

## An ERP Life-cycle-based Research Agenda

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**Abstract.** Since the study of ERP systems is a new area, there is very little theoretical or empirical research on the topic. Limited studies have been conducted in the past, but now, due to the magnitude of the ERP phenomenon, the need for such studies has become very important. With regard to research on ERP-related topics, we have found a large scope of research issues and a great number of influencing variables, which we have here attempted to organize into a framework. Thus, this initial position paper sets out to list, define and categorize the research issues relating to ERP systems within an ERP life-cycle process framework. The framework is structured in phases and dimensions. The phases are the different stages of an ERP system life-cycle within an organization, and the dimensions are the different viewpoints by which the phases could be analyzed.

### 1 Introduction and Motivation

According to a recent study by International Data Corporation the enterprise resource planning services and training market is expected to grow at a rate equal to or greater than the software industry to which it caters [Weston, 1998]. AMR research Inc., the leading industry and market analysis organization specializing in enterprise enabling technologies, predicts that the enterprise resource planning (ERP) software market will grow at a compound annual growth rate of 37 % over the next five years [Caruso 1998]. This market will continue to be one of the largest, fastest growing, and most influential in the applications industry, and is poised for steady growth into the new millenium, says AMR. Nowadays, the ERP industry is one of the most promising ones, which contrasts with the obvious lack of related academical research.

Certainly, because the study of ERP systems is a such a new area, there is very little theoretical or empirical research on the topic. Limited studies have been conducted in the past, but now, due to the magnitude of the ERP phenomom, the need for such studies has become very important. This initial position paper sets out to list, define and categorize the research issues around ERP systems within an ERP life-cycle process.

The research framework is structured in dimensions and phases, generic enough to permit the classification of research issues and comprehensive enough to give a general vision of the whole ERP life-cycle. While the current topics of interests are mainly centered on ERP acquisition and implementation, our framework also covers post-implementation phases current reached by a limited number of organizations. Within each phase, each issue may be defined and analyzed according to the dimensions that make up the orthogonal part of our framework. However, the information contained in this paper is intended only to provide a general summary. It does not purport to be a complete description of the research issues. The research framework issues raised in this paper are intended for researchers and practitioners who are interested in looking at the impact of the ERP systems in organizations.

The rest of this paper is organized as follows. We present an overview of ERP issues in the next section. In section 3 we present our research framework. Based on the phases and dimensions of the framework, section 4 discusses the research issues arisen. Some conclusions and ideas about further work are included in section 5.

## **2 ERP Overview**

Typically, Enterprise Resource Planning (ERP) are software packages composed of several modules, such as human resources, sales, finance and production, providing cross-organization integration of data through imbedded business processes. These software packages can be customized to answer the specific needs of each organization.

Regarding the significant impact of ERP systems on industry, [Davenport 1998b] refers that “the business worlds embrace of enterprise systems may in fact be the most important development in the corporate use of information technology in the 1990s”. The market for people who can work with these systems, implement these systems, and understand how these systems transform organizations is very big, and growing [Watson & Schneider 1999].

ERP implementations usually involve broad organizational transformation processes, with significant implications on the organization's management model, structure, management style and culture, and particularly, on people [Caldas & Wood, 1999]. As [Davenport 1998a] mentions, ERP systems are not projects that someday will end, but rather, they are a way of life. They require a high degree of alignment between business strategies, information technology strategies and organizational processes [Gibson et al., 1999], in the same line [Henderson & Venkatraman, 1991] mentions for more general enterprise information systems. Change seems to be the main phenomenon associated with an ERP system. According to [Jarke & Pohl 1993], in order to deal with change effectively, one has to establish the change vision in the given technical, social, and organizational context.

The interest of the scientific community in the ERP field is evident according to the new panels and tracks that some scientific events dedicate to the subject, such as Hawaii International Conference on Systems Science (HICSS), Association for Information Systems (AIS), International Information Management Association (IIMA), and Workshop on Information Technologies and Systems (WITS), as well as the birth of the EMRPS'99 itself. The main vendors also promote professional and commercial conferences like ERPWORLD or SAPPHIRE. The amount and quality of academic literature available in this field is just beginning to develop.

We believe that organizations and vendors should play an important role in researching on ERPs, because this kind of research is amenable to be field-based rather than laboratory-based. Consultants also play an important role in the research of some issues; over the years, they have accumulated probably the richest ERP experiences through thousands of ERP installations worldwide.

