

# Conceptual Framework for Evaluating the Effectiveness of the Implementation of Enterprise Resource Planning Systems in Small and Medium-Sized Enterprises

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## Summary:

The paper is concerned with problems arising in the implementation process of ERP systems including the risks of severe loss of time, investment and customer interest resulting from unsuccessful ERP implementations. The research problem of effectiveness calculation is outlined. A conceptual framework is proposed for calculating in advance the effectiveness of the possible implementation of an ERP system. The problem is decomposed in two major parts and indicators that can measure the effectiveness of an ERP implementation process are discussed.

**Key words:** ERP, implementation process, effectiveness calculation

**JEL Classification:** 030

## 1. Introduction

The enterprise resource planning (ERP) systems are related to the class of business software systems which are characterized by high complexity and whose design is based on the best business

practices [6]. Presumably these systems are built on a modular basis with a common database and they have to cover the whole enterprise i.e., on the one hand they manage supplies, production, sales, finance and accounting, etc., and on the other hand they provide an integrated and direct access to information flows in real time.

The development and implementation of software applications and the study of ERP systems in general is a difficult and responsible task [2]. The success of future work with the system to a great extent depends on the successful selection of modules for deployment and the process of the deployment itself.

The theory and practice of ERP do not provide a uniform approach for determining the sequence of implementation of the various possible components (particular modules) of the system and even more for accurately measuring of the success of this process. Moreover, unsuccessful attempts to implement ERP systems are reported, followed by severe loss of time, investment and customer interest. It is well-known that the implementation procedure is highly dependent on the specifics of the business processes in enterprises. They in turn are determined by

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the economic environment of operation; the characteristics of the industry and the branch; of the qualifications, skills and competence of employees, and other macroeconomic characteristics. To this variety of factors the strictly specific business organization of a company should be added that may be an additional aspect complicating the ERP implementation process [3, 4].

In the global theory and practice the so called critical success factors are known [5, 7, 12, 13] by which the success of ERP implementation is measured largely through the achievement of the objectives (purposes) originally specified by the customer. In general, these indicators can be

ERP systems can be defined as "a set of consecutive steps, a series of events, changing conditions or stages of thing". In the literature on process management, processes are also characterized as a strategic asset of any organization. On the other hand, the management of the implementation process can be associated with a definition given in [8] for process management – "managerial approach of bringing all aspects and activities within an organization to satisfy the needs of its service users." This effectively means that the implementation of an ERP system can be managed and directed in a certain direction (fig. 1).

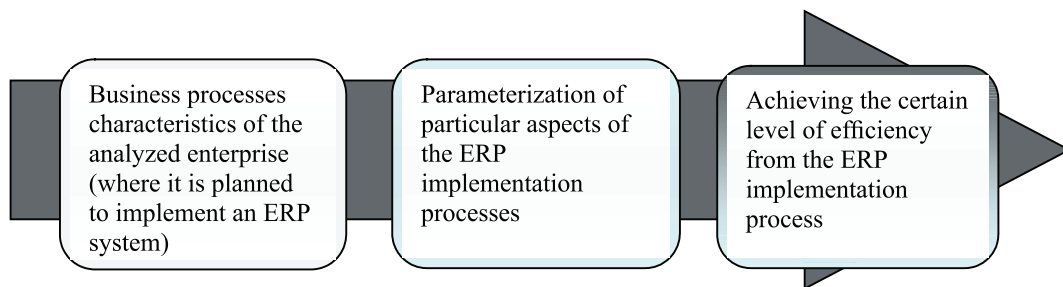


Fig. 1. Stages of implementation of an ERP system

realistically assessed after completion of the implementation process and their assessment is used for subsequent adaptation and resetting of the system parameters [10, 14]. In more unfavorable cases it is even possible to force the business to fit into the system, i.e., business process reengineering, which is a painful and undesirable process for the company, its management and employees. At present, the achievements of modern information technology are widely used in order to improve the process of implementing ERP systems in both large companies and small and medium-sized enterprises (SMEs).

