LAPPEENRANTA UNIVERSITY OF TECHNOLOGY
DEPARTMENT OF INDUSTRIAL ENGINEERING AND MANAGEMENT

SUCCESS FACTORS OF AN ENTERPRISE RESOURCE PLANNING SYSTEM

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SUMMARY

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Purpose of the thesis was to study enterprise resource planning systems in operational units of a company. System success factors were to be compared to Adelakun's model of information system quality dimensions that divides overall system quality into business, technical and user dimensions. Also an interdependency model of the success factors was to be developed for further development of the studied systems.

Information of the systems and their use was collected from implementation project documentation, interviews, satisfaction queries and system analyses. Both end-users and business management were in the target group. The collected information was analyzed according to Adelakun's three-dimensional information systems quality model and key success factors were searched.

Success factors that were found in the studied systems were consistent with existing literature. Also Adelakun's system success dimension model was validated in the researched cases. A model of interdependencies between the discovered success factors was prepared for utilization in further development of the studied systems.

TIIVISTELMÄ

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Hakusanat: toiminnanohjausjärjestelmä, ERP, menestystekijä, tietojärjestelmä, laatu, prosessikehitys

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Työn tarkoituksena oli tutkia yrityksen eri yksiköiden toiminnaohjausjärjestelmiä sekä verrata niiden menestystekijöitä Adelakunin malliin tietojärjestelmien laatu-ulottuvuuksista. Siinä järjestelmän kokonaislaatu jaetaan liiketoiminnalliseen, tekniseen ja käyttäjän kokemaan laatuun. Tulosten perusteella oli myös tavoitteena kehittää kyseisen toiminnanojausjärjestelmän kehittämistä varten malli onnistumistekijöiden keskinäisestä riippuvuudesta.

Tutkittavista järjestelmistä ja niiden käytöstä kerättiin tietoja käyttöönottoprojektien dokumentaatiosta, haastatteluin, kyselylomakkein ja järjestelmäanalyysein. Sekä loppukäyttäjät että yritysjohto olivat kyselyjen ja haastattelujen kohderyhmänä. Saatuja tietoja arvioitiin Adelakunin kolmiulotteisen tietojärjestelmän laatutekijämallin mukaisesti ja keskeisiä menestystekijöitä etsittiin.

Tutkituissa tapauksissa tietojärjestelmien menestyksen taustalta löytyi alan kirjallisuuden kanssa yhtäpitäviä tekijöitä. Myös Adelakunin laatu-ulottuvuusmalli osoittautui validiksi tutkituissa tapauksissa. Keskeisten menestystekijöiden välisistä vuorovaikutussuhteista rakennettiin malli, jota voidaan hyödyntää kyseisen järjestelmän jatkokehityksessä.

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ABBREVIATIONS

BOM	Bill of Materials
BPR	Business Process Re-engineering
CAD	Computer Aided Design
CODP	Customer Order Decoupling Point
EDI	Electronic Data Interchange
EVA	Economic Value Added
ERP	Enterprise Resource Planning
IS	Information Systems, also Information Services
IT	Information Technology
JIT/JOT	Just in time/ Just on time
KM	Knowledge Management
MRP	Materials Requirements Planning
MRP II	Manufacturing Resources Planning

1 INTRODUCTION

Complexity of modern businesses forces operational data to be utilized more efficiently than ever before. Business concepts often require extensive supply chain information from both supplier and customer side. Most companies rely heavily on information systems in operations and normal functioning is possible only if the systems provide support.

Besides operational information requirements there is a growing need for management planning and control tools. Information considering company's position is needed for quick business decisions. Previously the information has been produced by middle management that has been cut down in numbers. The manual information processing was slow and data analysis possibilities limited. New analysis dimensions and more powerful operational procedures are needed to fulfil business change requirements. The new information systems are offered as means to achieve these goals.

A process-oriented view of businesses began to appear in the 1980's. Organizations were seen as collections of processes instead of separate functions. The process view enabled also business information systems to be designed to support a flow-type work orientation. Tasks were no longer seen as basic units of work but as building blocks of processes that were subject to optimization.

Use of business processes drew attention to optimizing large parts of work at once. A concept of business process re-engineering arose and advocated a model for radical business process improvement. By mid 1990's a large part of business organizations in the western world had redesigned their ways to carry out operations. Information and material flows were streamlined and process steps reduced in order to shorten lead times, improve quality and increase throughput.

Enterprise resource planning (ERP) software came to market at the same time and promised an all-in-one solution for process standardization. The systems had evolved primarily from material resource planning (MRP) software of the 1970's and capacity planning systems (MRP II) of the 1980's. Many other functional systems had also affected the development of the ERP concept that integrated all organizational functions in the same software.

The integrated ERP system turned out to be a more difficult concept than expected. Implementation projects tend to cost more than was projected and actual benefits are often short of estimates. Numerous projects have been cancelled even at late stages but many companies still seek the promised benefits and launch new ERP projects. The decision to acquire ERP is now considered as a considerable risk that can threat the existence of almost any company, if the worst case scenario realizes. General understanding of what causes the risk is somewhat shallow. However, there are recognized connections between system success, implementation goals, implementation project management and actions after the system is operational.

There is a need to have more detailed understanding what is a desirable ERP system state and what can be done to reach it. Situations in companies differ greatly from each other, which diminishes a chance of building a generic concept of information system success. However, there seems to be certain characteristics that are paramount at conceptual level, regardless of size and business of a company.

