

## CONNECTIVITY OF ERP WITH LEGACY SYSTEMS<sup>1</sup>

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**Abstract:** *The purpose of this study is to propose the criteria for determining the appropriate connectivity of enterprise resource planning (ERP) systems. The result of this study provides a framework assisting ERP adopters in selecting integration approaches that are appropriate to their needs. A survey was conducted to obtain information from ERP users to learn about their opinions on factors and criteria affecting connectivity of ERP systems. Findings from the study revealed that data-oriented approach and application integration oriented approach are the preferred integration methodologies. Criteria for evaluating ERP connectivity include nature of the organization's business process, availability of technologies and service supports, nature of the organization's information system, system flexibility, degree of integration, transaction volume, implementation cost, ease of maintenance, implementation time, security, and budget. Finally, the study proposes a framework to determine appropriate connectivity of ERP systems.*

**Keywords:** *Enterprise resource planning, connectivity, integration, legacy system.*

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### 1. INTRODUCTION

In a highly competitive world, accurate and reliable information is crucial for an organization to stay competitive. An organization must be able to capture the whole picture of its own business operations. Therefore, an uninterrupted flow of information within the organization is required. With this in mind, companies invest millions of dollars in developing or acquiring computing systems. However, these systems are rarely able to talk to each other, and each business unit in an organization has its own computing system. What companies really need is an integrated, enterprise-wide system that automates central corporate activities such as manufacturing, human resources, finance and supply chain management. The enterprise resource planning (ERP) system can fulfil this business requirement.

An ERP system helps to streamline the flow of information among the business units that are unable to perform in traditional computing systems. It ties all business function

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units together. What one unit does also has an impact on the others because different departments share the same system and operate on the same data. Therefore, an ERP system allows business decisions to be made quickly and confidently in the knowledge that data is accurate and up-to-the-minute.

Currently, a lot of companies turn to the ERP system to increase efficiency and productivity, allowing companies to respond to customers' demands more accurately and efficiently than before. Major improvement results from adopting an integrated information system. Though the benefits of implementing ERP systems are many, these cannot be realized easily. The implementation of an ERP system can consume millions of dollars and take several years before the system can be bedded down. Success or failure depends on many factors including technical and managerial matters.

Ideally, organizations hope that ERP systems will replace legacy systems. However, complete system replacement is not practical, economical, or even feasible. An organization has to bear in mind that each organization is unique and no ERP application is suitable for every organization. Moreover, no ERP application offers every function that is required by every organization. Implementing ERP systems requires the customization of software to suit each organization. The degree of connectivity and integration determines how easily the ERP system will be integrated with other systems. The desired degree of connectivity and integration with other systems has to be decided before customizing an ERP application. This involves tradeoffs: a higher level of connectivity is expensive and hard to create and maintain, whereas a lower level of integration does not support a smooth flow of data. Though the highest level of connectivity is preferable, it does not guarantee success. Each organization needs to consider which level is worthwhile and suitable. To assist a potential organization in investigating an ERP system, and to aid in the preparation of an organization for ERP implementation, the appropriate criteria and a framework covering connectivity issues need to be developed.

## **2. ERP SURVEY**

For this study, a survey was conducted to determine ERP driving forces and current problems associated with connectivity, and to identify the critical factors of connectivity that an organization should consider when implementing ERP. The survey is based on in-depth interviews with selected organizations, which are all current ERP users in the government and business sectors. The interviews were designed to cover several sectors of businesses, such as banking and finance, telecommunications, entertainment, automotive manufacturing, high technology and electronics, and power and energy. Interviews were focused on personnel who were responsible for or involved in ERP implementation projects, or personnel who are currently responsible for ERP systems, such as an ERP project manager and IT manager or IS manager.

The interviewees were limited to organizations in which ERP systems went "live" and which are currently implementing ERP systems, not including planned users. With information available from ERP vendors and ERP consulting firms, some current ERP users could be identified. Interviews were conducted in twenty-two organizations: thirteen manufacturing companies and nine service companies. Organizations were selected by judgment sampling to make sure that the organizations contacted were the real users and the right population.

