

An Integrated Methodology for Implementing ERP Systems

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Abstract

In rapidly changing business environments, enterprise information systems have played a critical role in helping business gain competitive edges. But pursuing optimization at each system level has limitations when optimizing the whole system from an enterprise perspective. Enterprise resources planning (ERP) systems, introduced for solving these problems, integrate all core business systems and aim at system optimization at the enterprise level. Because ERP systems influence all business processes of an enterprise, a systematic implementation methodology is a critical factor for successful implementation of ERP systems.

This paper investigates ERP development methodology based on literature, experience, and the results of interviews with ERP developers. We review the related methodologies: software engineering (SE), information engineering (IE), and strategic information systems planning (SISP). We then propose an ERP implementation methodology which reflects additional considerations such as strategic redesign of processes and system implementation procedures with package applications. In this paper, we explore the definition of ERP, its major benefits, disadvantages, critical success factors, failures, and points to be considered when planning an ERP project. The seven-stage development process proposed, includes tasks, subtasks, deliverables and guidelines, and provides ERP developers with a helpful ERP development guideline.

1. Introduction

Enterprises are currently confronted with fundamental changes in their overall industrial framework. Worldwide competition, short innovation cycles, and high costs are compelling companies to structure business operations efficiently and effectively. In the 1990s, information technology and business process reengineering, used in conjunction with each other, have emerged as important tools which give organizations a leading edge. Enterprise-wide information management plays a decisive role in this process [11].

To survive in the highly competitive market, companies must pay particular attention to the following tasks:

- Optimization of all business processes along an entire enterprise value stream
- Use of the most modern data processing technology for optimization of enterprise-wide information management.

To achieve these tasks, many companies have already implemented or are implementing ERP(Enterprise Resource Planning) systems. As the ERP systems influence both the entire company's information system and business processes, CEOs should investigate ERP systems carefully and design a systematic implementation methodology before implementing any ERP system. This paper suggests a development methodology different from vendors' methodologies by comparing and reorganizing different kinds of methodologies.

This paper is organized as follows. Section 2 presents the evolution, definition and characteristics of ERP. Section 3 provides literature reviews various development methodologies such as Software Engineering, Strategic Information System Planning, and Information Engineering. In section 4, ERP methodology is suggested and explained. The final section discusses the results reached in this study and future research issues.

2. Basic concepts of ERP

2.1 History of ERP

The focus of manufacturing systems in the 1960s was on inventory control. Most of the software packages then were designed to handle inventory based on traditional inventory concepts. In the 1970s the focus shifted to MRP (Material Requirement Planning) systems, which take a product schedule as input and generate work and purchase orders as output [10]. In the 1980's MRP expanded from the mere management of materials to plant, personnel and distribution planning, now becoming MRP-II (Manufacturing Resource Planning).

Not all business processes needed IT support, but some did, hence MRPII systems supported a broader range of business processes than MRP. MRPII systems became so wide in scope that eventually they developed towards giving IT support to all parts of a manufacturing company. This is when the term ERP came into use to signify its enterprise-wide scope.

2.2 Definition of ERP

There are two common definitions of ERP:

1. ERP is an accounting-oriented information system for identifying and planning the enterprise-wide resources needed to take, make, ship, and account for customer orders. **(American Production & Inventory Control Society)**
2. ERP is a set of applications designed to bring business functions into balance, representing the next generation of business systems. **(Gartner Group)**

ERP packages (simply often called ERP), are integrated software packages that support the above ERP concepts. Originally, ERP packages were targeted at the manufacturing industry, and mainly consisted of functions for generally planning and managing core business functions such as sales management, production management, accounting and financial affairs, etc. However, in recent years, adaptation not only to the manufacturing industry, but also to diverse types of industry has become possible, and the expansion of implementation and use has been progressing on a global level. Nowadays, it is even said that the success of BPR (Business Process Re-Engineering) depends on the success of using ERP.

2.3 ERP benefits

There are many advantages to be gained by an enterprise upon implementing ERP [3]. One of the special features is "Integration". The most important reason why ERP packages are called integrated, is the automatic data update (automatic data exchange among applications), between related business components. Integration can be achieved through an integrated database, which stores all kinds of data generated within an enterprise. Since conventional company information systems are aimed at the optimization of independent business functions in business units, almost all are weak in terms of the communication and integration of information.

