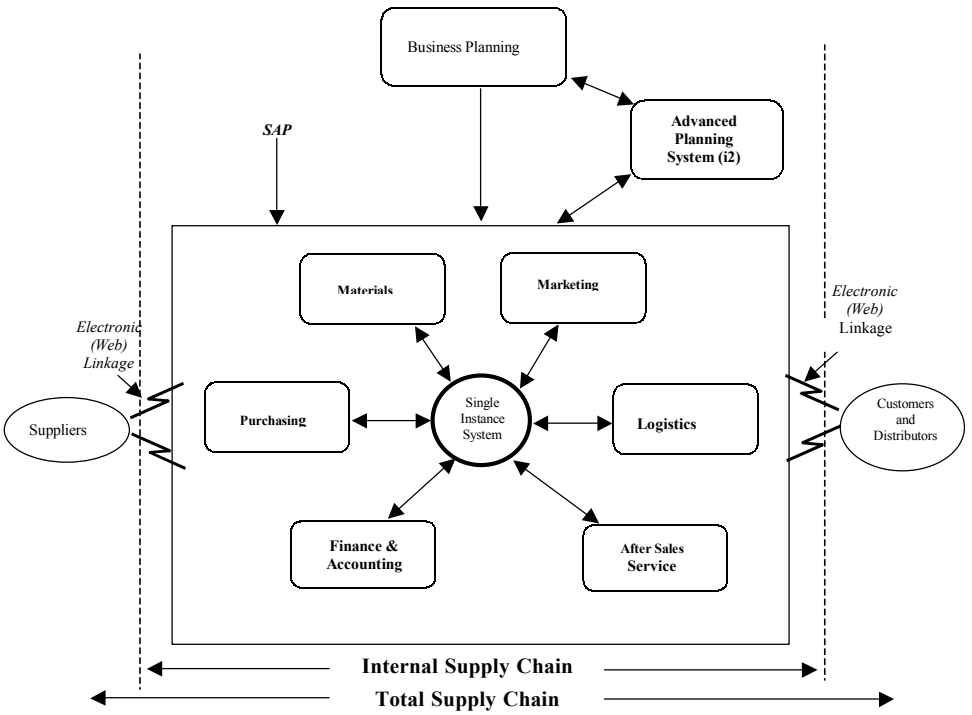
In 1998, Texas Instruments implemented the first release of the ERP system, which primarily consisted of a prototype implementation of the i2 system running on a Sun E10000 platform. This was the first step toward migrating the manufacturing and planning of TI's orders. In early 1999, TI began rolling out the second release. The initial deployment included the SAP Procurement and Materials Management module and the Financial Management and Reporting module. In the middle of 1999, TI completed the i2 Technologies software implementation as part of the third release. Finally, TI turned on the remaining financials, and new field sales, sales and distribution modules. Included in this release were the first Web-clients to be used with

SAP and a next-generation, distributor-reseller management system, both developed in conjunction with SAP.

A high-level architecture of TI's pioneering ERP implementation consists of SAP, and the i2 system for advanced planning and optimization (see Figure 2). The system is a pioneering large-scale global single-instance implementation of seven modules (finance, procurement and materials management, logistics, planning, field sales, and marketing) for all of TI's divisions, and it is in use by 10,000 TI employees to handle 45,000 semiconductor devices and 120,000 orders per month. As shown in the figure, this solution also enabled global Web access to information for TI's 3,000 external users at customer's, distributor's, and supplier's sites. In total, over 70% of the business transactions conducted with TI by all customers and partners are now via the Web or electronic data interchange (EDI). In summary, the implementation:

- Institutes standardized process to support the market trend of order-anywhere/ship-anywhere services;
- Provides global visibility of the system to customers and suppliers, permitting them to conduct many activities via the Web
- Standardizes key information technology systems so as to support

Figure 2: A conceptual model of ERP system, linkages



business goals.

The next two sections describe some of the activities involved in the substages of this large-scale implementation.

STAGES IN MANAGING THE GLOBAL ERP SYSTEM IMPLEMENTATION

We now describe TI's activities in each of the stages of the strategic framework that was generally described earlier in this case.

Strategy Formulation

Traditionally, TI was primarily running what was called a "commodity" business, wherein orders were received, manufactured and shipped as a batch. Throughout the 1980s and 90s markets evolved from the one-size-fits-all status to one in which customers started demanding customized products. This mass customization phenomenon, combined with the maturity of TI's business, caused it to reexamine its goals and strategies. TI started its shift towards a more customized product environment.