**2. ERP implementation process**

Using a conventional definition of a "process", the implementation process of

**3. Research problem**

The literature review shows that there are no complete solutions to the research problem of evaluating the effectiveness of ERP systems implementation [9, 11]. In the literature however, there are a number of studies on the component (modular) structure of ERP systems, the risk assessment in the implementation of software, and, of course, on measuring the effectiveness of IT solutions.

The effectiveness is a difficult and complex concept with diverse aspects. Indicators that can measure the effectiveness of a process vary widely and are difficult to define. These factors motivate the main problem of our research: development of an innovative methodology

for measuring the effectiveness of the implementation process, and on this basis determining opportunities/possibilities for improvements in this process. Therefore the main objective in studying the implementation process can be formulated as follows: By analyzing the characteristics of the process of ERP system implementation on one hand, and the characteristics of SMEs on the other hand, to propose a methodology and accompanying software solutions for measuring the efficiency. To this end, we propose a procedure of investigation including the following main steps:

- analysis of the problem;
- consideration of the results of previous studies;
- clarification of the research concepts and categories and developing a methodology for evaluating effectiveness in the implementation of ERP systems in small and medium-sized enterprises;
- conducting experimental study and a statistical treatment of results;
- processing of the results obtained through the development and implementation of appropriate software tools;
- identification of the strengths and weaknesses of the proposed methodology for measuring the effectiveness and potential for future development.

We also propose to decompose the research problem of evaluating the effectiveness of ERP systems in SME into two parts. The first one is related to the analyzed company and its business processes. The second part concerns the implementation process itself. It is also a complex combination of activities and, to be more precise, a series of activities. It is suggested to use all these activities as indicators for measuring the effect of implementing an ERP system or its particular modules. It is quite possible, according to the information needs of the companies, for part of this sequence to be changed or modified.

The determination of the characteristics of the ERP implementation requires a thorough study of all aspects of the process:

- information needs;
- information flows;
- applicable legislation;
- used documents;
- application software used;
- qualifications and competence of employees;
- nature of company management;
- characteristics of planning and forecasting in it and many others.

The main problem, however, is focused on the development of a methodology for measuring the effectiveness of the deployment of an ERP system even at the stage of examination of ERP perspectives. Regarding the implementation of ERP systems in general, the following major elements can be identified that affect contradictory research problems, namely:

- Performing a comprehensive empirical survey of SMEs that have implemented or currently are under implementation of an ERP system allows for individual characteristics of the analyzed business processes to be clarified and indicators for different methods of effectiveness measuring of the implementation to be defined. However, it should be noted that there are many peculiarities in each individual company, so a generalized treatment is needed, which smoothes out these differences;
- The process of implementation of any software is dependent on the software itself (not in each ERP system a large parameterization of the process can be made);
- Measurement of the supposed level of efficiency of ERP implementation process in a company should be performed beforehand, at the exploratory stage. At the same time the implementation itself has a certain time period during which the

analyzed company continues to evolve and change, which can alter perceptions of the effectiveness. It is therefore necessary to design a component of the assessment methodology that reflects this process;

- The presence of qualitative and quantitative characteristics in different parts of the business processes in small and medium-sized companies is considered a substantial contradiction. The measurement of any effects on quality characteristics is quite difficult and requires a scheme for making quantitative measures to qualitative values (to be given meanings and effect to be measured);
- A contradiction in the subject area also exists that culminates in a restrictive condition of the availability of budget for implementation. Then the following important question arises: "at what price is the parameterization of the elements of implementation to achieve higher efficiency of the software done?". The authors' opinion is that there is a relationship between the effectiveness of implementation and economic efficiency, as one concept rather incorporates the other.

These considerations lead to the conceptual idea of defining several stages for a possible solution for effectiveness calculation of ERP implementation in SMEs, explained in the next sections of the paper.

#### 4. General description of the proposed methodology

A schematic description of the proposed solution is shown in fig. 2 and it consists of the following stages:

1. In the examination of conditions for ERP system implementation, the initial idea about a sequence of implementation stages and features of the particular stages is defined.

