

# Investigation of System of Criteria within Selection Processes for ERP Systems

## A Middle-European perspective

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**Abstract—** The application and introduction of ERP systems have become a central issue for management and operation of enterprises. The competition on market enforces the improvement and optimization of business processes at enterprises to increase their efficiency, effectiveness, and to manage better the resources outside of the company. The primary task of ERP systems is to achieve the before-mentioned objectives. For this reason the selection of a particular ERP system has a decisive effect on the future operation and profitability of the enterprise, i.e. the selection phase is highly relevant step within the introduction and implementation stage of an ERP system. The issues that are worth investigating are the criteria applied at the decision. The qualitative correlation between the size of enterprises, market position, etc. and the applied selection criteria for ERP systems could be analyzed as to whether which criteria are made use of at multinational enterprises or at SMEs. Our research is grounded in a literature review and case studies of everyday practice related to introduction, implementation and roll-out of ERP systems and it tries to provide answers for the above raised questions..

**Index Terms—**Business, Enterprise Resource Planning, Information Systems, Information architecture, Information management, Information processing.

### I. INTRODUCTION

SURVEYS and practical experiences have shown that all areas of enterprise operation have been affected by cost savings including the IT related fields, the main objectives are modified to increasing the economic efficiency instead of earlier ones. The economic crisis has resulted generally in dramatic impact on IT budgets at enterprises. The GDP of World has increased only by 1.8%, within the European Union has decreased in average by 0.2% in 2010. In spite of efforts for cost-efficiency, the enterprises invested into product developments (48% in the survey) beside IT (48%). However, the IT budget decreased by 6% at enterprises involved in the

survey in 2009. A slight budget increase is projected in 2010 from 2009's historic budget cuts; but the increase still left the IT function at enterprises with fewer resources in 2010 than they had in 2008. In 2011 a moderate increase for spending are anticipated [43].

In spite of the enduring economic and financial crisis, the introduction and adoption of ERP systems continues. We have investigated the trends in a small EU member country (Hungary) empirically and by publications related to business management and economics. There are clear tendencies that even the small and medium enterprises (SME) that had data processing systems which had been previously developed individually or tailored to the specific requirements started projects to buy ready-made or commercially available Off-The-Shelf (*COTS*) products on the market. The reaction to enforcement for modernization by technology and business processes is to procure, customize and integrate easily accessible program packages on the market. The main reason is that the previously developed, legacy systems cannot comply with the recent requirements related to information processing, namely cost-efficiency, staffing level and other labor conditions.

The program packages that support the operation of enterprises comprehensively have been denominated as ERP (Enterprise Resource Planning) systems; however there is serious criticism whether the technical terminology is consistent with real content and with the notion of "planning". Nevertheless, the ERP systems achieve an enterprise-wide integration that affect the whole enterprise, the group of companies, moreover the member companies of supply chains. The vendors involved in the eco-system of the given company enhance the particular implementation of ERP system with extra functional content. The ERP system should cover requirements at companies in various industrial sectors having different manufacturing procedures – as series production, custom-made individual products, mixed assembling processes, integration to CAD systems, process engineering, especially in chemical industry where the continuous controlling of chemical processes is needed to monitor the basic materials how they are mixed for production of plastics [14]. There are ERP systems that are dedicated to large and medium sized enterprises, to particular sectors as commerce or to companies having business functions overarching from manufacturing to sales and delivery [11]. Packages devoted to SMEs where the owner generally at the same time the managing director and the companies are flexible, resilient,

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adaptive ones with low staffing level are proliferating as well.

There are individually developed systems, e. g. invoicing programs that are linked not only one industrial sector but could be applied in several sectors, however they cannot be considered as a standard solution. We conclude that there are **individually developed** and **standard systems** within the industrial sector specific solutions as so much as among the general purpose systems created for supporting enterprise governance can be found standard and specifically developed ones.

In this paper, an **ERP system** is understood as an enterprise-wide, comprehensive information system involving all information processing activities that covers the human resource, production, commercial, planning, inventory, material planning, management control and monitoring business processes by placing them into a unified framework.