1.1 Objectives and Scope

There are three objectives for this thesis. Firstly, success factors of the ERP systems that are studied in the case are to be identified. Secondly, an information system quality model by Adelakun (1999) is to be validated in the study cases and, thirdly, suggestions that can be used to improve the case system are to be developed.

Success factors in the case ERP system are searched. The goal is to find the most important matters affecting success. The factors are to be categorized chronologically into three phases. The first one concentrates to the factors that appear before the implementation project start. The second phase deals with matters during the implementation project and the last one covers the matters that affect operational systems.

Adelakun (1999 p. 110) has presented an information systems quality model. The second goal is to validate it. The model consists of three dimensions that affect system success. He argues that focusing on business quality, technical quality and user quality will ensure satisfactory overall system quality and success. The model also links the cost of fixing quality problems to the phase they originate. Early intervention reduces the cost but the problems can appear in several phases. Therefore this report uses a chronological approach to the system success factors. Adelakun's model will be applied in the studied cases. Especially usability of his three quality dimensions is under consideration.

Thirdly, the success factors are interpreted and system improvement possibilities are sought. The aim is to provide a useful analysis that can be used to optimize the studied system.

No exact technical, project management, etc. framework will be constructed for ERP project management or system maintenance. Neither is this study aimed for describing exact corrective actions for the case systems, even though suggestions are made. The results are applicable only in the studied case because only a few empirical cases are studied and the used methods do not support generalized conclusions.

1.2 Methods

A participatory approach to the research subject is taken. Action research methods are used, namely familiarizing to the subject from inside and taking part to the studied phenomenon. Researcher's opinions and experiences impact the results. The researcher is a part of the studied system and has himself some effect on it. Therefore the results are valid only in the context of the studied company.

The report is divided into two main parts. In the first one the theoretical background is introduced. The second part presents results the studied system and experiences from it. The first part is based on existing literature and publications that cover the field. Because of iterative nature of the research, the theoretical construct is built simultaneously with the empirical part. Therefore factors that have significance in the case companies, are emphasized also in the first part. Promising leads in literature are followed as well. Therefore the covered topics depend heavily on judgement of the researcher and his paradigms about the subject.

The study focuses on finding ways to understand the case systems and to utilize the understanding in improvement activities. Hence there are two kinds of potential benefits, increasing knowledge and practical improvement of the systems.

As numerous social factors affect enterprise resource planning systems, the stakeholders must be an integral part of the study. Qualitative factors have to be understood from their point of view but other useful views should also be looked for. Qualitative material is acquired from interviews and survey comments.

An ERP system in an international machinery corporation originating in Finland is studied. Case information is collected from company's project documentation, user interviews and a business manager survey. Experiences from an ERP help desk are analyzed and data is also directly extracted from the systems. These five sources of information are combined to form an impression of the system status.

The project documentation consists of corporate blueprints about the general ERP model and implementation project documentation. Because each site has had a project of its own, the general characteristics of each case are studied. This knowledge is later combined with information about the system success in the respective site to find interdependencies. The corporate level information provides a basis for positioning the corporation in a system scope taxonomy.

User interviews are conducted in five small locations using the ERP. The locations are also selected for detailed study in this thesis. The purpose of the interview round is to gain understanding of the systems and to find out what kind of problems exist and if there are any development suggestions. All interviews are based on the same themes that are introduced in appendix 1. Also the interviewees' positions are listed.

A questionnaire is targeted to business managers to find out how they feel about the system. Emphasis is on business benefits they consider as results of the system. Questions are presented in appendix 2. The businesses using the system are considered to be internal customers of the systems department. The survey results are also used to improve the situation in the corporation. System development issues are analyzed according to the satisfaction query results. System weaknesses, that are seen important from business point of view, are added in a prioritized optimization issue list.

Analyses of 220 help desk cases, reported during a time of about 13 months, provide one more view to the systems. The cases have originated in the five studied locations using the ERP system. The problems are classified into three categories according to underlying cause. They are conceptual misunderstandings, technical causes and system change requests. A summary by site and cause can be found in appendix 3. The help desk utilizes an intranet application that documents questions and actions. No telephone calls are normally made in the process. Therefore practically all information is available for analysis.

Some facts and numbers for comparison are directly taken from the systems. ERP module usage and user interfaces are studied site by site. Also general understanding of each business's size is developed and it can be used to establish relations between success factors.

The information sources differ from each other and therefore offer variable insights. No single source of information is emphasized over the others. Because of the relatively long – one year – period of the thesis work, there are also plenty of implicit learning and personal opinions involved. Some matters may be stressed more than an outside observer might do and there may be myopia to other facts. Therefore the overall case method is highly participatory.

1.3 Overview of the Report

The report consists of the theoretical part that draws together existing knowledge from literature and of a case description of ERP system in practice. The theoretical part contains four chapters. At first an overview of ERP systems is presented and after that three chapters are devoted to different phases of system acquisition process as illustrated in Figure 1.