All in all, we found a large scope of research issues and a great number of influencing variables, and here we have attempted to organize the research issues into a framework.

### 3 ERP Life-cycle Framework

We have mapped the research issues that can be analyzed in the ERP life-cycle process using the framework presented in Figure 1.

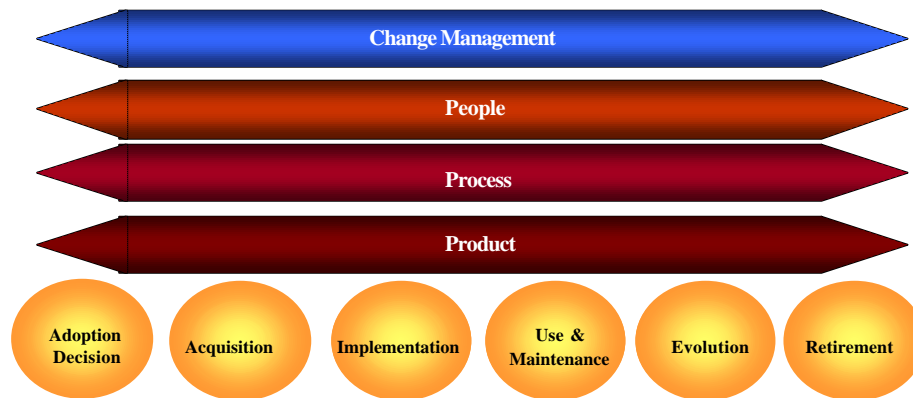


Fig. 1. The ERP life-cycle framework.

The framework is structured in phases and dimensions. Phases are the different stages of an ERP system life-cycle within an organization and dimensions are the different viewpoints by which the phases could be analyzed. We describe the dimensions and phases in the following sections. The dimensional vision of the framework presents a

set of related issues. For instance, the change management dimension embodies cultural issues, organizational structures, roles and skills, management of strategic change and business process re-engineering. Finally, we would like to focus on the issues discussed here, from the viewpoint of organizations but without forgetting the vendors' perspective. Issues relating to vertical markets, mid-market focus, componentization, data warehousing, business modelling, and technology changes or skills are important issues to vendors.

The research framework is flexible and generic in order to make possible the allocation of research issues and to give a general vision of the whole ERP life-cycle, without giving attention only to some aspects. Nowadays, the majority of problems focus only on the acquisition and the implementation phases, because the technology is new with few organizations in the post-implementation phases, but it is vital to form a general vision to prevent future problems. Each issue should be analyzed and defined according to the dimensions that make up the orthogonal part of our framework. This orthogonality should be made more explicit in future upgrades of this framework. This framework is useful for identifying the origins and impacts of change, and thus provides a way of identifying and characterizing research issues in ERP systems.

### 3.1 Phases of the ERP Life-cycle

The phases of the ERP life-cycle consist in the several stages that an ERP system goes through during its whole life within the hosting organization. They are the following: adoption decision phase, acquisition phase, implementation phase, use and maintenance phase, evolution phase and retirement phase. Next, we describe each phase.

1. **Adoption decision phase.** This phase is the one during which managers must question the need for a new ERP system while selecting the general information system approach that will best address the critical business challenges and improve the organizational strategy. This decision phase includes the definition of system requirements, its goals and benefits, and an analysis of the impact of adoption at a business and organizational level.
2. **Acquisition phase.** This phase consists of the product selection that best fits the requirements of the organization. Thus, minimizing the need for customization. A consulting company is also selected to help in the next phases of the ERP life-cycle especially in the implementation phase. Factors such as price, training and maintenance services are analyzed and, the contractual agreement is defined. In this phase, it is also important to make an analysis of the return on investment of the selected product.