The *ERP systems* are composed of several functional services that are implemented as modules. Considering *ERP systems*, the concept of modules and their mapping to business services and processes are diverse, however their fundamental property is incorporated in the fact that they are grounded in one, unified database, moreover they provide the opportunity for step-by-step introduction, implementation and roll-out.

The fundamental benefits of ERP systems do not in fact come from their inherent “planning” capabilities but rather from their abilities to process transactions efficiently and to provide organized record keeping structures for such transactions. Planning and decision support applications represent optional additions to the basic transaction processing, query and report capabilities included with a typical system. ERP systems represent corporate infrastructures, much in the same way that physical highway systems or telecommunication infrastructure of a country do.

The selection of an adequate ERP system is not an easy task for any future, potential user as the experience shows that any information processing system – even the outstanding ones – is worth for the user inasmuch as the user organization can enable a part or the whole of the system to utilize or exploit the functionally provided by automated solution. The implementation is a part of a long preparation that is independent from the fact as whether to the selected solution which environment will be operated in. The success or failure of implementation ERP systems is widely discussed in several publications. In next chapters, we analyze the phases of implementation process and providing some answers for the raised issues. The qualitative correlation between the size of enterprises, market position, etc. and the applied selection criteria for ERP systems could be analyzed as to whether which criteria are made use of at multinational enterprises or at SMEs.

We have grounded our investigation in theses that were created on ERP at a Hungarian College as students’ research project. There was an empirical research on architectural approaches of subsidiaries belonging to international companies and operating in Hungary [12]. The research was carried out by a consortium of Hungarian Universities and Colleges. However, the previous research focused on the

enterprise and information architecture, the experiences on ERP introduction and selection process have been built in this recent research. Beside companies situated in Hungary, the investigation covered practice of ERP introduction at several German companies either based on publications or in-depth interviews with managers responsible for ERP systems.

There was a comprehensive literature review related to ERP introduction and implementation that we will discuss in detail.

## II. LITERATURE REVIEW

There are several, concurrent definition and circumscription for ERP, we have tried to collect some of them to get a touch and feelings about the ERP systems:

1. “A process by which a company (often a manufacturer) manages and integrates the important parts of its business. An ERP management information system integrates areas such as planning, purchasing, inventory, sales, marketing, finance, human resources, etc. ERP is most frequently used in the context of software. As the methodology has become more popular, large software applications have been developed to help companies implement ERP in their organization. Think of ERP as the glue that binds the different computer systems for a large organization. Typically each department would have their own system optimized for that division's particular tasks. With ERP, each department still has their own system, but they can communicate and share information easier with the rest of the company” [23].
2. Latest phase in the development of computerized systems for managing organizational resources. ERP is intended to integrate enterprise-wide information systems. ERP connects all organizational operations (personnel, the financial accounting system, production, marketing, distribution, etc.) and also connects the organization with its suppliers and customers [41].
3. A collection of applications that can be used to manage the whole business. ERP Systems integrate sales, manufacturing, human resources, logistics, accounting, and other enterprise functions. ERP allows all functions to share a common database and business analysis tools [50].
4. Enterprise resource planning (ERP) is an integrated computer-based system used to manage internal and external resources including tangible assets, financial resources, materials, and human resources. It is a software architecture whose purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders. Built on a centralized database and normally utilizing a common computing platform, ERP systems consolidate all business operations into a uniform and enterprise wide system environment. [5].
5. An industry term for the broad set of activities supported by multi-module application software that help a manufacturer or other business manage the important

parts of its business, including product planning, parts purchasing, maintaining inventories, interacting with suppliers, providing customer service, and tracking orders. ERP can also include application modules for the finance and human resources aspects of a business. [21][21].

6. A business management system that integrates all facets of the business, including planning, manufacturing, sales, and marketing. As the ERP methodology has become more popular, software applications have emerged to help business managers implement ERP.
7. An ERP system is recently considered as a comprehensive, integrated application system, that unifies in itself functional services as processes for administration (order processing, accounting, inventory, customer credit/debit handling, etc.) , management (planning, monitoring, controlling, governing etc.), and disposal (shipping, purchase ordering, job shop scheduling, production control, etc.) [26].
8. The essence of ERP is “integrating the resource of the entire ‘enterprise’ from an information standpoint.”[24]. The essences of ERP are information sharing (which is the same as a common central database) and process integration (the unique character of ERP systems).