Within this new customized product environment, TI had a number of customer needs that could not be met easily. For example, a customer in Taiwan wanted to place all orders in California and then allocate a worldwide destination for the ordered products only at the time of shipping. This was difficult for TI to coordinate, because each of the regions was on a separate system. Other customers wanted to place orders for complete sets of devices that all worked together. Since its existing system could not handle such orders, TI had to enter the order for each device separately. The delivery of each of the devices was done at different times, implying that the customer will have to carry inventory while waiting for the remainder of the set. Manual workarounds and interventions were needed to handle these kinds of demands. Thus, the goal was to determine the appropriate processes and information systems that had to be put in place in order to support such agile design and manufacturing strategies (see, for example, Peters & Saidin, 2000, who describe the use of IT for supporting mass customization).

Another goal was a move toward supplier-managed inventory and customer-managed orders. Going beyond EDI and extending e-commerce meant that TI decided that leveraging the capabilities of the Internet to provide visibility of its systems to its customers and suppliers would be necessary. Finally, standardizing systems was another integrative corporate goal. TI's strategy was to ensure standardization of its systems as much as possible. Specific areas such as factory automation were left to use custom solutions,

but other areas such as planning were required to be on standardized open systems in order to support the other goals.

TI makes extensive use of metrics. Strategic goals are translated into tactical and operational quantifiable objectives. Key metrics are developed and used as a fact-based management approach that keep clarity in the project direction and manage the scope of the project. The metrics include standard operationally and organizationally strategic ones, such as Time, Cost, Flexibility and Quality. In addition, since TI's manufacturing equipment is very expensive, its management made it clear that it was also concerned with level of use—Utilization—of the organizational equipment.

Process Planning and Systems Design

TI conducted a massive reengineering effort for the whole organization with the goal of setting standard processes globally. The major result of this effort was to declare that all inventory and manufacturing management be done globally. This process change caused the practice of earmarking a production lot for specific customers to be discontinued. There were thousands of programs in use at that time, and this proliferation of stand-alone systems inhibited the implementation of global processes. Thus, a proposal to implement an ERP system was made to the president and other strategic business unit managers.

Many organizations find multiple-instance implementations more flexible and sometimes easier to implement. Yet TI decided to implement a single-instance ERP system so as to fully leverage the system's capabilities to support the flexibility and standardization demanded by global processes. After site visits by major ERP vendors, TI selected SAP, mostly because of its scalability to handle voluminous amounts of data. Yet, the actual selection and justification included the evaluation of a number of systems by TI. These systems were evaluated through a questionnaire that contained hundreds of detailed questions pertaining to capabilities, ranging from user friendliness to support of major functions. Many of these same questions were used in aiding in the system justification.

System Justification

A budget of approximately $250 million was set for the implementation. The justification of the system was done using a combination of tangible and intangible factors at both the enterprise and business-unit levels. Standard hard-justification measures such as ROI and IRR were used to ensure the financial viability of the project. In fact, if these were the only measures to be used, then the system would have been justified. Yet, the data for these measures were still

forecasts and estimates. Strengthening the financial justification by evaluating other measures and factors helped to provide stronger foundation for managerial acceptance. In estimating financial measures, global capacity utilization as a result of the ERP system was also projected. The project managers kept in mind that such projections were only guidelines that could get offset or boosted as a result of other continuous-improvement activities that were ongoing in the company. These estimates ranged from 3-5% output improvements based on current assets, which although seemingly small, amounted to increased cost savings of several hundred million dollars. Some additional intangible and tangible factors included:

- TI's proprietary-mainframe-based ordering was incompatible with the goal of moving toward a Web-based e-commerce model.
- TI had thousands of programs that incurred huge maintenance costs such as integration among these software systems.
- Accurate global inventory was not possible without a "single-instance" ERP system.
- An ERP system would facilitate in cycle-time reduction, which would help TI compete effectively in the custom DSP market.

Through this business case justification, acceptable financial returns, along with strategic factors such as competing effectively within a given niche market, and operational factors, such as global inventory management, all played a role in ERP's justification at TI.