## **3. ERP DRIVING FORCES AND IMPLEMENTATION**

The survey results revealed the following ERP driving forces and ERP implementation:

### *3.1. ERP DRIVING FORCES*

There is a variety of reasons or driving forces for using ERP systems, but the most important one is the need for integration of process and information. The appeal of an integrated information system resulting from implementation of an ERP system is clear. For example, when the sales force enters an order on a computer, the transaction proceeds through the entire company. Inventory lists and parts' supplies are updated automatically. Production schedules and balance sheet reflects changes. By making its information more readily available and shortening the business cycle, the organization can get many benefits resulting from increased competitiveness, reduced inventory, lower costs, and improved customer services.

For international companies, the driving force for using ERP comes mostly from their headquarters, which push ERP system to their branch offices. This happens because of the success and benefits of ERP implementation they have realized from the practice in headquarters and of other countries' branch offices. What is more, the standardization of business practices of all branches is developed, so it is easier and faster to retrieve information and analyze data globally. Other driving forces include a desire to follow the trend, media influence, inefficiency of the legacy system, pressure from clients and/or suppliers, and the need for a program that can fulfill business functions.

### *3.2. ERP IMPLEMENTATION*

Although ERP is evolved from and developed for manufacturing, it is feasible for the service sector to use ERP, but not all modules that come with an ERP package can be used. Currently, ERP vendors also provide solutions for different industries such as healthcare, banking, education, and the public sector.

The study revealed that the basic or fundamental functional modules that most organizations in manufacturing industries have implemented are financial accounting, material management, production planning, sales and distribution, and controlling. These modules are associated with the core activities of an organization, which are the processes from manufacturing to distribution and to preparing financial information. Although the nature of service industry is different from manufacturing, some functional modules can be used. In any type of organization, the financial module is the first module to be implemented because it provides the basic pulse of an organization. It also affects all other modules.

In order to implement an ERP system, business requirements must be identified and then the requirements are mapped with the ERP package. A decision must be made about customizing an ERP application to fit a business's need, or changing business practices to suit the ERP software. According to the study, there were very few cases in which organizations chose either of these two end approaches. Most organizations chose the middle way, by adapting business processes that they considered would be enhanced by following the standard of ERP applications, and customizing the functional modules for which it was not practical to change the business practice. Successful implementation requires the knowledge of the existing system from the in-house team plus the experience and expertise in ERP from the external consultant. Because ERP is still a new concept and so takes a lot of effort for the organization to gain expertise in ERP, ERP consultants play a major role in the implementation of ERP systems.

Although there are many choices, such as the "big-bang" approach and the accelerated method, for implementing ERP, many companies choose a phased roll-out as an implementation strategy by first implementing the modules that are the most critical and

that have the most links with other modules. Then the modules that are involved with the modules of previous implementation phases are implemented accordingly.

#### **4. ERP CONNECTIVITY**

Although the full benefit of an ERP system will accrue if all the ERP modules are implemented together, many organizations implement ERP modules only in those functions that are considered to be of strategic importance. Implementation only of functional modules of ERP application will benefit organizations in terms of integration and connectivity, but it is not practical to do so because sometimes the functions that are needed by organization are not provided in ERP applications. And even when the functions are provided in ERP applications, they may be too general or the functions are not deep or specific enough to meet the requirement of business process. In addition, some organizations need to interface ERP systems with legacy systems because they contain critical business data that sometimes cannot be extracted from legacy systems and converted for use in a new system.

Other driving forces towards interfacing ERP systems with legacy systems or third-party applications include lack of analytical capability of ERP systems, the need to follow the application used by headquarters, increased efficiency in terms of operation, no budget to buy more ERP application user license, and the belief that the existing application is good enough.

The study, however, found that many organizations threw away legacy systems after ERP systems went "live". It was perceived that legacy systems were inadequate information systems. Other reasons were that information required by management was not available immediately; data of various systems was inconsistent; applications could not be integrated; documentation was frequently lacking; and costs of running both ERP systems and legacy systems were high.