The second special feature is the system's "Adaptation to Globalization". With this feature multinational environments such as multiple languages, currencies, and accounting standards, can be covered by one system. This function is essential in coping with company globalization and system unification.

The third feature is the "Boosting of Planning-type Functions". By enabling the comprehensive and unified management of related businesses and their data, it becomes possible to fully utilize many types of decision-making support functions and simulation functions. Furthermore, since it becomes capable of flexibly carrying out filing and analysis of data from a variety of dimensions in real time, one is able to feed back results to more highly-precise planning.

Finally, "Utilization of the Latest Information Technology" is another feature that might be considered. A significant feature of open systems/client server technology, such as the Internet and CALS (Commerce At Light Speed) can be adapted to the system by upgrading the module of an ERP vendor.

The benefits gained by an enterprise on account of implementing ERP packages are [9]:

- ERP improves timeliness of information by permitting daily posting instead of monthly posting.
- ERP helps to achieve competitive advantages by improving business processes.
- ERP provides a unified customer database usable by all applications.
- ERP improves international operations by supporting a variety of tax structures, invoicing schemes, multiple

currencies, multiple period accounting and multiple languages.

- ERP improves information access and management throughout the enterprise.

2.4 Disadvantages of ERP

Although there are many advantages of an ERP system, there are still some disadvantages. For example, cost is a very important issue for an organization to consider when implementing ERP systems. The high costs of implementing an ERP system are so prohibitive that they would be out of reach for many small businesses. Another disadvantage would be the security breaches within the system. It is difficult to find out who has the access to the system and who can change the information within the system. Moreover, for a business, time is a valuable resource. Since an ERP system does not take a short time to implement, it may slow down the routine operations within organizations while implementing. Now, there may be a problem for those who have not been trained with the skills necessary to work with an ERP system. This is a problem which affects an organization as a whole, and many organizations have already begun to design some employee retraining programs. Since implementing an ERP system really takes much effort and resources, it is recommended that the company considers critical success factors and pitfalls before implementing an ERP system. In the future, more and more businesses will be using ERP systems to help them manage important parts of their business.

3. Proposed methodology framework

We have reviewed the related methodologies in the previous section. In this section, we propose an ERP implementation methodology which reflects the additional considerations such as strategic redesign of processes and system implementation procedures with package applications. The Simplified components of a general methodology for system development are shown in Figure 1 [4]. The scope of the proposed methodology, including phases, tasks, subtasks, deliverables and guidelines, is also represented in Figure 1.

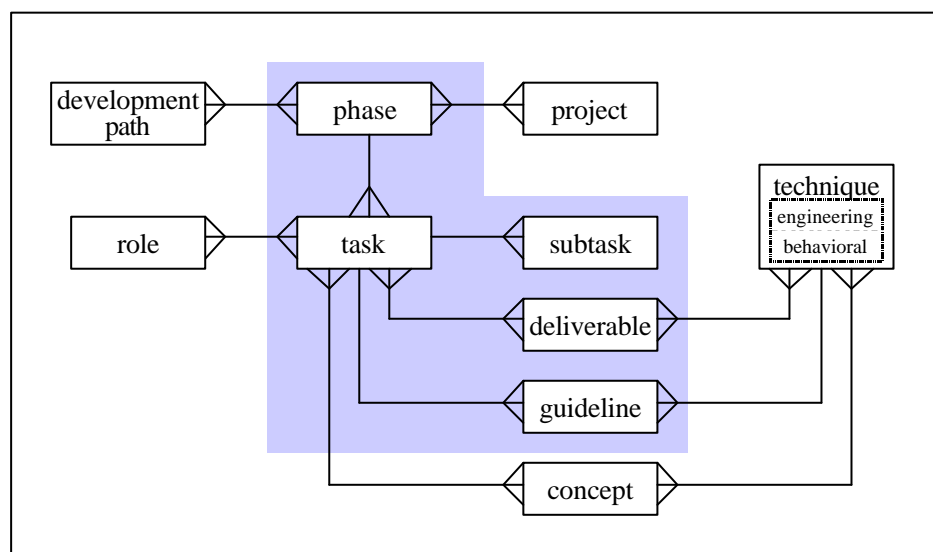


Figure 1. Entity relationship diagram representing components of the methodology

A proposed methodology is primarily based on the classical methodologies: software engineering, information engineering, and strategic information systems planning.