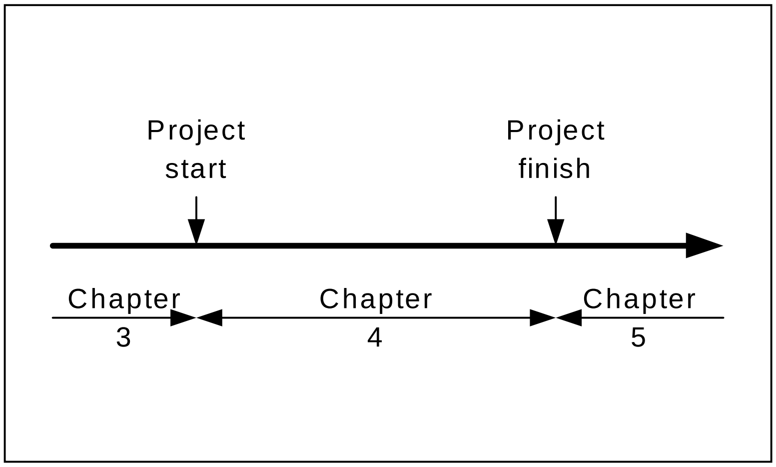

Figure 1. Scope of Chapters 3-5

In Chapter 3 knowledge of pre-implementation factors that contribute to the system success is studied. It deals with decisions and preconditions that lead to system acquisition. Beliefs and expectations are formed at this stage and their correspondence to reality has an effect on perceived success later.

Chapter 4 concentrates on the implementation project itself. Matters included between project start and closing are discussed. Mostly general project management issues draw attention but a considerable number of change management issues are also covered. Software installation and setup are not the main part, but rather supplementary knowledge to build a model of a complex business process development project.

The last part of theoretical construct is chapter 5 that covers events after the system project end. It clarifies causes of perceived success in continuous process improvement. Business process development techniques that have an essential role in ERP system maintenance and update are discussed among other appropriate matters.

The case study in Chapter 6 begins with an overview of the studied corporation and the ERP system it uses. ERP projects in the studied corporate companies are described.

Results and conclusions are presented in Chapter 7. Validation of theory in the particular case is looked for. An interaction model of success factors that are affirmed by the case is constructed. It should provide means to optimize the systems in practice.

2 CONCEPT OF ENTERPRISE RESOURCE PLANNING SYSTEMS

Globalization, increased competition and shortened product life cycles require more efficient logistics and manufacturing flexibility. Organizational units need to operate tightly integrated to accomplish it. To relieve this need, enterprise resource planning systems appeared in the early 1990's after information technology permitted large systems to be built at reasonable cost. (Sadagopan 1998)

Technological advances in information systems have stimulated large changes in business methods. ERP is not the first type of system that applies IT in businesses nor it will be the last one, but it is a noteworthy system trajectory because it changes the relation between business functions. ERP evolved from earlier systems that utilized IT in less integrated form in the business environment. The ERP background is discussed in Chapter 2.1. A more detailed view of ERP composition can be found in Chapter 2.2 and ERP's contribution to information management in Chapter 2.3.

2.1 ERP Background

ERP systems evolved from Materials Requirements Planning (MRP) systems of the 1970's and Manufacturing Resources Planning (MRP II) systems of the 1980's. Assembly operations involving thousands of parts, such as automobile manufacturing, led to large inventories. The need to drive down the large inventory levels resulted in the early MRP II systems that planned the order releases. (Sadagopan 1998)

Materials requirements planning systems were built to calculate material requirements for production and purchasing. The systems were based on a product hierarchy that can be used to break down the final product to smaller and smaller pieces that were either manufactured from a certain raw material or purchased. The manufacturing hierarchy is usually known as bill of materials (BOM). (Sadagopan 1998)

Manufacturing resource-planning systems included the control of manufacturing capacity. Modules like shop floor control (SFC) that could be used to monitor and control manufacturing operations at desired level were introduced. Cost accounting functionality enhanced results the systems had in production environment. (Sadagopan 1998)

ERP systems have added integration to finance, human resources and various other functions found inside an organization. Multi-site control has become a standard feature in the most advanced systems. Complexity has grown into a key issue since most business functions are included in the systems and therefore the need for business process development is paramount. (Sadagopan 1998)

ERP is not just a reaction to developing IS possibilities but an evolution towards a more standardized business model. It may be discussed if the standardized model is needed but its implications are radical. No part of an organization can design the ways of working without considering the whole company's interests. In many cases ERP system will not allow undefined variation in business processes. (Shaw 2000)

Since the emergence of the ERP in the early 1990's, the scope of the business information systems has further widened. Supply chain management stretches now further and it is not limited inside a single company. Integration to various other systems inside and outside the organization is a norm and a prerequisite for business success.

2.2 ERP Composition

Enterprise resource planning software consists of integrated functional systems. Formal definitions often circle around modules or application packages of the systems, usually finance, distribution, manufacturing, human resources, etc. The purpose of the systems is to provide a common database for the whole organization. The uniform and comprehensive data can be used to monitor the organization and to automate routine processes. Underlying the concept of ERP is the paradigm, that all businesses have profound similarities. (Stenbeck 1998)

Stenbeck (1998) calls his idea the "principle of unique similarities". There is uniformity among different organizations. E.g. most of them seek productivity gains and improve their products or services to provide more value to customers. Many companies, regardless of the business, observe that competitors are copying their competitive advantage faster and faster and learning from the mistakes the market leaders have done. The most obvious similarities among businesses are the ways they handle their legal duties, taxes and financial information, for example.

The differences that make organizations unique are normally not as numerous as the similarities. There are ways to make the company more attractive to its customers. These are the unique competitive factors that ensure staying in business. The competitive edges do not last infinitely but their relative magnitude is constantly changing since competitors acquire the underlying knowledge and new innovations are made inside and outside of the organization. The unique features are vital for business and usually they form the most difficult processes to include in the corporate information system. By definition uniqueness is something that is one of its kind, "the quality or state of standing alone and without a peer", as Merriam-Webster's Collegiate Thesaurus (2001) states it. Therefore unique processes that make a company competitive cannot be bought in packaged software but truly unique features have to be built or configured to the systems in-house.