System Configuration

The goals and processes described above entailed a number of changes at the detailed level. Many of the changes are difficult to manage because of drastic changes needed to the ways of doing business (e.g., the business rules). The processes used to address the arising conflicts range from top-management-enabled dialogue among the participants to top-management-backed decisions that laid down the policy for TI. A few examples follow:

- All inventory is global. For example, inventory in Europe must ship, if needed, to any part of the globe, rather than be held for European orders that can potentially come at some time in the future.
- The number of levels of approval on a purchase order was standardized at four (there were some countries that had fifteen levels).
- Authorization amounts were standardized according to the level of the concerned person in the organization.
- An 18-character, globally accepted part number became an agreed upon standard. This standardization involved a huge IS and business effort because changes had to be made to the databases, programs supported by them, and some manufacturing procedures, in addition to having to

communicate the changes to the customers.

- All systems were mandated to be in English except for customer-specific information such as addresses, etc., used for external communication with them. In general, English was used when information was to be shared among multinational facilities, while local data, specific to a facility, could be in the local language.

Implementation

In this phase, concepts and goals are translated into tangible action, and as a result, it is perhaps one of most difficult phases of the project. General principles such as global processes and standard systems need to be backed up by convincing and deploying the right people to implement the processes.

We briefly describe TI's implementation phase in the following categories, startup, project management, and "going live". This description contains the manner by which problems were addressed in each category.

Startup. A number of key personnel, along with their families, were expatriated to the US and stationed in Dallas for a few years. About 250 people were transitioned from TI to Andersen Consulting (i.e., put on Andersen's payroll) which became the main provisioner of services with respect to the ERP system. IT outsourcing in this case involved Andersen Consulting taking over the employment and management of former TI people.

Project Management. Change management played a large role in this stage. The roles of training, planning, and communicating were of equal importance. All management levels were involved in this process, as were various vendors and suppliers. Some of the practices included:

- On-site experts were made available to new users of the system.
- A help desk was set up to handle problems that could not be addressed by these experts.
- A ticketing system for managing and prioritizing problems was also established (e.g., a system stop was a high-priority ticket that would get round-the-clock attention).

Handling Go-Live. To get prepared for "go-live", the key managers who were stationed in Dallas were sent back to their territories for educating the next level of users. Using selected experts, user-acceptance scripts were defined and tested, with problems, if any, being resolved as per one of the schemes outlined above. Daily conference calls were set up for thirty days prior to go-live to obtain status checks on progress and on the tickets.

Based on the results of these checks, a risk analysis was conducted weekly to determine the effects of various potential failures. The imple-

mentation plan was to have a few go-live dates one after another, but in relatively quick succession. Except for the planning system, in all the other stages, in this case a direct conversion was employed. That is, with a downtime of about two to three hours during a weekend, the old system was turned off and the new one turned on.

Post-Implementation Status

The system met most of its goals nine months after the complete implementation. Response time for the system has exceeded expectations, with 90 percent of the transactions worldwide getting a response within three seconds. There are around 13,000 users (10,000 TI + 3,000 outside) on the system, with concurrent users ranging from 300 to 1,700. The integrated system allowed TI to better manufacture and deliver its 120,000 orders per month involving 45,000 devices.

Some of the key performance measures and parameters evaluated were:

Productivity Dip. There was a period of reduced productivity. Given the voluminous changes involved, this was to be expected. TI expected this and discussed with Andersen methods to ameliorate this problem.

On-time Delivery. TI was not hitting its goal of on-time delivery. In addition to the new system, market conditions caused more orders than they could deliver. They were falling short of capacity.

Single-instance, global system. The single-instance, integrated, global model was successful, fundamentally transforming how business is conducted at TI.

Better response. Because of its Web capability, the system is used by TI's external constituents as well, namely, distributors, customers, suppliers, and field sales people worldwide. This Web capability allowed easier-to-use order management systems for customers. Customers no longer had to use TI-specific software applications and/or costly point-to-point connections.

*Inventory reduction. S*ome TI factories reported output increases of 5-10%, and up to 15% reduction in work-in-process inventory.

MANAGERIAL IMPLICATIONS

This case study of a successful ERP/e-commerce implementation offers and reiterates a number of lessons for the management of these systems. The following lessons are summarized:

Conduct a Thorough Strategic Plan - The case illustrated how market forces had compelled the company to make radical shifts in its organizational environment and culture.

Align IT Plans with Business Plans - Conduct reengineering studies and develop strategic IT plans to align key IT needs with those of the business.

Get Top Management Support - The prescription of top management support has been made ever since early IT implementations (O'Toole & O'Toole, 1966) to the present. Strangely enough, as stated by Jarvenpaa and Ives (1991), it also remains to be one of the prescriptions that have been regularly ignored. In this case, TI's president and the Chairman of TI's Board communicated the importance and status in their quarterly satellite broadcasts to the company. The president sat in on quarterly meetings, and even stipulated that if anyone wished to "customize" aspects of the system that they would have to personally explain it to him and show why TI would get more profit out of this change.