##### *4.1. OBSTACLES TO INTERFACING ERP WITH LEGACY SYSTEMS/ THIRD-PARTY APPLICATIONS*

- Data structure of ERP is very complex. The ERP application is a proprietary system and each ERP vendor has its own data structure standard. The ERP schema contains hundreds of tables inside which users do not know when one transaction occurs and which tables are updated. In addition, customizing a certain table would affect many other tables that may not be known to the user.
- Third-party application cannot directly interface with an ERP system. Since the nature of ERP is proprietary, the degree of proprietorship differs from application to application. Therefore, the available options for interfacing other applications to ERP applications depend on the ERP application. However, ERP vendors provide opportunities for integration through published integration frameworks, application program interfaces, or middleware. Even if an integration framework is available, organizations require understanding of ERP native and enabling technologies, which is time-consuming. Another and easier way of interfacing third-party applications is to use the applications that are the partners to or certified by the ERP application. However, this limits the choices of third-party applications because some organizations have to use applications that were implemented before the implementation of ERP systems.

- Lack of knowledge about ERP. From the study, it was seen that organizations rarely have knowledge about ERP systems. They also lack computing personnel who are experienced in ERP. Besides, the training fee of ERP is quite expensive, and after training, personnel know only about ERP in terms of uses, not the technical aspects about ERP application. Therefore, they need help from consultants. Consultants, however, are not always the solution. In some cases, an organization wants to interface with a certain third-party application about which ERP consultants do not have knowledge. So far most consultants still lack knowledge about application integration technology.

## **4.2. INTEGRATION TECHNOLOGIES**

Currently many ERP vendors and third-party application vendors are adopting interface standards like COBRA, Microsoft's Component Object Model (COM), Object Linking and Embedding (OLE), Enterprise JavaBeans, and XML. However, those methodologies those employed for interfacing ERP systems with legacy systems/third-party applications can be grouped into data-oriented and application integration oriented approaches.

In a data-oriented approach, information moves in and out of ERP's relational databases to external applications or systems, which can be accomplished with database-oriented middleware products, message brokers, data migration software packages, or even with the replication and data link features in most popular relational databases.

It was found from the survey that most organizations that employ the data-orientation approach wrote code to move data from ERP to external applications. Employing this approach, programmers need to understand the details of database schema of both systems. The databases provide the best point of integration, as long as there is no need to access the business processes encapsulated within the application.

In an application integration oriented approach, the ERP application integrates with other applications by using well-defined application interfaces. The study revealed that organizations employing this approach enjoyed the benefit of middleware products rather than developing their own.

Many ERP and EAI vendors have released tools that can move data between ERP packages, on the basis of an understanding of the APIs and data mappings that are implemented by the ERP packages being linked together. This eliminates the need for customized coding to integrate the packages. However, not all packages are supported, and it is unclear who will be the eventual winners in this emerging product category.

## **5. CRITICAL FACTORS OF CONNECTIVITY THAT A COMPANY SHOULD CONSIDER**

### **5.1. CRITICAL FACTORS**

Based on the survey, the following are the critical factors of connectivity that a company should consider when implementing ERP.

- *Open/Closed System.* The nature of the system being connected and the existing system is important. If one the systems is closed, it is very difficult to interface or connect with other systems. Therefore, an organization should select an ERP application that is quite open and has various means of integration with other applications. This also applies to the selection of third-party applications.

- *Degree of Customization.* Whenever the processes represented in an ERP application differ significantly from the processes used by the organization, the following options can be performed by an organization. The options are to build the organizational process into the ERP software by customizing the ERP application or changing the organizational practice to suit the process native to the ERP application. Traditional common sense would force people to customize the application to meet the needs of the organization. However, too much customization will raise problems. The first problem arises out of the fact that any customization done locally is outside the core ERP application; then, the next release of the ERP application would not support local customization. Modifications would have to be redone by the end user for the new release. Secondly, by over-customizing, the implementers would lose the benefit of best practice in the industry which is embedded with ERP applications. According to the survey, organizations try to minimize customization by adjusting the business practices that can be changed. If an organization wants to replace any manual work with a computerized system, the functional modules that are provided with the ERP application are taken into consideration first, since the functional modules that come from the same application vendor possess a high degree of connectivity and integration.
- *Existing Infrastructure.* If a legacy system interfaces with an ERP system, the existing infrastructure (such as databases) plays a significant role, especially if the data-oriented approach is the choice of integration. If a legacy system is abandoned after an ERP system comes in, attributes of the existing system (such as databases) determine the degree of difficulty in data extraction and conversion. This is true if the database of the existing system is different from that of the ERP system. Problems resulting from not having the right infrastructure can result in poor system performance or unacceptable downtime at a time when users and management tend to have the highest expectations.
- *Similarity of system infrastructures.* This would result from the existing infrastructure of legacy systems and of ERP systems. From the study, it was found, however, that the infrastructure of the ERP system is always different from that of the legacy system. Many databases of legacy systems are in-house developed, and the database structure was not up to standard.
- *Standard of software employed.* The key to enabling different vendors' software packages to interoperate is industry-wide standards, both business and technical. If ERP vendors employ the same standard, it is possible and easy for one vendor's software component to replace another vendor's without forcing a new round of reengineering. Besides, there are more choices for third-party application selection if all ERP vendors employ the standard. Technical standards are necessary because there has to be a way for different vendors' packages to communicate with one another. Employing standards lessens and eases customization requirements and reduces implementation time for connecting third-party applications with the ERP system, and improves connectivity.
- *Security.* Security must be present as a service across all tiers of the ERP core infrastructure to obtain the necessary granularity expected of enterprise