3. **Implementation phase.** This phase consists of the customization or parameterization and adaptation of the ERP package acquired according to the needs of the organization. Usually this task is made with the help of consultants who provide implementation methodologies, know-how and training.
4. **Use and maintenance phase.** This phase consists of the use of the product in a way that returns expected benefits and minimizes disruption. During this phase, one must be aware of the aspects related to functionality, usability and adequacy to the organizational and business processes. Once a system is implemented, it must be maintained, because malfunctions have to be corrected, special optimization requests have to be met, and general systems improvements have to be made.
5. **Evolution phase.** This phase corresponds to the integration of more capabilities into the ERP system, providing new benefits, such as advanced planning and scheduling, supply-chain management, customer relationship management, workflow, and expanding the frontiers to external collaboration with other partners.
6. **Retirement phase.** This phase corresponds to the stage when with the appearance of new technologies or the inadequacy of the ERP system or approach to the business needs, managers decide if they will substitute the ERP software with other information system approach more adequate to the organizational needs of the moment.

### 3.2 Dimensions of the ERP Life-cycle

We defined four areas of concern or viewpoints by which the different phases of the life-cycle should be analyzed: product, process, people and change management.

1. **Product.** This dimension focuses on aspects related to the particular ERP product in consideration, such as functionality, and on related technical aspects, such as hardware and base software needs. A thorough understanding of the software tool's capabilities must exist in order to make an alignment with the business strategy in order to determine whether the software is being used effectively, in accordance with the needs of the organization, and how it can best be applied to further the goals of the organization.
2. **Process.** Each organization has its own core capabilities and functionality that must be supported by an ERP system. Also, an ERP system must help the decision-making required to manage the resources and functions of the organization. Usually, the main ERP investment focus is on re-engineering processes to enable the organization to adapt to the new business models and functional requirements of the ERP system in order to achieve better performance.
3. **People.** This dimension refers to the human resources and their skills and roles in an ERP system life-cycle. These skills and roles must be developed to minimize

the impact of the introduction and diffusion of an ERP system, in order to reduce risk and manage complexity, while facilitating organizational change. Dealing with contingencies, changing practices, and adapting to a new organizational structure and culture are some aspects that must be learned.

4. **Change management.** This dimension refers to the body of knowledge that is used to ensure that a complex change, like that associated with a big system, gets the right results, in the right timeframe, at the right costs [Holland & Davis, 1998]. The change management approach tries to ensure the acceptance and readiness of the new system, allowing the organization to get the benefits of its use.

## 4 Research Issues within the Framework

In this section we provide a preliminary list of the research issues classified according to the above ERP life-cycle phases. The list is not intended to be exhaustive, and we tried to focus on the major issues that we found. For each phase we present a summary table and then a brief description, where we have sometimes related the issues with the above dimensions.

### 1. Adoption decision phase research issues:

• Kind of solution	– Bespoke application development – Best-of-breed integration – ERP package
• Requirements definition	

The research issues here are related to the “why” of a new solution for the information system of the organization, and the kind of solution that best fits the needs of the organization. The definition of the requirements, goals and benefits of the new solution are important aspects of this phase.

Managers have to decide what kind of enterprise information system they want for their organizations. [Reda 1998] mentions that "unlike integrating a new software program or adding on a new piece of hardware, the decision to implement an ERP system triggers change across the enterprise, including how a organization is managed, how its internal divisions interact and how it responds to the marketplace". This decision will have impact on the business and organizational processes and, in most cases, on the organization strategy.

Currently, general information systems approaches considered by organizations are: developing a bespoke proprietary system; integrating best-of-breed packages; and implementing an ERP package. The decision should be analyzed from the viewpoint

of the four dimensions of our framework and not only from economical or technical perspectives.

## 2. Acquisition phase research issues:

• Product selection	– Selection methods – Functionality vs technology – Critical factors of selection – Sizing models
• Consultant selection	– Critical factors of selection – Selection methods – Roles
• Contractual agreement	– Price model – Services included
• Return on investment	– Critical factors – ROI methodologies

The research issues in the acquisition phase focus on the selection of both the product and a consultant. Implementation consultants can help an organization to make the right decisions in setting up an ERP system. They also help to determine where the ERP system does not supply the organization's needs and help to customize ERP functionalities to meet them.

There is a lack of studies about the critical factors and methodologies that could help this process (see [Sistach et al. 1999] for a first attempt). Other relevant issues are: the definition of the role of each party (vendor, customer and consultant), the contractual agreement, the different price models, and the analysis of returns on the investment.

Another important issue is the definition of the hardware and base software needs associated to the ERP system. Usually, vendors offer their sizing models, but there are not many guarantees of their reliability [Marion 1998]. The product selection is one issue that should be related with the four dimensions of our framework. Thus, we have the technical aspects (the product dimension) about the software and software requirements but also functionality (the people and process dimensions). Finally the change management dimension that corresponds to the impact of the new system in the organization.