Change Management - Set realistic user expectations such as the initial productivity dips. User involvement is critical. Andersen Consulting's process helped to ensure that such was the case. Make sure that the user is supported to help improve user satisfaction.

Strong Champion Characteristics - In TI's situation, the manager of the ERP project had over two decades of experience in various levels of the organization. This manager had broad knowledge of Corporate operations since he was in charge of the previous business process reengineering programs that formed the foundation of the new ERP system. Previously he was a vice president of one of TI's divisions.

Rationalize Business Models and Processes - Make sure the business models and processes fit within the strategic direction and goals of the organization. Time, mass customization, and flexibility concerns led to a global model. Part of this rationalization was also completed after the SAP system was agreed upon, since SAP required business processes to be completed as specified by them or significant customization of the system would be required.

Manage External Enterprises - Appropriate and well-planned involvement of consultants is important for keeping the project on a tight schedule. Further, with the advent of e-commerce, companies are more likely to ship and order goods on the basis of Web-based inputs (Kalakota & Whinston, 1996). A training program must encompass such constituents as well, an aspect that seems to be ignored in the research literature. Managing external enterprise relationships (and systems) is not something that many organizations have had experience completing. This makes the e-commerce setting more complex, especially when organizations seek to integrate inter-organizational systems.

Manage Using Metrics - TI and Andersen Consulting have a corporate

culture and policy that requires the stringent and formal use of metrics in the management and evaluation of projects. They attribute this policy adherence as one of the key reasons for success of the ERP implementation.

CONCLUSION

Traditional information systems are often implemented with the goal of improving the internal productivity of an organization. In contrast, modern enterprise and inter-enterprise systems have supply chain integration as an additional and an increasingly critical goal. This makes their management and implementation a very time-consuming and difficult task. TI's ERP implementation with an e-commerce perspective compounded these inherent difficulties by requiring additional features.

- It is a single-instance system, providing access to the same data, irrespective of the geographic location of the user.
- It provides access to 3,000 external users (customers and suppliers), thereby enabling 70% of the transactions to be conducted electronically.

Management did see some problems in this implementation process and tried to address the issues. Some of the major problems included:

1. The software for supply chain management (Red Pepper) that was initially chosen did not meet expectations of TI. This system had to be scrapped; this resulted in a multimillion dollar cost. The i2 system was then implemented.
2. A productivity dip did occur. The implementation had to address this issue for all managers throughout the organization who had some stake in the performance of the system. The expectations that this would occur were communicated through newsletters and messages. Consistent and continuous communication helped to mitigate a situation that could have caused a major project failure.
3. Getting buy-in from internal functions not directly associated with the implementation process was difficult. This occurred with the marketing function. This function needed to be on board for the e-commerce linkage with customers to work effectively. Training and pressures from upper level management helped to ease the transition for the global marketing group.
4. Engineering is still not fully integrated into the ERP system. The e-commerce linkage incorporating product design with the ERP system was not feasible for management. For such a technology driven organization, the lack of engineering function integration with the ERP system may need to be investigated.

Key Questions to consider:

1. Can a large multinational organization implement a single instance global ERP system without the aid of an outside consultant? Could they manage this process even after implementation? Is outsourcing the IS function for ERP a good idea?
2. Which functions are critical within a global ERP system? Why would engineering not be considered a central function for E-commerce? Why should it be?
3. What metrics could be considered for system selection, system implementation, system auditing? Would these be the same metrics? Can e-commerce based metrics be used? What type of e-commerce based metrics may exist?
4. What lessons could be learned from TI's implementation process that could be used for future module integration? How much inter-organizational system integration is required for TI in the ERP/e-commerce system linkage?

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BIOGRAPHICAL SKETCHES

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Joseph Sarkis *is currently an Associate Professor at the Graduate School of Management at Clark University. He earned his PhD from the State University of New York at Buffalo. His research interests include manufacturing strategy and management, with a specific emphasis on performance management, justification issues, enterprise modeling and environmentally conscious operations and logisitics. He has published over 120 articles in a number of peer reviewed academic journals and conferences. He is a member of the American Production and Inventory Control Society (APICS), Institute for Operations Research and Management Sciences (INFORMS), the Decision Sciences Institute (DSI), and the Production and Operations Management Society (POMS). He is also a certified production and inventory manager (CPIM).*