applications. It is critical that data be exposed only to applications and users who have the proper credentials.

- *Third-party support.* Since organizations lack expertise in ERP systems, support from the vendors then is the major consideration. The level of support from third-party vendors depends on whether they are partners of the ERP applications or not. If they are, it reduces the problem of integration, updating and maintenance of the software. Troubleshooting service is another issue that should be considered when selecting third-party applications. Users need consultants to help them solve problems in a timely manner, with minimal interruption of their businesses. Furthermore, user training and documentation should be provided from third-party support.
- *Installation.* As mentioned earlier, the success of ERP implementation depends on more than just integrating it to other systems in the organization; it has to mirror the business of the organization. Installing an ERP system is not an easy task like installing Windows. The current state of the organization and its business processes have to be mapped to the ERP system. Data is extracted and transferred to the new system. Although it sounds simple, it is not at all easy. Implementation time is about one year as a minimum, and for some organizations it takes about two or three years. The way the ERP systems are configured will affect the way and choices ERP systems can interface with other systems, and how effective the flow of data between interconnected systems will be.

## *5.2. CRITERIA TO DETERMINE APPROPRIATE CONNECTIVITY*

The survey showed the interviewees' opinions towards the criteria that should be used to determine the appropriate level of connection:

- *Nature of business process of organization.* The most important criterion is the nature of the business process. The success in implementing an ERP system depends on how many of the business processes of the organization can be mirrored by an ERP system. To smooth the flow of information, the selected integration methodology should facilitate the businesses.
- *Availability of technologies and service support.* Before selecting the integration approach, an organization should study what technologies and support are available in local market and understand what is needed for the organization. Advantages and disadvantages should be weighed thoroughly. Organizations should choose the technology for which service support is locally present and ensure that the support technology is not outdated, since technology changes rapidly. Selecting a knowledgeable consultant can help the organization solve this issue.
- *Nature of information system of organization.* The information system of an ERP system includes hardware, operating system, database, and ERP application. The most important component when talking about integration issues is the database, if the organization chooses the database as a point of integration. The database of a system being integrated with ERP, like a legacy system, can come from the same vendor or different vendors, or even be databases that employ different data models. The solution, after weighing costs and benefits, may be database replication and data federation.