Software engineering encompasses a set of three key elements – methods, tools, and procedures – that enable managers to control the process of software development and provide practitioners with a foundation for building high-quality software in a productive manner [5]. Information Engineering was proposed by James Martin to develop integrated systems which support real business needs defined by the objectives and strategies of the business, and to deliver information systems which meet the needs of the business at the time delivery but in a framework which allows flexibility for future change. The purpose of Information Engineering is to develop integrated systems that support real business needs defined by the objectives and strategies of the business [2]. Strategic Information Systems Planning (SISP) methodology proposed by Jennifer Rowley consists of seven key

sub-processes which underline the importance of designing information systems against an assessment of corporate strategy [7]. SISP methodologies offer a supremely structured approach for carrying out the Information Systems Planning process in a short time with maximum strategic and technological effectiveness [6].

Software engineering is the methodology which can be applied to the general system development environment. The basic skeleton of the proposed methodology is derived from SE excluding the design phase. As ERP system development premise a package employment, we do not emphasize design tasks in ERP system relatively. We have reflected the strategic planning concept of information engineering and strategic information systems planning because ERP systems are applied to the main systems of corporations and need enterprise-wide process reengineering. Finally, we have referred to the package enabled reengineering (PER) methodology and Accelerated SAP (ASAP) methodology suggested by SAP, ERP vendor. This can be represented as in Figure 2.

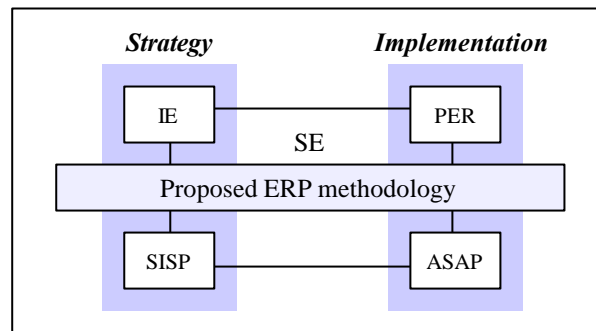


Figure 2. Framework of the proposed methodology

4. A seven-stage ERP implementation process

The Proposed methodology consists of the following seven phases: project preparation, business strategy planning, requirements analysis, implementation, migration, production, extension.

Figure 3 shows a proposed ERP development process.

4.1 Project preparation

The purpose of this phase is to provide the initial planning and preparation for the project. In this phase, there are important issues to be addressed, including project goals and objectives, the scope of project, the overall project schedule and its implementation sequence, the project organization, and resources. By addressing these issues early in this phase, the project can proceed efficiently, and a solid foundation for a successful implementation can be established. Deliverables are described in the parenthesis of each task.

This phase consists of the following tasks:

- **Establish the scope of the system (project scope)**

This task defines the scope of the system to be implemented. To clarify the scope at the beginning of the project becomes a critical success factor of the project. In this task, the role of each component in a system and the boundary to the external environment are defined.

- **Analyze risks and allocate resources (resource assignment)**

As enterprise-wide processes in a corporation are reorganized according to the ERP package in the ERP project, sufficient pre-consideration, especially risk analysis, is necessary. This task defines the specific resources planned for the project including hardware, development tools, package application, communication utility, and development staff.

- **Estimate costs (project budget plan)**

A budget plan for the project is established in this task. It is important to budget all of the expenses likely to occur so that management can properly plan for the required funding.

- **Define work tasks and schedule (project schedule)**

This task defines activities, tasks, and deliverables for each phase in a proceeding a project. The plan can be regularly revised, if necessary, at a later date. However, it is important to start with a solid, well prepared project plan, and to communicate this plan to the project team.