ERP selection is an important decision making problem of organizations and influences directly the performance. The ERP selection process is tedious and time consuming as it has to deal with the complexity of business environment, and in project management sense it should solve problems of resource shortages. There are a lot of ERP alternatives in market [48]. The selection of best suitable ERP system provides positive results at enterprises like increasing productivity, timely delivery, reduction of setup time, reduction of purchasing cost. The failure in selection of ERP system firstly leads to the failure of ERP introduction or adaptation project or secondly to degradation of company performance [27]. It is a fact that software programs are costly and their adaptation takes too much time so that the cost of wrong selection is high.

Several research studies have been conducted to identify relevant factors having impact on success of implementation and introduction at ERP systems. The major part of studies have chosen the case study paradigm, i.e. many of them focused on single case study of “how we implemented ERP systems in our company” ([2], [6], [31], [51]). Furthermore, several studies that have measured ERP implementation success used only one or two factors of ERP implementation success ([2], [3], [30], [47], [44], [45]).

The literature contains several viewpoints concerning what variables are required for implementation success or responsible for failure. The literature research shows that problems with the implementation of ERP systems emerge for a number of reasons.

We can summarize briefly the reasons as follows:

- Generally there is a need for business process change or re-engineering for fitting together the business processes and information processes of an ERP system. Leaving

out the required business process alignment could lead later operational problems.

- Lack of commitment from top management, deficiency in data accuracy, and short of user involvement can attribute to system implementation failures appearing typically during the operation phase.
- Education and training to make use of ERP system are frequently under estimated and are given less time due to schedule pressures.
- The synergy demanded by cross-functional business processes are not understood properly.

The above mentioned issues may have consequences in case they are not handled within the project correctly.

An ERP system is a socio-technology system so that finding an exact definition of measurement for implementation success is hard task. There are competing measurement approaches and concepts coming from research literature and practice. Some factors that can be encountered in the literature:

- User satisfaction ([1], [2], [3], [31], [51]).
- Intended business performance improvements ([1],[20], [30]).
- On time ([1],[20], [30]).
- Within budget ([1],[20], [30]).
- System acceptance and usage ([2], [3], [51]).
- Predetermined corporate goals ([1], [47], [51]).

A case study examines a phenomenon in its natural environment, applying multiple methods of data collection to gather information from one or a few entities (people, groups, or organizations). By its approach, case study paradigm as a research tool is well suited to the study of Information System (IS) implementation, especially when contextual environment is important and the phenomenon is temporary. The researcher has no control over the surroundings changing in time so that the research is typically qualitative investigation and exploratory to discover the answers for questions as the “how” and “why”. It is suggested to utilize multiple case studies to enhance the methodological exactitude of study through “strengthening the precision, the validity and stability of the findings” [34]. The case studies paradigm provide a sound basis for scientific generalization if it is correctly used.

### III. PHASES OF ERP INTRODUCTION

The reason why a decision may have been made to replace an operational system by an ERP solution can be concluded from several basic causes. One of the origins for such a decision is that the enterprise would like to save or strengthen its market position through acquisitions or internal growth. The IT/IS system can be adjusted to these changes flexibly if there is a “quantum leap” in IS service quality by introducing an ERP system considered as a “best practice” in the industry sector. The other important factor is the competition on the market. The price competition enforces the companies to optimize, to make transparent of their manufacturing, procurement processes, furthermore to monitor their

performance and at the same time to increase the resource utilization of business processes. Beside the market competition there are other compelling sources to optimize and to increase performance in enterprise governance and information processing. These factors pushes towards to improve efficiency and effectiveness of enterprises. The major task of ERP systems is to provide a solution for the before-mentioned issues.