- *System flexibility.* The architecture and integration approach of an ERP system should be selected carefully since it becomes the IT backbone of organization. A system should be planned for future changes, such as more applications being connected to the ERP system, or the number users of ERP system increasing. Then, addition of more users and applications should not affect, or have a minimal effect on, the existing system. If many different types of applications will interface with the ERP system, the organization should choose the approach that is efficient for interfacing many different types of applications, such as an application integration oriented approach.
- *Degree of integration.* Although tight integration is an ideal solution, other factors like cost and budget may affect the decision about degree of integration. For example, it is cost-effective to choose a less tight integration approach for a system that does not require tight integration, like the human resource system. However, tight integration is appropriate for the system in which transactions occurring have a critical effect on other systems, such as material management and production planning.
- *Transaction volume.* Transaction volume determines the necessity of real-time processing. If the amount of data being transferred among ERP and other systems is low, it may not be worth the investment. Batch processing may be the option for this case. If the volume of information that needs to move from one application to another is low and is moving between two databases, it is generally easier to use some form of data-level integration tool.
- *Implementation cost.* Typically, costs involved in ERP implementation include cost of ERP application, cost of hardware (host and workstations), training cost, consulting cost, and maintenance cost. Actually, the cost of ERP is generally 30 percent of total cost of implementation. A user should examine needs and available technologies to estimate costs. A user may compare costs charged by each ERP consultant and choose the most cost-effective one.
- *Ease of maintenance.* Ease of maintenance should be taken into consideration when selecting approaches to integration, since the ERP system becomes the IT infrastructure for the organization. Although certain approaches may be easier to implement than others, the cost and effort to maintain it must be considered, because the system may last the life of the organization.
- *Implementation time.* Time to implement can range from one to five years or more. Time to implement the integration approach should be kept at a minimum because ERP involves the core activities of the organization.
- *Access control and data security.* Security must be present at all tiers of the ERP system (presentation, application, and database server). It is critical that data be exposed only to applications and users who have the proper credentials. Only authorized users may gain access to data, through identification codes and passwords. Authentication and encryption techniques should be provided in ERP network as well; they protect transmitted data from being disclosed and changed.
- *Budget.* Each integration approach has different costs and benefits. However, the selection of the appropriate integration approach should be considered on the basis of efficiency rather than cost. Money should not limit what is the

best for the organization. So the management should provide support in term of budget.

## 6. CONCLUSION

This study presents critical factors of connectivity that organizations should consider, as well as a framework to determine appropriate connectivity of ERP systems and legacy systems/third-party applications that will be used for making decisions on ERP implementation. To successfully interface ERP systems with legacy systems or third-party applications, eight important factors should be taken into consideration. These factors include open/closed system, degree of customization, existing infrastructure, similarity of system infrastructures, employment of standards, security, third-party support, and installation.

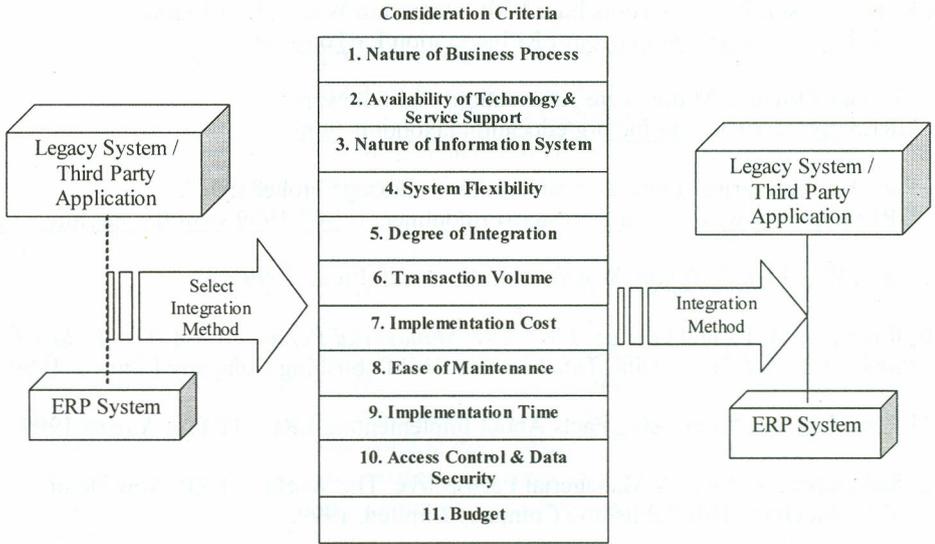


Figure 1: A Framework to Determine Appropriate Connectivity of ERP Systems

Figure 1 presents the framework for an organization to determine the appropriate connectivity of ERP systems and legacy systems/third-party applications. In the case of organizations start their computing systems by implementing ERP systems, selecting third-party applications that are partners of ERP vendors is the best solution for connectivity among systems. However this may not be possible for the organizations that have long-established computing systems in their organizations. Then, the criteria should be taken into consideration when analyzing the appropriate connectivity approach of ERP systems.

The results and conclusions of the study mainly concern intra-organizational connectivity of ERP systems. The further study of an ERP-to-ERP system, could focus on the selection of integration methodology that can eliminate the differences in ERP systems of business partners.

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