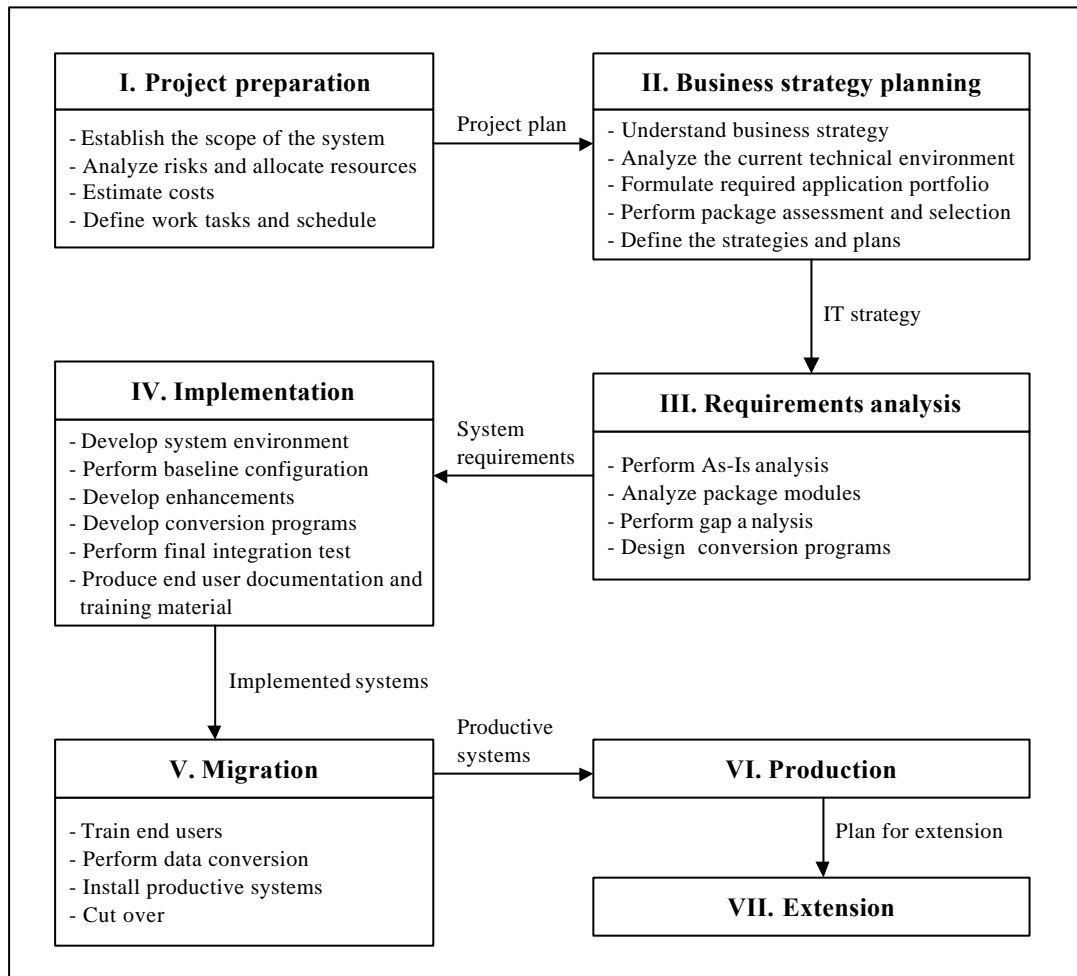


Figure 3. Proposed seven-stage ERP implementation process

4.2 Business strategy planning

ERP does not support the specific area in a corporation. Because it needs reengineering of all processes in a corporation, a more strategic approach than the one in the general system development is needed. In other words, establishing an information system strategy at the enterprise level is necessary. It needs to answer the following three questions:

- What position is the corporation taking as of now?
- What position would it like to take in the future?
- What path should it take to reach the objective?

Business strategy planning consists of the following five tasks:

- **Understand business strategy (business strategy)**

The purpose of this task is to identify the business strategy and information needs of the company. An Information system strategy must be established based on the business strategy. To fully understand the business strategy of the enterprise becomes the basis of establishing a consistent information strategy, determining future information needs of the enterprise and supporting the future business needs. Sometimes the business strategy is explicitly specified, in other cases the project team must derive business strategy from interviews with top management.

- **Analyze the current technical environment (technical environment)**

The current technical environment of the enterprise is analyzed in this task. It results in supporting decision making when applying ERP system. The scope of the analysis includes hardware/software facilities and all required components such as communication facilities, office automation facilities, and data storage facilities. Assessing the current environment is important in establishing the future technical strategy.