The samples in practice demonstrates that the introduction and application of ERP is a longstanding process. The selection of a proper solution is a several year project that can be divided up into stages however it takes time but the reward could be competitive advantage and efficient operation at enterprises. Perceiving the situation the vendors offer approaches to shorten the introductory time and to save costs. The required activities are planned and monitored till the introduction and operation by vendors so that they ensuring a successful project execution [14].

There is a seven phase model for ERP introduction: proposal for changeover, analysis, conceptual plan, short listing the potential solutions, selection process, decision for the designated one, and project closure [52]. In this study we define five stages taken into account the practical experiences: decision on changeover, selection of ERP solution, training, evaluation.

#### A. Modernization of operational system

The experience shows that protecting the market position, the growth of enterprises is accompanied by the demand for higher data and information processing volume. The companies frequently encounter a decision situation how they can modernize existing data processing system. There are three different ways: *development*, *package procurement* and *renting or leasing* the ERP services.

At the beginning it is difficult to decide whether a program package as COTS (Commercial off-the-shelf) should be procured or a supplier should be found to develop a customized solution who can adapt its basic system to our requirement. The decision is hard as the package solution cannot cover all business processes at the enterprise. A developed system may comply with requirements and it can be tailor made for specific business processes; however it requires more resources[4].

Before the decision between the package solution and development an analysis can be carried out on potential solutions then a management decision is made. During the analysis the benefits and disadvantages of the package solution are assessed.

Benefits:

- Short introduction time;
- Lower costs than development;
- The package solution incorporates long term experiences in the sense of integration:
  - Contains fewer deficiencies as it has got through serious defects elimination;
  - Provides potential advanced governance, control and management solutions to be realized;

- It integrates various and different business areas and functions;
- The external relationship as the supply-chain management, customer relationship has been integrated;
- New information and software technology is instituted;
- The mounting data processing requirement is handled by architecture to be scaled.

The disadvantages of a package solution:

- There is generally a discrepancy between information services of the package and the business process of the organization;
- To integrate the new requirements into a package needs more resources and costs as development from scratch;
- Hardware infrastructure enhancement is necessary procuring new software system;
- The utilization of staff at the IT function in the enterprise decreases and the skill and knowledge of staff does not develop.
- The dependency on the vendor grows; the requirements for change can be satisfied only by the assistance of the vendor ([10], [42]).

The third opportunity is renting or paying a fee for all or some services of an ERP system. At small and micro enterprises, frequently there is a lack of knowledge and skill of business management, e.g. on the field of calculation for a quotation, or material management. The current ERP systems contain proper information system processes for managing and controlling micro enterprises as well. The financial resources at small and micro enterprises had not made a real option to procure an ERP system previously and to employ staff having skill in IT operation.

However most recently, the **ASP (Application Service Providing)** is an appropriate, cost-effective solution for micro and small enterprises. The services can be accessed through the **Cloud Computing** too.

In the life of many companies arrive the moment that the decision on modernization of the enterprise management system cannot be postponed, i.e. the management should start a project for selection a proper ERP solution and initiate the decision making process.

#### B. Decision making on the introduction of an ERP solution

The question emerges whether what the factors are that lead companies to consider replacing the operational legacy system fully or partially with a new information system.

To find answer for the question we have investigated cases covering a wide spectrum and we have collected and highlighted justification from the projects executed to introduce ERP like systems.

A Hungarian Ltd. decided to adopt an ERP (ProFinance™, <http://www.profinance.ch/deutsch/index.asp>) system, their justification contained three items having grounds in the underdeveloped, legacy information processing system:

- The rapidly developing enterprise owned old, legacy information processing system that did not cover all business processes. For this reason, the introduction and implementation of a more modern enterprise management system became the must.
- In the region, the other, concurrent companies have adopted and will have implemented various management systems gaining competitive advantage.
- There is intention to develop and to extend the retail branch of the enterprise. The new information system should have a steady and reliable on-line connection between the retail shops and the wholesale units.

The advancement in IT that has led to decreasing in price of hardware has resulted in acceleration of information system development to replace the legacy systems.