A known problem with integrated ERP software is that they cannot provide all parts of the system equal functionality with the best-of-breed specialized software, even though ideally the single vendor-approach yields significant advantage in implementations and support. The largest vendors of ERP systems have opened their products to third party systems to overcome the problem. They have also realized that specialized vendors can outpace them in the fast moving market (Stedman 2000). Without open application programming interfaces integration can be an agonizing process and its results last only until the next system upgrade. (Hoffman 1998)

Less tightly integrated systems provide flexibility to business units to perform their operations. The downside is that connecting best-of-breed software to the existing system can be really costly. Connections to old legacy system can take a large bite of money, up to a half of the cost of an ERP implementation. The newest ERP systems can do this much cheaper and easier, the trend still being towards a more open systems environment. (Hoffman 1998)

The system has to be able to supply various kinds of data about business. ERP suites offer a variety of built-in reports but there are some problems. The reporting needs depend on organization and processes. There are technical difficulties using the same system for data entry and reporting. Changes in reporting structure combined with variations in corporate ERP systems make direct reporting impractical. Time needed to fulfil reporting requirements is a paramount measure of development success. Often it may bypass even some report accuracy requirements, especially in internal reporting where the emphasis is on trends not on exact figures.

2.3 Information Management Role of ERP

ERP system is a tool for collecting and storing information in a defined form. Knowledge management (KM) is a closely related concept that deals with controlling and utilizing information and knowledge. From its standpoint, ERP systems control raw data that has no value outside of the natural context. The raw data has to be refined to knowledge about the business to get value out of it.

Ward (1996 p. 359) points out that a majority of information used by people in business is not automated, it cannot be found in any information system. Therefore there are challenges to utilize information systems and to optimally benefit from them.

Knowledge management is not discussed in great detail but some concepts of information transformation are presented. A model constructed by Nonaka and Konno (1998) describing knowledge transformations is shortly introduced.

Nonaka and Takeuchi (1995 p. 60) introduced a concept of tacit and explicit knowledge. Knowledge can be divided in two main categories, tacit and explicit. Explicit knowledge is formulated and can be expressed in punctual form, in writing, drawings, etc. Tacit knowledge is amorphous or fuzzy and it cannot be expressed directly. Only indirect signs may indicate its existence, e.g. experienced professionals seem to do things right even though they may not even know themselves why they choose particular solutions.

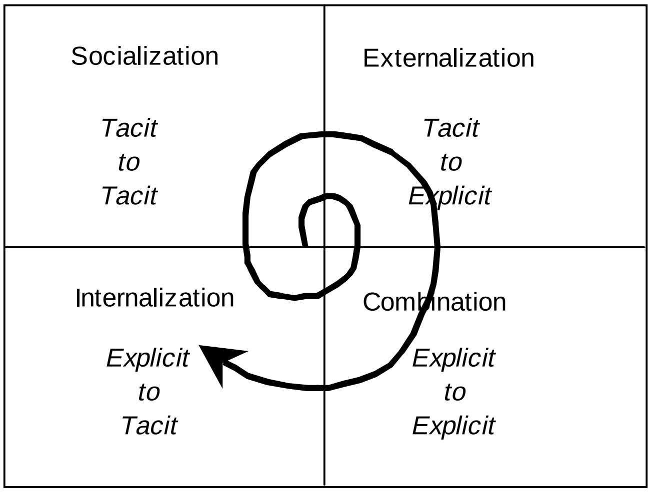

Figure 2. Knowledge spiral (Nonaka & Konno 1998 p. 43)

Data storage and management tools handle explicit knowledge. Their potential in knowledge management is transforming and distributing explicit knowledge. In the model by Nonaka and Konno (1998), presented in Figure 2, the combination and internalization phases can utilize ERP system. Understanding and knowledge grow step by step, forming a spiral that goes though all transformations during each circle. The scope of knowledge grows, which means that comprehension of the actual topic increases and also critical thinking capabilities mature. At the outer circles the knowledge can be actively questioned and tested.

The combination happens when information in explicit format is communicated between groups of people. Information systems provide good tools for this kind of interaction, especially for analysis and distribution of large amounts of data. In practice the data could be performance reports, operational analysis, etc. that are communicated to groups of people in a well-known form.

In the internalization phase a person acquires knowledge in an explicit form and builds his own tacit knowledge structures. Any written information can provide the starting point in ERP environment. Coded information is available and there is a task that can be accomplished with the available information. Gradually the person creates more or less conscious understanding of the problem and possible solutions. It takes time to master the task but the information provides a basis for growing the expertise. Expert systems are a well-known example of internalization. At first the users rely on the program logic for decisions but gradually they accumulate understanding of the problem. Eventually there may be no need for the system, whatsoever.

As a conclusion, ERP systems provide means to capture data from the business processes. They can also feed the captured raw data back into the processes where it can be utilized and transformed to information. People process the data into information and no automated tool can replace them. The processes have to be considered in wide meaning. Returning data to process can happen in forms of operational data, e.g. a delivery address, or as an executive report of previous years' sales. Therefore a primary ERP function is the capability to report data in various formats of that support operations and management.