- **Formulate required application portfolio (application portfolio)**

Strategic planning of information systems involves more than merely project development plans. It requires an architectural framework into which separate systems built by separate organization fit. It is desirable that these separate building blocks of a computerized enterprise fit together. In this step, the overall corporate application portfolio is set up by using a structured top-down approach.

- **Perform package assessment and selection [1] (selected package)**

As most ERP systems are implemented by applying a package rather than in-house development, it is essential to evaluate and select an appropriate ERP package. The company determines the package evaluation criteria and selects the most suitable package using the determined criteria. The company needs to analyze how the package cope with the future change of business environment by investigating the functions of each package and the future trends of ERP packages. Supporting ability and service level are also important evaluation factors.

- **Define the strategies and plans (strategies and plans)**

Based on the analysis of business strategies and IT opportunities, the information systems strategies are established within this task. A master plan for developing the future information system is also established in this task.

4.3 Requirements analysis

In most system development projects, requirement analysis is the phase in which data and process requirements are identified and more detail analysis is performed. In ERP projects, however, we identify current processes and analyze gaps against processes supported by the ERP package. Then we define the final processes to be implemented. Gap analysis identifies the requirements of additional development and analyzes functionalities in detail. In this phase, the process redesign task and package implementation task are performed in parallel. Through understanding and diagnosing the current processes from a customer viewpoint, problems are revealed. Based on these results, designing new processes and mapping To-Be processes into the package module are performed. Requirements analysis consists of the following four tasks:

- **Perform As-Is analysis (results of As-Is analysis)**

This task analyzes the current processes of an enterprise. The result of As-Is analysis becomes the starting point of making a To-Be process model. In this task, we focus on the limitations, problems, and additional requirements of the business processes supported by the current system. Subtasks to be performed are as follows:

- Process hierarchy analysis: Classify all processes in the enterprise into process categories and decompose them into sub-processes until each process cannot be broken down any more. A process hierarchy diagram can help us to understand enterprise-wide processes.
- Process map analysis: Identify process flows, across organizations, from receiving customer requests to providing the results to customers.
- Process description: Create a process profile, including process definition, input/output data, processing mechanism, and related systems.
- Refine the results of process analysis. Review the process hierarchy diagram, process map and process description with users and then refine the results of process analysis and finally obtain the approval of the results.

- **Analyze package modules (package module description)**

This task identifies the main functionalities and supporting processes of each module of the package to be employed. We analyze all functions and processes included in the package based on identified value chains. Test cases may be created if necessary. Main areas such as manufacturing, finance, human resources, supply chain planning, and project management are covered within this task. We identify company-specific parameters, such as titles of account, product codes and department codes, as well as global parameters, such as countries, currencies and units of measurement. These are critical for the configuration of processes.

- **Gap analysis (results of gap analysis)**

The purpose of this task is to identify gaps between the As-Is model and processes supported by the package and to create a To-Be model. The To-Be model includes the requirements of additional development such as extended functionality, enhancements, interface requirements and reporting requirements. The following three subtasks are to be performed:

- Determine the need for extended functionality: Address any unique considerations about each business process in relation to special functions within the system.
- Determine required interfaces: Identify all required interfaces, and develop a conceptual design. This should include interfaces to legacy systems that will be maintained.
- Make a To-Be model: Create future required process model based on the results of As-Is analysis and that of the package module analysis.

- **Design conversion programs (conversion procedure)**

The purpose of this task is to identify all data conversion requirements. Some data from existing legacy systems must be converted into the new system, and it is needed to identify both manual and automated conversions. The followings should be considered:

1. Determine if this specific process requires data to be transferred.
2. Identify what data needs to be transferred.
3. Design a conversion procedure.

4.4 Implementation

ERP systems are implemented using the results of the requirements analysis in the previous phase. This phase is relatively dependent on the selected ERP package. In this phase, parameter setting, enhancements and conversion programs development, and end use documentation are performed.

- **Develop system environment**

The purpose of this task is to install and technically configure the development systems. Within this task, system administration procedures for the development system should be defined and tested.