A company (Borstlap b.v.) from Netherland had an AS/400 based system named TOTICS and had operated for 20 years. At the beginning, the system satisfied perfectly the customer requirement, moreover the continuous development for enhancement and improvement sustained the daily operation. However, the system slowly became obsolete in spite of all efforts. There was no support for accounting, finance, human resource management and other important business areas of the company. The system lagged behind supporting management of modern systems. The information to supply management decision was difficult to retrieve, sometimes impossible. The question "Whether does the company need a new information system and if the answer yes then why?" has been responded:

- The new system is pre-condition to realize the business strategy plan;
- The new IS provides better reliability, higher service level for customers;
- Within the business group is to increase efficiency and to make more transparent the business process;
- The system should support the business planning and consequently the cost-efficiency and serving the clients;
- The new IS creates the opportunity for an integrated system[46].

The subsidiary of a multinational oil company in Hungary used to employ JDE (J.D. Edwards) ERP system. The company has roughly 100 subsidiaries world-wide and they had applied a wide variety of ERP systems. The company decided to eliminate the heterogeneity of systems. The enterprises wanted one integrated solution. Considering the opportunities, the top management of multinational company made the decision for a project called Global SAP, GSAP project [25]. The Dutch company settled to introduce SAP R/3 as well.

In one of our empirical research, we have met the following approach ([35],[12]): some business administration functions are centralized at some regional headquarters as e.g. invoice processing and payment. The SAP FI module is procured and customized to be dedicated to this task. The customization primarily meant specific parameters that reflect the country

specific legal environment. This research pinpointed to the fact that the country-specific and country-wide solutions used previously have been replaced by ERP modules as finance, sales and delivery, customer and supplier management. Consequently, a business function is covered totally by a single ERP module introduced during the changeover.

In the above mentioned cases, the selection phase has been left out. The top management at both companies has made a strategic decision choosing an ERP system that is considered as best practice.

Within the globalised business life, both example (the Dutch and multinational oil company) highlight the causes that has led to the decision for changeover and application of an integrated ERP.

### C. Causes for Changeover

As the before mentioned cases demonstrate, the base for a changeover to an ERP system consists of:

- the requirement for information processing volume caused by the growth of business, acquiring larger market share or the intention of it;
- necessity for modernization of legacy systems;
- the requirement for company-wide integration, unification and creating uniformity in information processing.

However, there are issues to be considered before decision on a changeover:

- Whether are consultants needed although the system will be operated by the staff at the enterprise?
- Whether the costs, the whole project budget can be planned in the selection phase? Some issues:
  - Fix cost at one-time investment, and variable cost at operation time;
  - Infrastructure investment and procurement;
  - Business efficiency and effectiveness of the new IT/IS solution;
  - Can be higher income for the enterprise anticipated?
  - Training and education for the employees and their costs including to maintain the skill level.
  - Would the inventory management be improved?
  - Which are the business areas where cost savings can be achieved? Efficiency of production could decrease the costs of salaries and wages?
  - Whether should a save deposit be established for financing the unexpected cost growth after ERP implementation?

### D. Objectives of ERP selection and practical approaches

The difficulties in selection of ERP system did not originate from the fact that too few ERP system is available on market, in spite of it there are the multitude of ERP system. There are hundred vendors beside the major players in Germany [15].

The primary vendor selection could be based on the market position within the specific ERP sector[33]. There are four factors that can be combined variably to represent the market position within competition in a Cartesian chart, namely the competitive advantage, financial soundness, technical knowledge and skill, the stability of business environment.

The ERP system vendors can be shown in such a chart.

The investigation of potential ERP solution should take into account business and financial consideration beside the information technology viewpoints (e.g. software and programming environment, information system function etc.). A Hungarian Ltd. (TMF Magyarország Kft) had as selection goals for ERP:

- the system supplier should be a domestic vendor, the vendor should commit itself for satisfying the users' request for change;
- user friendliness, easy handling of user interface and ability for customization;
- capability for integration and interoperation with other systems;
- The IT stability of IS should be high [9].

#### E. Business Case

One of the major objectives during ERP selection is to mitigate the risks inherent in the selection process. In literature, there are lots of methods and models that have been widely discussed; two of them is outlined below.