2. According to the indicators in particular methods of the methodology, the activity of the investigated small and medium-sized enterprise is analyzed.
3. Determination of the initial value of the effectiveness of implementation based on preliminary studies and the initial idea of the implementation process.
4. Formulation of requirements for determining possibilities to increase the efficiency.
5. Use of a software prototype to determine possibilities, resources and ways to improve the effectiveness of implementation through adaptation and parameterization of individual elements of the implementation process.
6. Final determination of the possibilities for parameterization of the elements of the process.
7. Parameterization of the implementation process and determination of the ultimate effectiveness cost as a result of adaptation.

It should be noted that the investigation of business processes and in particular of the ERP implementation process is related to basic aspects of the theory and practice of corporative management, perceived as a sequence of planning, organization, motivation and control of economic activity.

The idea of parameterization of particular aspects of the ERP implementation process and realization of possibilities for adjustment of part of the business application logic to achieve the planned level of efficiency is innovative in nature. This makes the topic related to the accounting theory and practice (storehouse setting-up, accounting, etc.). Besides that, the proposed methodology is related to the problems of financial theory arising in the process of measuring and evaluating the economic efficiency of the ERP implementation by using static and dynamic methods for ROI. Last but not least, the implementation of an ERP system largely depends on the qualifications, skills and competence of the analyzed company,

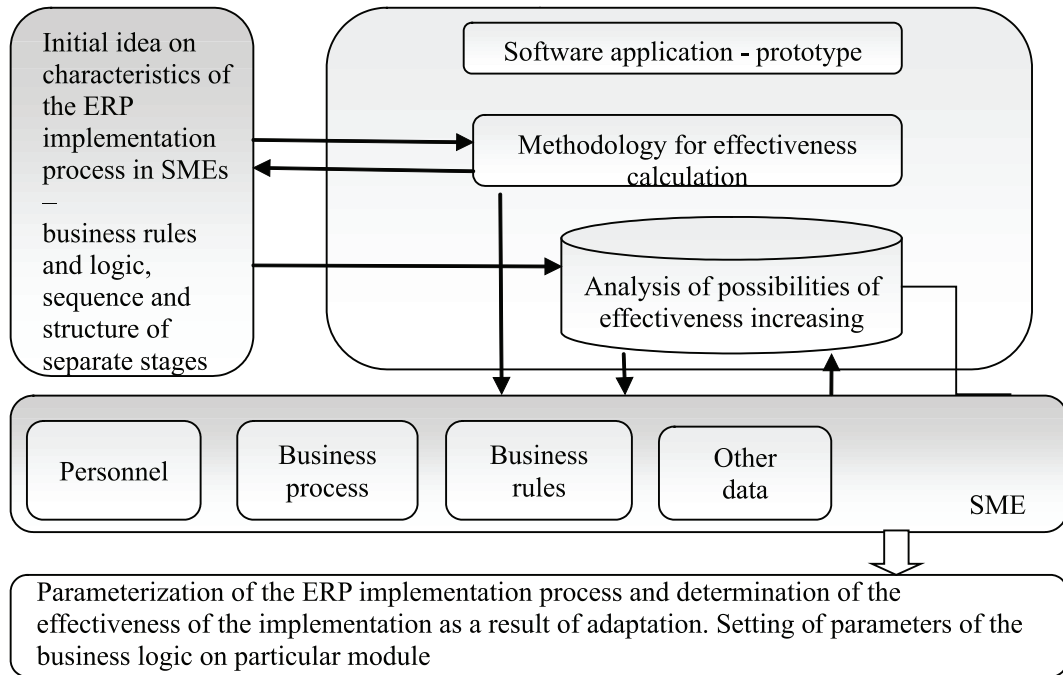


Fig. 2. Methodology for effectiveness calculation – place and significance

as well as of the implementation team. Here reference may be made to the question of motivation as part of the management process. This consideration connects our methodology with the theory and practice of human resource management.