3 MOTIVES AND BACKGROUND FOR SYSTEM INVESTMENT

Companies seek benefits from Enterprise Resource Planning (ERP) systems in various ways. Most commonly benefits are pursued in process improvement, correction of problems with existing systems, systems integration and organizational structure changes (Hyvönen 2000 p. 41; Parr & Shanks 2000). Some aspects are strategically important, e.g. creating additional value for customers and some are intended to rationalize processes. In this chapter motives for ERP investment are discussed, starting from businesses' strategic objectives and the potential of information systems promoting them. Connection between organizational change and the need for ERP systems is often said to have the most important influence in perceived success. Interaction between business process change and systems development gets here a great deal of attention.

In Chapter 3 explicitly expressed goals of investments are analyzed according to their strategic importance. A concept for analyzing information system parts by their strategic position is introduced. It is noteworthy that benefits differ from academic and system vendor's point of view. This is discussed in detail in subsection 3.4.

3.1 Investment Decision Stage Success Criteria

Successful ERP initiative focuses management attention and persuade them of concept importance. Prior to project launch it is vital to sell the need of change to the people responsible of business, because there are many obstacles to overcome later during implementation.

Direct measurement of investment proposal success is hardly possible. Management expectations and commitment affect subsequent project phases but they are mostly formed prior to launching the project. Project resources are given based on management's view of possible benefits and demand to get the work done.

Pre-project actions can be viewed as success if they provide the management a realistic impression of possible ERP benefits and requirements. If the top management is willing to fully support the effort there is a chance to succeed.

Project success can be used as a surrogate measure for pre-project actions. Meeting budgets, schedules and expectations does not only depend on project execution but also on actions taken before any kind of project is officially started.

3.2 Link to Corporate Strategy

According to Anthony (1991 p. 326) business strategies can be divided into two levels by their scope. The corporate level strategy should answer to two basic questions. Firstly, in what set of businesses – industries or sub-industries – should the firm be? Secondly, what should be the mission of the business units? Answering these questions may need a deletion, retention or acquisition of businesses in the corporation's portfolio.

At the business unit level Anthony states two strategic questions as well. For each chosen business, what should be its mission? How should the business unit compete to accomplish its mission?

The first question is relevant for both corporate and business unit levels but in diversified firms there is a difference between the two levels. Resources have to be allocated to appropriate purposes and it requires decisions about each business line. For single business firms there is only one combined strategy that deals with issues related closely to business unit level issues. (Anthony et. al. 1991 p. 328)

The approach is somewhat crude but the second level clarifies the scope of strategic issues that are faced in business information systems development. The latter category is relevant for ERP projects and business process development. Underlying are the questions what is the mission and how should it be accomplished. Processes are developed to satisfy the mission and information systems can have a significant role in some processes, often acting as enablers for the operational business model.

Outcomes of the business strategy assessment can be divided into two main categories. Either the basis of competitive advantage is cost leadership or there is more value added to customers. The latter outcome leads to differentiation and focused differentiation and it often needs innovative information systems that must be developed for the particular case. Cost leadership strategies do not focus on adding value but reducing costs.

Organizational control is kept tight and processes are trimmed, which requires streamlined operational support systems.

Information systems are implemented to support operations. The systems can also be viewed from strategy standpoint, how well they support strategic objectives. Some systems may be essential for smooth operations and some may provide unique capabilities. According to Peter Drucker (1995) the latter is what provides organization's strategic advantage whereas common but vital tasks can even be outsourced. He suggests that system's impact on the organization itself cannot alone describe its strategic significance. A position as a strategic system necessitates that the system provides true competitive advantage. Figure 3 illustrates Adelakun's (1999) view of the matter. Business operations usually contain both competitive advantages and information systems. There is the intersection where information systems either support or enable the strategic advantage. The enablers are undoubtedly strategic systems.

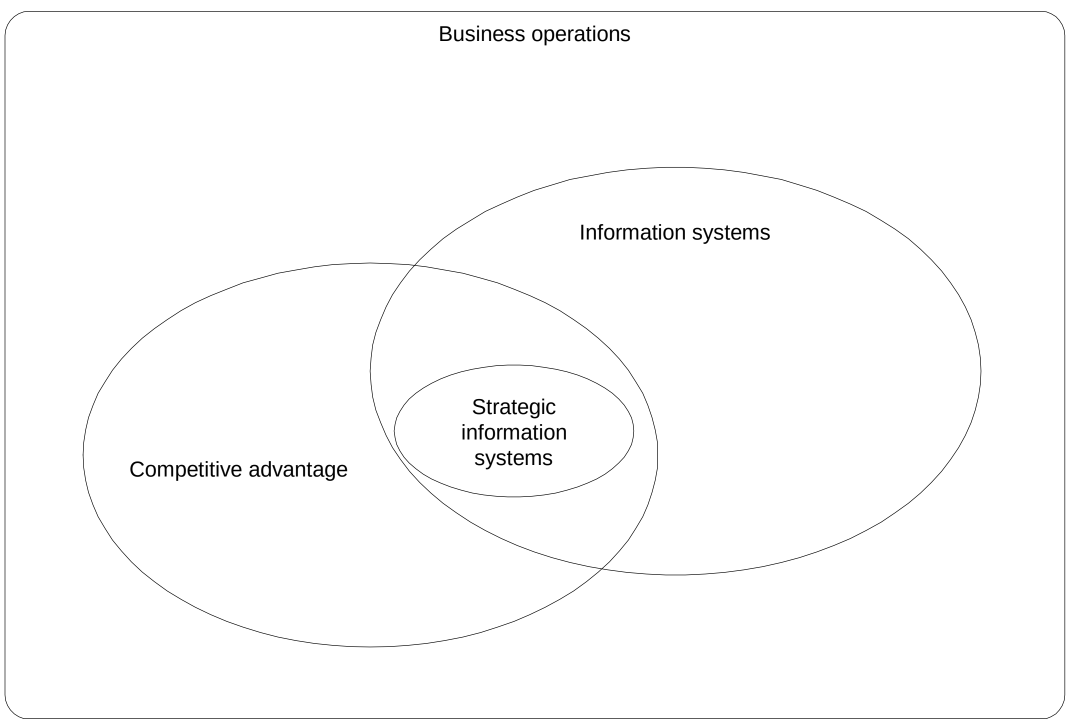

Figure 3. Role of strategic information systems (Adelakun 1999 p. 109)