When management considers several conflicting goals to be achieved, multi-criteria decision making (MCDM) models enable effective results in the ERP selection process. Subjective decision-making processes related to conflicting business problems with trade-off relationships may produce sub-optimal results. Appropriate ERP strategies must be established on a compromise-based and objective decision-making process among diverse stakeholders ([7], [38]).

Analytic hierarchy process (AHP) is a generally used method for arranging goals, objectives in a hierarchical order. The basic aim of method is to support the decision making in a systematical manner using mathematical and computational procedures.

The basic problems with both approaches is that the mathematical theory in background should be understood by top management and other stakeholders participating in the decision making process. One of the potential solution for that problem is to provide a simplified model for management that clearly defines the alternatives to make the selection easy [39].

Both MCDM and AHP are discussed in literature, there are some case studies where the application of methods is demonstrated ([49], [19]). In our research, we have not encountered any sample where either MCDM or AHP approach has been used. The complexity of transformation from a system of multiple-criteria on quality to numbers and measures may be one of the reasons.

Besides the business and technical criteria and risks there are financial ones too. The financial perspective is based on cost savings and quantifiable implementation benefits. Evaluation methods include Net-Present-Value, Cost-Benefit Analysis, Payback, Return on Investment, etc. To assess the financial parameters one of the analysis models is the ROI (Return on Investment) that can be applied.

There is an elaborated method that consists of several hundred questions. The inquiries address the efficiency of information processing taking into account the particularities

of various industry sectors and size of enterprises. However, the extensive questionnaire does not solve the problem deriving from lack of information at stakeholders. There is a dearth of reliable information on the following subjects [18]:

- knowledge of the actual functions within the ERP system;
- the applied software and –generally – information technology;
- the market position, the economic capability, viability of the potential vendor;
- the comprehensive view of the alternative, competing solutions existing on market;
- the potential improvement of information processing;
- the comparative analysis of references for alternative solutions and their implemented instances.

However, there are controversies on whether which financial analysis approach fits bet to a successful ERP selection process, there are positive examples that demonstrates that ROI is a good compromise for assessing the financial risks of an ERP adaption process and other socio-technical viewpoints[28].

TCO (Total Cost of Ownership) has been used by some cases as well. The comparison of the potential alternatives as procuring, renting, leasing or paying per usage for services through Cloud Computing can be carried out by TCO approaches. A well founded TCO model provides the opportunity for controlling the costs known in advance in the future and the flexible reaction to the changing business environment by enterprises. At Hungarian Ltd. the TCO model was employed to analyze the costs for introduction and operation. The main components were as follows:

- capital expenditure (46 %, hardware, software, network);
- system administration (12% upgrade, update, maintenance );
- technical support (16%, hardware maintenance, supervising, virus protection, other technical services);
- end-user supports (26%, training and education).

#### F. Soft Criteria for Selection

Besides the service quality and financial criteria, there are lots of other objectives that should be taken into account during the selection process. The compliance to the requirements of the company is one of the most important criteria. To clarify and to define accurately the compliance criteria, a business process modeling should be carried out to discover and to map the whole business process that will be involved in the ERP introduction. To explore the discrepancies between the existing processes and the processes of potential ERP systems, a *gap analysis* should be performed. The questions are: which business processes can be automated by the ERP system, which business processes should be adjusted to the ERP system processes, and which ERP system process may be slightly modified to the current or aligned business processes.

The new ERP system may fulfill the recent requirements;

however the ERP system should be prepared for future demands [29]. The stability of information systems means the adaptability to changes of technology, business processes and business environment so that anticipated feature of ERP system is certain degree stability.

The issue of stability has got specific interpretation in the case of ERP systems. ERP systems are software packages that can be tailored to the specific requirement in a certain degree. ERP systems generally contain many functions. During the gap analysis, the functions and their modules are chosen that fits to the decision regarding that what business process will have been automated. The experiences shows that if the set of functions is minimized for several reasons – financial, compliance, project timing, resources etc. – then later on, the enhancement and evolutionary development to react to the changing environment may cause extra costs and other operational difficulties in spite of the maximization of collection of functions [15]. The augmentation of an implemented ERP system with new functionalities leads to higher expenditure. It seems a better solution considering costs and benefits to buy the potentially applicable functions and then if necessary the required function is made operational.