## 3. Implementation phase research issues:

<ul style="list-style-type: none"> <li>• Methodologies</li> </ul>	<ul style="list-style-type: none"> <li>– Methodology selection</li> <li>– Implementation strategy</li> <li>– Modular approach vs Big Bang</li> <li>– Critical factors of selection</li> </ul>
<ul style="list-style-type: none"> <li>• Time period implementation</li> </ul>	<ul style="list-style-type: none"> <li>– Rapid implementation</li> <li>– Large implementation</li> <li>– Advantages and disadvantages</li> </ul>
<ul style="list-style-type: none"> <li>• Project team</li> </ul>	<ul style="list-style-type: none"> <li>– Roles and skills</li> <li>– Structure of the team</li> </ul>
<ul style="list-style-type: none"> <li>• Training</li> </ul>	<ul style="list-style-type: none"> <li>– Scope of training</li> <li>– Cost</li> <li>– Training methods</li> </ul>
<ul style="list-style-type: none"> <li>• Adaptation and data conversion</li> </ul>	<ul style="list-style-type: none"> <li>– Software adaptation</li> <li>– Data transfer</li> <li>– Link to other systems</li> </ul>
<ul style="list-style-type: none"> <li>• Risk management</li> </ul>	<ul style="list-style-type: none"> <li>– Success vs failure</li> <li>– Critical factors</li> <li>– Risk management methodologies</li> </ul>

This is one of the most critical phases of the ERP life-cycle scheme. Implementing an ERP system requires resources to install software and hardware, modelling business processes, train users, connect to legacy systems and convert data from other systems. Most of the time, these tasks are made with the help of consultants, helping in the implementation methodology selection that must be adequate to the binomial product-organization. [Kirchmer 1999] refers that the implementation of ERP systems ties up substantial corporate resources for a relatively long period of time, sometimes years, and an organization can not afford to suffer a total project failure. Efficient and effective planning and execution of the implementation project will obviously improve chances of success. Furthermore, a head start over the competition can become an important factor in achieving competitive advantage, says Kirchmer.

Typically, an implementation methodology has a project preparation, a business overview, realization and final preparation. The time implementation period and the project team are critical factors related with this phase. One of the features in ERP systems is their customization to the user needs because ERP systems are developed to meet the common demand of many enterprises [Huang 1999]. Thus, the main task within the implementation phase is the adaptation of the ERP software to the specific requirements of the hosting organization. Sometimes, the adaptation works the other way around, with organizational business processes being adapted to the ERP standard functionalities. During or after software adaptation the task of training starts. Although training will be a continuous activity during the life-cycle process, in this

phase it is all the more relevant because of the necessity of training technical users. The final step is the software configuration and data conversion and the links to other systems.

In this phase the risk management associated is analyzed. Although the issue of risk management is important in all the phases of the life-cycle (related with the change management dimension), its analysis is crucial in the beginning of this phase for the next implementation steps. [Holland & Davis 1998] says that the basis for a successful implementation is the management of technical, business and organizational risks. Technical risks (related with the product dimension) are related with questions like: Will the system work properly, according to requirements?, Will it be finished on time?, Will it come in on budget? Business risks (related with the process dimension) is the chance the system will not pay off in money and purpose for the implementing organization. One of the factors that can cause the failure of the implementation process is the lack of alignment between imbedded processes and organizational business goals and priorities. Organizational risks (related with the people and change management dimensions) is the chance the organization will not use the full potential of the new system.

#### 4. Use and maintenance phase research issues:

<ul style="list-style-type: none"><li>• Functionality</li><li>• Usability</li></ul>	<ul style="list-style-type: none"><li>– Measurement of performance</li><li>– Human computer interaction</li></ul>
<ul style="list-style-type: none"><li>• Maintenance</li></ul>	<ul style="list-style-type: none"><li>– Infrastructure management support</li><li>– Upgrade management</li><li>– Network resource planning (NRP)</li></ul>
<ul style="list-style-type: none"><li>• Maintenance outsourcing</li></ul>	<ul style="list-style-type: none"><li>– Critical factors</li><li>– Outsourcing services</li><li>– Outsourcing models</li></ul>