In the past companies organized themselves almost solely on basis of material flows. There were functions to receive raw materials, store them and to manufacture, pack and transport goods. Companies still have to take care that the physical product is made and delivered but it is not the only way to build an organization. Information has become the backbone of successful corporations. Knowledge about markets, logistical chain, engineering advances, etc. can be utilized more efficiently than even before. Just like factories no longer need to be arranged around large steam engines, there is no longer a need to build companies strictly functionally. The latest advance in information effectiveness is focusing around external information. In practice this may mean e.g. customer relationships management systems. (Drucker 1995 p. 169)

3.2.1 Information Systems Categories

There are several ways to categorize information systems. Often they are classified according to organizational levels, functional areas, support provided by the system or the system architecture (Turban 1996 p. 38). Here a division by the strategic position of the system is used. Four stages in information system life cycle can be identified, high potential, strategic, key operational and support (Ward 1996 p.364). The original McFarlan (1984) model is illustrated in Figure 4. Key operational quadrant is also knows as factory and high potential as turnaround (Ward 1996 p. 32). An example of systems in each category is shown in Table 1.

High potential systems are either based of new unproven technology or they employ existing technologies to gain untried business benefits. Their value for business or organization structures may not be fully understood but potentially valuable systems are further developed with more resources. (Ward 1996 p. 365)

Strategic information systems are crucial for strategic goals of business and their development may enable additional value to customer. Business is highly dependent of them, which leads to requirements in flexible development and high system performance. Objectives of strategic information systems normally include adding value, not cost reduction (Ward 1996 p. 25). Typical strategic information requirements according to Ward (1996 p. 363) are:

- access to new market information
- automated communications with external bodies
- restructuring existing information to meet new demands
- use of multiple media formats and multimedia
- user friendly access to unstructured information
- business performance measurement
- "what if" analysis
- human resources information

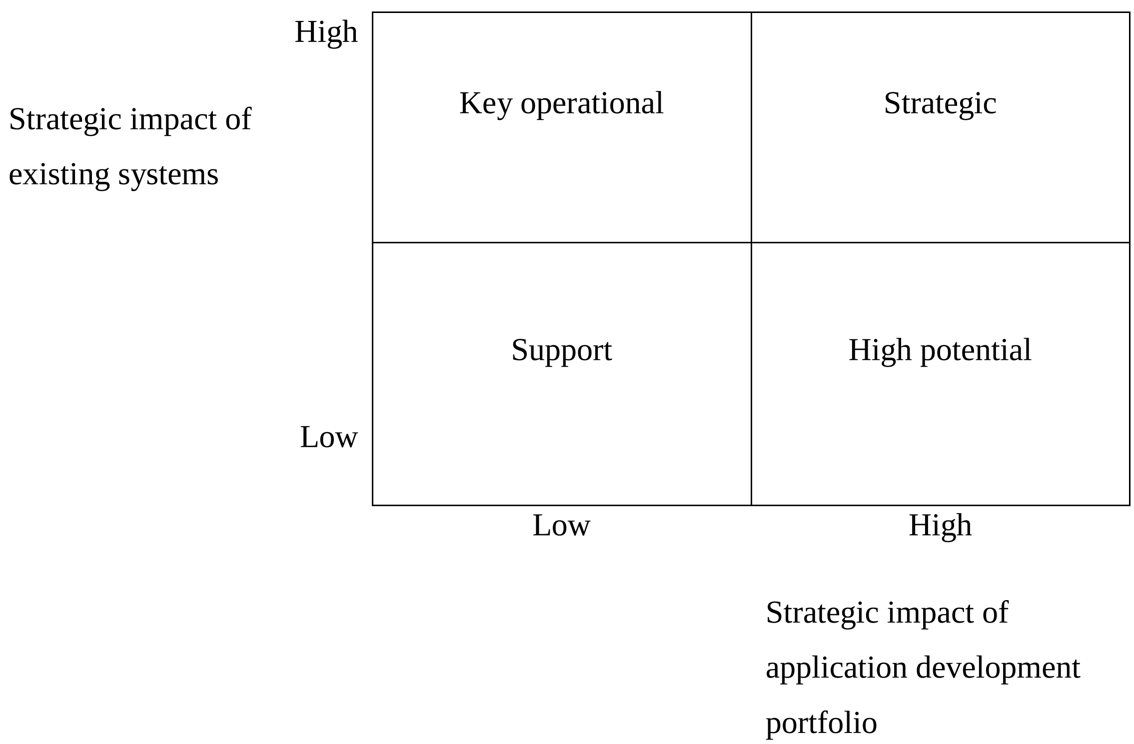

Figure 4. The strategic grid model (McFarlan 1984)

Key Operational systems support primary operational processes and are essential for their effective day-to-day running. Integration of processes and applications is aspired. The philosophy behind the category is avoidance of disadvantage, meaning that package software are normally used and own development focuses on integration. It should be noted that resources for key operational system improvement usually have to be diverted from strategic systems development. (Ward 1996 p. 366)

Support systems contain information that has less affect on activities. Usually such information arises from legal or corporate wide reporting requirements that are irrelevant for the subject organization. Only minimum effort should be used for development. (Ward 1996 p. 366)

Ross (1999) claims that ERP provides a basis for unconventional business methods and businesses. In her opinion the biggest impact of the system is not detectable by traditional operational measures but on parts of processes that have not been measured at all previously. ERP smoothes transition between one task to another and can help to create a new process arrangement. Therefore ERP can have a strong strategic role under certain conditions.