The flexibility of ERP systems is a success criterion within the corporate and SME world [14]. In this context, the *flexibility* is an overarching concept that involves the simultaneous use of various languages carrying out even the same task, at the same time, furthermore adaptation to the changing business and market environment. Acquiring new markets or setting up factory in foreign countries may mean totally new logistics or supply chain system which the ERP system should be adjusted to. The multi-national enterprises operating on various markets in different countries have as basic interest that their information system should support both specific requirements at each single country and requirements at corporate level. The headquarters of multinational corporations tend to centralize their management, control and governance systems to ensure an integrated and unified business administration. This tendency results in globalised ERP systems. The top management at the center of enterprises has various opportunities to find a satisfactory solution among the potential ERP systems ([12], [35]). The concrete implementation is situated in the centralization-decentralization continuum both horizontally and vertically regarding the Zachmann architecture to provide the support that is required the top management of enterprises.

Other uncertainty factor is the structure of business processes and organization and the capability for adjustment to the processes provided by an ERP system. A German company had outsourced the business processes for sales and distribution to several third parties. However, the company has acquired a firm that was specialized in sales and distribution so that the German enterprise has eliminated the outsourcing and incorporated business processes related to sales and distribution. On integrating the newly acquired subsidiary, a new ERP system dedicated to customer-supplier relationship has been introduced at the same time. The new system supports the business processes from quotation, through

contracting and distribution to shipping. A serious and conflict generating task was the re-engineering the business processes related to the outsourced sales and distribution functions and adapting them to processes at the subsidiary. Finally, the project achieved their goals. The ERP system adaptation and transformation of business processes has as outcome a solid market position. The ERP system adaptation may have as a side-effect stronger market position, efficient internal business processes and a profound transformation of whole activities in the enterprise.

On selecting an ERP system to support globalised business activities, so-called country specific features should be taken into account. Such features include as follows:

- custom and excise handling;
- tax, revenue handling;
- commercial code;
- financial an cost accounting;
- banking, rules for bank accounts;
- local legal environment, jurisdiction.

The potential ERP system may or may not contain the above listed, country specific features. An enterprise operating on the globalised market should consider these particularities and make decision to make up for the lacking functionalities. The required customization needs extra implementation effort generally. Some examples for the difficulties that occurred [8]:

- Country specific, compulsory Chart of Account (Belgium);
- Accounting the transfer prices (Brazil);
- Handling and accounting the billing credit (Bulgaria);
- Country specific Payroll (Chile).

The described cases underpin the fact that during the selection process business-oriented criteria play important role besides financial considerations. Such factors are as follows: user friendliness, usability, interoperability and/or compatibility, common requirements for ERP systems, reputation of vendor and its products, capability of system for application in a globalised business eco-system overarching several, different countries.

#### G. Summary of Experiences

In this research we have investigated twelve Hungarian companies, sixteen subsidiaries of multi-national companies operating in Hungary at a previous research [12], and five companies in Germany [40].

The cases show that criteria on financial, business, technical and market position play role within the selection process of ERP system. The aspects are as usability, interoperability, compatibility, functionality of system and the reputation of the vendor and its products, and the applicability locally or globally.

- The criteria that are worth taking into account are as follows:
- current market position and long term sustainability and viability on market;
- the alignment and/or the capability for adjustment of

the potential ERP system to the specific industrial sector or business area, the references of successful implementation;

- financial and business parameters;
- the degree of dedication of rival enterprises to implementation and application of ERP solutions;
- interoperability, capability for integration to other legacy systems to be kept in operation;
- the applied technologies for data management, software and information processing;
- the support provided by the vendor at the introduction and operation of the system;
- The costs and options for maintenance, upgrade, update and adaptation to the changing legal environment;
- language versions, localization opportunities in the case of multi-national, global companies;
- existence of country specific solutions at some business areas (e.g. accounting);
- IT networking capability of ERP system to be adjusted to recent state of the decentralization-centralization demand.