During and after the ERP system implementation, organizations try to integrate the system in its daily activities through ERP use and maintenance. Managers want to see the expected results of the investments made in the new system. The issues related to the use and maintenance of ERP systems arise. Issues related to usability, performance measurements, infrastructure management support, upgrading systems and network resource planning are very important in this phase. [Hayes 1998] refers that managers who make ERP systems the backbone of their corporate computing environments are finding that it affects all the other technical decisions. For example, getting peripheral systems to interact with the main ERP system can be difficult (the product dimension) and, the interfaces should be user-friendly (the people and change management dimension). To minimize the lack of expertise and to reduce costs, organizations may use maintenance outsourcing. There is a need of studying the outsourcing models and their critical factors.

#### 5. Evolution phase research issues:

<ul style="list-style-type: none"> <li>• Extended applications</li> </ul>	<ul style="list-style-type: none"> <li>– Supply chain management</li> <li>– Advanced planning and scheduling</li> <li>– Customer relationship management</li> <li>– Business intelligence</li> <li>– Strategic management</li> <li>– Business to business</li> <li>– Workflow</li> </ul>
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Despite the effort of ERP vendors to expand the functionality of their products, ERP packages still do not do everything that organizations need. [Stein 1998] refers that organizations are "extending ERP systems to provide better business value, with tighter collaboration with customers, suppliers, and ultimately end users, both domestically and globally". The notion of "extended ERP" is gaining momentum. Many vendors are now selling the idea of the need to increase the traditional capabilities of ERP systems with new applications, such as supply-chain management, advanced planning and scheduling, customer relationship management, and business intelligence.

One of the main weaknesses of the E-R-P equation lays in the narrow "P" (planning) functionality of current products. Andre Zoltan [in Whealthey 1998] criticizes the term ERP as unfortunate because it induces "people to expect that the system will be doing more enterprise resource planning that it really does". To mitigate that problem vendors are just starting to include some more advanced planning and scheduling applications as well as strategic management functionalities.

#### 6. Retirement phase research issues:

<ul style="list-style-type: none"> <li>• Kind of application</li> <li>• Cost analysis</li> <li>• Factors of the "Why" retirement</li> <li>• "When" abandon the ERP system</li> <li>• Technology trends</li> </ul>	<ul style="list-style-type: none"> <li>– Old proprietary systems</li> <li>– New ERP system</li> </ul>
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Now, the majority of organizations are in the implementation or in the use and maintenance phases. However, there are already cases of organizations that for various reasons have abandoned their ERP implementation projects and are rapidly returning to their proprietary systems. Some other organizations have changed from an ERP product to a different one in the middle of the implementation phase. This last situation takes back the organization to the adoption decision phase of our framework. The retirement phase is especially related with the change management dimension.

## 5 Conclusions and Further Work

The information contained in this paper is intended only to provide a general summary. It does not purport to be a complete description of the research issues. Even if this paper may only be considered as a first attempt to set up a life-cycle-based framework for classifying research issues, we may already emphasize some learning points:

1. ERP systems are more than a new information technology. They are more business-process-oriented than technology-oriented. As [Davenport 1998] says, an ERP is not a project, it is a way of life.
2. Until now, the majority of research on ERP systems has been made by vendors or consultants, and neither of them may be assumed to be always neutral in their conclusions.
3. With experience in researching in many other types of information systems, the information systems scientific community can improve or help organizations in all the phases of the ERP life-cycle, providing answers to some of the issues found.
4. The future of ERP systems is not defined, but ERP systems are expected to be present in the market for many years to come, because of the investment effort made in the last years on these systems.

Our long-term research objective is to identify those research issues that occur in ERP systems, and then map them in the research framework, perhaps with more detail related to the dimensions we found. The issues must be defined with the viewpoints of consultants, vendors and academics. The research focus should be on capturing the knowledge of ERP practioners, vendors and consultants. This study intends to focus the research issues in an organizational context. Therefore, both quantitative and qualitative research approaches seem to be promising and beneficial.

Ultimately, we hope to get information about research teams that develop each one of the topics presented. ERP systems offer many potential areas for research, several of which have been discussed in this paper. The research framework issues raised in this paper are intended for researchers and practioners who are interested in looking at the impact of the ERP systems in organizations.

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