- **Perform baseline configuration [8] (baseline configuration)**

The purpose of this task is to configure and confirm settings from the baseline for scenarios, processes, and functions. During baseline configuration, work on processes that can be configured without programming or enhancements.

- **Develop enhancements [8] (enhancements)**

The purpose of this task is to develop additional functions outlined in the requirements analysis. We can enhance standard package functions. Each enhancement requires maintenance procedures, which can impact system performance. We must ensure that enhancement programs are complete and accurate. We develop enhancement programs and then test and migrate them.

- **Develop conversion programs (conversion programs)**

This task contains activities to create programs and manual procedures for transferring data from the company legacy systems to ERP package. We must ensure that data conversion is complete, accurate, and in place to support final integration testing. Conversion procedures are created and then conversion programs are tested and migrated.

- **Final integration test (test results)**

The final integration test is planned and executed. This is important for the functional verification of productive systems. The test includes verification of dependencies of business processes on the value chain, interfaces, reporting functions, and enhancements. Remote locations should be included in the test.

- **End user documentation and training material (end user document)**

The purpose of this task is to develop user documentation and training for system operation. This task consists of the following subtasks: prepare a user documentation development plan, create user documentation, develop user training materials, and prepare for user training.

4.5 Migration

During the migration phase, the following activities need to be done: set up the production procedures, install the production system environment, perform data conversion, implement the new system in production, and review the system installation. Deliverables of this phase are productive systems.

- **End user training**

The purpose of this task is to ensure that all users are adequately trained before the go live date. Training must reflect the scope of the package implementation and the needs of the individual user. User training must include

general package training, as well as company-specific package training, based upon one's own business processes.

- **Data conversion (productive systems)**

Systems are needed for automatic conversion of data and for manual entry of those data which cannot be converted automatically. These systems should be carefully tested and reviewed with the end user. Tests need to be designed to ensure that the converted data works well with the new application programs. In this task, we execute the data conversion program, load existing data into the system's database, test the data loading and conversion to verify data quality, and review the results to ensure that the acceptance test criteria are met.

- **Productive system installation (installed systems)**

The purpose of this task is to install and deliver the final system for end users to use:

- Install the final system. Install and deliver ERP at sites.
- Tune the system. The installed ERP system should be evaluated, with the intent of improving its performance where necessary, ensuring the best user acceptance, and optimizing the system functionality.

- **Cut over**

The purpose of this task is to obtain final approval from the steering committee for the system to go live. All preparations for the technical, application, and organizational aspects of the project are ready for live business operations. Cut Over to Production System and final approval for going live are performed.

4.6 Production

The purpose of this phase is to move from a development environment to a live productive operation. During this phase, users of ERP systems may encounter many problems. There must be an operation staff support organization easily accessible to all users. This phase is also used to monitor system transactions and to optimize overall system performance. Finally, the completed project is closed.

4.7 Extension

The purpose of this phase is to plan extension of ERP for the future. Over time, the original environment for which the software was developed is likely to change. Adaptive maintenance results in modification to the software to accommodate changes to its external environment. As software is used, the user will recognize additional functions that will provide benefit. Continuous maintenance extends the software beyond its original function requirements.

5. Conclusions

The more severe the world-wide competition is, the more decisive role an information system plays in an enterprise. The recent trend in implementing information system is constructing an ERP system to gain an enterprise-wide optimized information system. However, there is no systematic methodology reflecting the characteristics of ERP systems as stated in the early part of the paper.

In this paper, we have discussed the general concepts of ERP and reviewed related methodologies: strategic information systems planning, software engineering, and information engineering. We have suggested a guideline that ERP developers should consider when implementing an ERP system. As a result of this research, ERP developers will be provided with a systematic development methodology. Utilizing the proposed methodology, they are also able to avoid some hidden pitfalls as well as failure cases at the same time. We have described seven stages of ERP development process and their activities as useful guidelines for building an ERP system. The seven-stage development process may provide ERP developers with useful solutions because no development standards have so far been accepted as development methodology for an ERP.

In the future it is expected that enterprise information systems will be integrated with the internet. When an information system is implemented with the internet, it can have many benefits - uniform interface, rapid reflection of advanced information technology, and world-wide accessibility. Many vendors are already preparing for the internet-based ERP system. So further research is required on a specified development methodology considering the internet-based ERP system.

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