The theoretically complex approaches grounded in mathematics for assessment are used rarely nevertheless the business or financial models for evaluating the benefits and costs can be met frequently. The financial models as 'Return on Investment', 'Net Present Value' etc. can be computed in spreadsheets. There are models prepared in spreadsheets or in text books that can be readily applied in spreadsheets. However, MCDM, AHP and ANP require modeling efforts and do not exist easily available tools for carrying out the mapping between the quality criteria and their mathematical representation. The intention to use fuzzy versions increases the complexities and difficulties to be dealt with. In a commercial environment, there is not enough knowledge to use the complex approaches even if third party consultants are involved.

#### H. Solutions and Recommendations

The case studies show by the experience that the ideal typical approach for ERP introduction and implementation as follows:

- A carefully elaborated project plan is required to schedule the activities, tasks for implementation of ERP system. The plan is accepted and monitored by the top management to support the team dedicated to the ERP system adaptation.
- The proposed stages for changeover:
  - PERT /CPM network for the whole project;
  - Formal project initiation including the staffing the project team, detailed planning the single tasks;
  - A selection process for ERP;
  - Customization of the selected ERP;
  - Designing and introducing data coding scheme, data conversion process;

- Testing the ERP system;
- Re-engineering the internal business processes of the enterprise ;
- Training and education for user how to use the ERP system, and periodical re-training;
- Formal launching the system for operation;

The occurring, new user requirements should be satisfied by development whereas it is needed to ensure the continuous maintenance, e.g. update and upgrade of software and hardware in order to keep the system up-to-date within changing internal and external business environment.

#### IV. FUTURE RESEARCH DIRECTIONS

The future research should deal with the changing IT environment, especially the proliferation of *Cloud Computing*, the Software as a Service (SaaS), the application as a service, namely the ERP system services. In this situation, it will be worth investigating how the notion of ASP (Application Service Provider) changes and what the particular features may have regarding the ERP services. Similarly important phenomenon is the concept of Web services and its promise the flexible configuration and re-configuration of information system services along with the business processes.

These rapidly changing IT / IS environment enforces to raise the same research questions on issues of selection, introduction, adoption, customization and operation of the ERP service.

We have investigated in multiple case studies criteria for selection of ERP systems. We have encountered various viewpoints out of customer organizations and financial and business models applied for evaluation. Another thread of investigation could be whether what computational intelligence and other computational models may be employed in the before-outlined changing environment that could flexible fit to the given situation and may provide useful information for the customer.

#### V. CONCLUSION

The multiple case studies and financial analysis models presented in this paper provide assistance for the decision making processes at enterprises where the changeover issue is reviewed.

TABLE I  
FACTORS HAVING IMPACT ON ERP INTRODUCTION AND IMPLEMENTATION

The results of research can be summarized in a table as a conclusion (Table I): The results of research can be summarized in a table. The assessment of each single factor is founded on analyzing the in-depth interviews, case studies, scientific, technical, business publications and other reports, overall 40 companies were involved in the research. We have analyzed the *frequency of occurrence* of each single selection criterion in case studies and their exercised impacts on the final success of ERP systems.



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TABLE I  
FACTORS HAVING IMPACT ON ERP INTRODUCTION AND IMPLEMENTATION

Factors' effects on ERP implementation	Occurrence in case studies						
	weak positive impact	average positive impact	strong positive impact	Neutral	average negative impact	weak negative impact	strong negative impact
Top management support	8	5	6	6	2	3	3
Company-wide support	8	5	4	4	4	4	4
Business process reengineering	1	2	6	6	6	6	6
Effective project management	7	7	7	3	3	3	3
Organizational culture	1	2	4	4	9	6	7
Education and training	2	7	12	3	3	3	3
User involvement	1	2	6	6	6	6	6
User characteristics	2	3	7	3	3	7	8
ERP software suitability	8	8	12	2	1	1	1
Information quality	8	8	12	2	1	1	1
System quality	8	8	12	2	1	1	1
ERP vendor quality	2	8	12	7	1	2	1
<b>Total :</b>	56	65	100	48	40	43	44

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