Possible new business methods may prove that some parts of ERP are strategic but it depends on business context. As mentioned earlier, strategic systems support competitive advantages. Therefore company's strategic choices of pursued advantages limit the strategic potential of ERP. It cannot be a strategic system if the processes it supports are not strategically important.

It can be argued that ERP modules fall in several categories. E.g. Ward (1996 p. 34) locates accounting in support systems, inventory management in key operational, and order management in strategic and EDI connections in high potential quadrant. Since strategic advantages reshape themselves continuously, information systems move from one quadrant to another. A logical path would start as high potential system that gradually gains strategic importance. After losing potential for strategic advantage it may become either a key operational or a support system. Eventually the system is abolished when it fails to meet changing business needs.

Table 1. Example systems portfolio in a manufacturing company (Ward 1996 p.34)

Key Operational	*Strategic*
Bill of materials database	Order management
Inventory management	Links to suppliers (JIT/JOT)
Shop floor control	Multi site MRP II
Product costing	Sales forecasts & market analysis
Maintenance scheduling	Product profitability analysis
Employee database	
Receivables & payables	
CAD (product design)	
Customer database	
Support	*High Potential*
Time recording	EDI with wholesalers
Budgetary control	Manpower planning
Expense reporting	Decision support (capacity planning)
General accounting	Expert fault diagnosis
Maintenance costing	Document processing
Cost accounting	
CAD (layout design)	
Payroll	

3.2.2 Determining Strategic Position of an Information System

Since information systems can be categorized by strategic significance, tools for such division are needed. The approach based on system deliverables is used here. ERP systems consist of parts in several categories and the model by Ward and Murray (1997) helps to determine significance of each of them separately. Even though the whole system can be more valuable than sum of its parts, the classification can effectively be used to select correct measures and investment criteria for separate system modules.

Table 2. Benefits categorizing table (Ward & Murray 1997, p. 33)

Degree of measurability	Benefit	Enables new function	Improves process	Discontinuation of task
Economical				
Quantitatively measurable				
Measurable				
Observable				

Rows in Table 2 indicate to what extend a project is based on belief or well thought goals. Expected benefits are shown in columns. If two top rows contain little or no data, the project predominantly bases itself on faith, not on defined goals. In support IS projects the benefits usually concentrate in discontinuation of tasks, whereas benefits from key operational system are in improved process. Strategic systems often justify themselves by enabling new functions.

As can be seen in Table 2, the degree of measurability in expected benefits varies. Here a four-level model is introduced. Each level is a subset of the level below; e.g. all economical benefits are quantitatively measurable – which means they are measurable – which means they are observable. The lowest row, perceptiveness, is the widest class. Practically any physical behavior can be observed and conclusions can be drawn from observations. The next step is requirement of measurability. A set of attributes has to be defined that can be reasonably valued by qualitative or quantitative methods. Quantitative measurement methods make up the third category and in the fourth one, the benefits can be precisely measured by economic means.

Traditional capital investment appraisals classify investments somewhat differently. Therefore a line between the concept introduced here and traditional investment division can be drawn.

Surprisingly few ERP investment projects have tangible goals. Few companies implementing them have set up measures to evaluate investment even though ERP is usually the largest information systems investment they have and at least a half of all IT projects are not as successful as they should be (Keil 1995). The position of ERP as a strategic system may blur measurement possibilities. However, as Drucker (1995 p. 40) notes, most future dominant trends are visible well in advance. Strategy should include tools to measure long term success of investments.

3.3 Process Approach to Business Activities

Companies conduct various functions to achieve business goals. Throughout industrial era the functions have been considered the most important factor in deciding the form of an organization. This has resulted in functional departments like manufacturing, sales, development and accounting. Usually none of them alone can perform all required tasks to fulfil the business needs.

Business can be viewed as logically related tasks that have to be carried out to achieve a defined business outcome, an output for a customer or market. The consecutive tasks needed to achieve the desired result form a business process. The core idea of process approach is to take distance from functional orientation and to consider the company as an entity capable of executing business processes alone or with other companies (Hannus 1994 p. 31). An outsider view helps analyzing how much value is produced in the process. There may be steps that add value and steps that may even deduct it. Process approach with value analysis provides a basis for business development (Hannus 1994, p.18).

3.3.1 Business Process Development

Business processes form a framework for operational development. Process phases that do not add value or even reduce value are considered as candidates for abolishment. Also smooth transitions between phases is a favorable condition. Every organization has internal transaction costs caused by organizational actions taken to acquire input needed to produce output. They are the costs that are realized to maintain the procedure, not to carry out the actual value-adding process (Coase 1937). Reducing their total share is a normal goal for process development effort.

Total functionality of a value chain is an economic reality that overruns legal fiction of a legal entity. Customers do not care if a company produces its products or if it subcontracts them. Only the results, compliance of requirements and cost are meaningful, not the question who owns what and who has taken care of a particular step in the process. Therefore the whole value chain has to be managed. In traditional businesses newcomers that have gained significant market share, usually have a cost advantage of about 30% because of well managed value chain. Drucker (1995 p. 127) argues that all successful cost-cutters have adopted a view that includes also business partners, not just internal processes.