The ability to measure and to estimate in advance the effectiveness of implementing such a system allows the enterprise to properly plan its investment policy and to avoid possible errors from inappropriate deployments of costly software and related negative consequences. On the other hand, the quantitative performance criteria and methods for their evaluation help choosing the best software solutions depending on the specific needs of the enterprise. Ultimately, the achievement of planned

efficiency within the proposed framework for effectiveness evaluation will contribute to the optimization of the overall business of the company, increasing its competitiveness and market share.

### 5. A General concept for methodological solution

The American Heritage Dictionary [1] defines methodology as "A body of practices, procedures, and rules used by those who work in a discipline or engage in an inquiry; a set of working methods". In this context a methodology for estimating the effectiveness of ERP implementation in SME is considered as a set of methods (Table 1.)

Methods in the structure of the methodology for effectiveness calculation					
Initial conditions	Modules for implementation	Sequence of implementation	Functionality settings	User training	Economic efficiency

Table. 1. Methods for effectiveness calculation

Each method for assessing the effectiveness in the proposed technology consists of:

- A general description of the method including the representation of the type and common functioning of the method and its place in the proposed methodology;
- A definition of a list of indicators in the structure of each method. A definition of the relationship between different indicators in the structure of the method according to their information source;
- Developing an algorithm for calculating the ultimate efficiency cost measured by a corresponding method. A prerequisite and part of the algorithm is a relevant mathematical formalism;
- Common graphical scheme for the description of each method in the innovative technology.

The following scheme (fig. 3) is proposed to identify the main characteristics of each of the methods for evaluating the effectiveness.

### 6. Effectiveness estimation of an ERP system

In this section we discuss the main aspects of analyzing various software solutions for

ERP systems. A comparative analysis of such software products includes the following steps.

- Defining the scope of comparative analysis. From an innovation point of view, a useful analysis should include features and benchmarks used by the world's leading software for setup and parameterization of ERP systems.
- Determining the criteria (indicators) for comparison. This stage is one of the most important necessary to perform comparative analysis. It is important that the indicators (criteria) for comparison are formulated according to the purpose of analysis. For example, the comparison among several software products can be aimed at identifying their strengths and weaknesses and determining the opportunities for entry or for using other software. The formulation of benchmarks must precede the description and analysis of the software. Depending on the way of formation of value indicators included in the assessment, they can be divided into several groups:

*Qualitative criteria* (indicators) can be divided into:

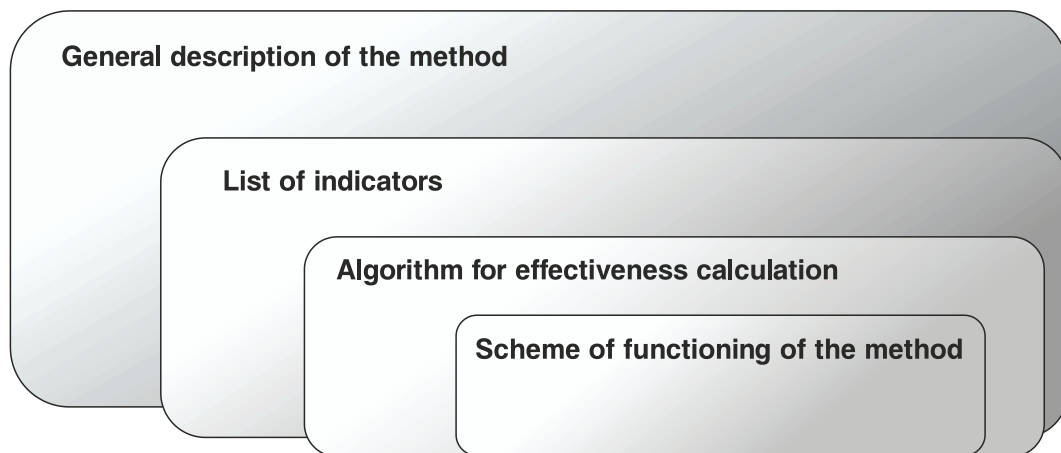


Fig. 2. Methodology for effectiveness calculation – place and significance



## Articles

- Criteria with possible value of "Yes / No";
  - Criteria with possible specific descriptive value (e.g. "there is a link to the server");
  - Criteria under which the value is "not relevant for this analysis."
- Quantitative criteria* can be divided into:
- Criteria under which the higher value is associated with a better condition;
  - Criteria on which the lower value is associated with a better condition;
  - Criteria under which the value is close to an average value that is associated with a better condition.
- Developing a system of weight coefficients. If the results of a comparative analysis are used to perform a SWOT analysis of the compared software solution a system of weights for individual indicators (benchmarks) is needed. The formation of a system of weight coefficients can be done in many different ways as the primary goal should be striving to reduce subjectivity. The following steps for defining a system of weight coefficients are proposed.
    - *Development of a questionnaire to determine the weights of benchmarking criteria.* The first step is to develop a questionnaire to determine the level of importance of each criterion. Through it all the experts rank criteria (indicators) (determining what is more or less important) in terms of the study;
    - *Designation of experts.* These are specialists in the implementation of ERP systems that are familiar with the analyzed knowledge processes, legal framework, IT practice and specificities;
    - *Completion of questionnaires to determine the weighting is done by interviewing the expert;*
  - *The determination of the system of weight coefficients* is performed by calculating a weighted average of the degrees of importance given by each expert and share of the expert in the system. In practice, however, equal relative shares of each of the experts often are taken thus making the final value as arithmetic average;
  - *The resulting weights for each of the criteria form the whole system.*
  - Studying the characteristics of a comparator software. At this stage, an analysis of the functionality and how to use the capabilities of comparators is needed in details. The stage is in line with the definition of benchmarks for which reason the analysis must be consistent and purposeful.
  - Performing a comparative analysis. The main activity at this stage is to establish the strengths, weaknesses, opportunities and threats for each of the analyzed types of software (SWOT analysis). These types of indicators are important in terms of the specifics of the comparative analysis. For performing a SWOT analysis, to each of the analyzed types of software and under application of the scores method depending on the meanings of specific criteria together with the specific type of each item, a certain number of points ranging from 0 to 100 is assigned. The calculation of the resultant value is available in two varieties:
    - *Arithmetic calculation.* In this case the points that are placed on all indicators are summed and the sum is divided by the number of indicators. The main advantage of the average approach is that it does not require the formation of a

system of weight coefficients. The main disadvantage seems to be that the most important parameters are ignored at the expense of less important due to lack of weights;

- *Weighted average calculation.* The points that are placed on each indicator are multiplied by the weight factor of the indicator and summed. The main advantage of the weighted average approach is the ability to determine the extent of seriousness of the indicators by the value of their weighting. The main disadvantage is the need to establish a system of weight coefficients.

## 7. Conclusion

The economic situation both on global and national scale is highly variable. In recent years, the national and global business operates in a severe financial and economic crisis. On one hand, it creates conditions for the use of ICT as a tool to reduce the overall costs for businesses and improve their competitiveness. On the other hand, however, companies are more frequently in a difficult position to implement comprehensive information projects. This gives grounds to seek all opportunities to increase the effectiveness of the software used in small and medium-sized enterprises and to improve their overall financial situation. The variable economic situation enforces, and requires new approaches to manage company resources, including by establishing systems for a comprehensive enterprise resource management (ERP systems).

For small and medium-sized enterprises it is particularly important to recognize the elements of successful implementation of

ERP. In this paper we have developed a conceptual framework for a priori estimation of the implementation effectiveness of ERP systems in small and medium-sized companies. As a whole, the technology includes methods for effectiveness assessment and a comparative analysis of the software solutions. The main conclusions of the paper are as follows:

- Implementation as a process has a certain effectiveness depending on the correspondence between the stages, elements, sequences and specifics of the company in which it takes place.
- The effectiveness of the process of ERP system implementation can be defined and measured in every SME through the application of appropriate indicators and methods.
- The methodology for calculating the effectiveness of ERP implementation in SMEs has to be constructed from methods related to the basic elements and stages of the implementation process.
- The effectiveness estimation of a future implementation of an ERP system can be a reason for applying software solutions for adaptation and parameterization of certain elements and stages of the process according to specific business rules and with the purpose of a successful ERP system implementation.

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