Hannus (1994 p. 99) suggests that business process development can be classified into three categories according to effort scope and implications. His model is illustrated in Figure 5. The least ambitious is continuous improvement that focuses on small steps to right direction. Radical redesign of core processes starts from questioning the assumptions that form the basis for organization's processes. Extensive internal reformation of the organization is likely to occur. Thirdly, the most challenging way to improve organizational efficiency is to redefine the business. Customers, products and ways to operate are questioned. E.g. new technologies may form a basis for totally new business concepts that can be utilized in-house or transferred to spin-offs.

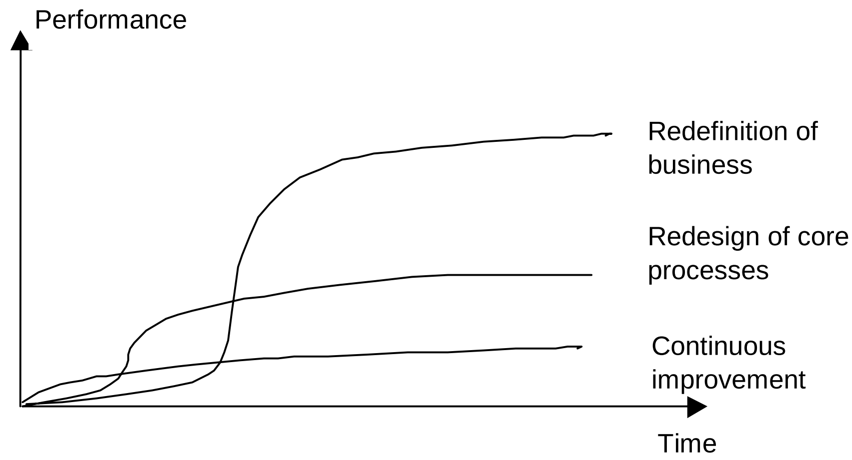

Figure 5. Change categories according to Hannus (1994 p. 99)

The first business process development category, continuous development, concentrates on doing things right, while the second and the third category focus on doing the right things. Degree of uncertainty affects what kind of change is needed. In a predictable environment continuous improvement provides means to accomplish required tasks, but if external shocks affect the company, a more radical change is needed. Because of decrease in business predictability questioning the very basis of the business is needed more often than in the past. (Hannus 1994 p. 99)

Origins of revolutionary improvement lie often in information technology. It changes either customer needs or means to satisfy the needs. If existing processes are not compatible with the new vision, evaluation of the situation may result in a process re-engineering project. Precondition is that the benefits are large enough. Normally a radical improvement is sought e.g. to reduce lead times 90% or improve productivity 300%, etc. Such vast benefits do not appear without risks and serious effort. (Hannus 1994 p. 99)

3.3.2 Business Process Re-engineering

Business process re-engineering (BPR) is a concept of radical change that emerged from articles by Michael Hammer, Thomas Davenport and James Short in the beginning of the 1990's. It pursues radical improvements instead of continuous change. Information technology acts as an enabler of the business process change and therefore ERP has been connected to re-engineering.

Re-engineering concept uses experiences of other process management schools that arose in the 1980's to promote business performance with an emphasis on quality and process efficiency (Hannus 1994 p. 222). Hammer (1994 p. 105) argues that breaking old assumptions is the first step of re-engineering process. The old processes must be questioned and judged if they make sense in the new environment. Traditionally information systems have been seen as tools that can be adapted to fulfil business requirements. BPR considers information technology as an enabler that has a revolutionary role. It offers business opportunities that have strategic implications and may require abandonment of existing paradigms that form foundations for business ideas.

According to Davenport (1995) there exist two types of process information. There is so called performance loop, which ensures that objectives are being met. Secondly, relevance loop tries to make sure that right processes are in use. Knowledge management terminology calls these single loop learning and double loop learning. BPR concentrates on the double loop learning as it questions the purpose of organizations.

Single loop learning, which is also known as adaptive learning, aims to conform performance objectives. It concentrates on capability to adapt to external conditions and it is a precondition for double loop learning. Double loop learning, which is also known as generative learning, means continuous questioning of existing paradigms and ways of working. This is a fundamental requirement for re-engineering. Organization has to be able to impugn its purpose before it can successfully carry trough truly radical change. Viewing the company as a set of processes helps forming a vision of its purpose. (Malhotra 1996)

Davenport (1995) claims that the process approach has been neglected in older quality management schools. Malcom Baldrige award has 7.5% of its total score in "information and analysis" category and a good evaluation in the field can be achieved with no organized process information systems. Baldrige examiners have noted that firms interpret these requirements in more diverse ways than in other categories.

Grover (2000) argues that functionally oriented organizations are much more resistant to spontaneous change than process oriented ones. Functional orientation tends to hide the need for change, since reasons for organization's existence are not directly connected to external matters but rather on internal interaction between departments.

Deeper aspects of business process change are often ignored according to Grover (2000). Only shallow changes in processes are made e.g. combining consecutive steps or removing unnecessary ones. A more thorough approach would include company culture, performance measurement, skill development and structural realignment aspects. It has been found that applying the deeper approach enhances results experienced by re-engineered companies. IT-staff acts as a gatekeeper in the process. IT professionals are among the first to participate into the effort and by nature their field is multi-disciplinary.

Need of business process change arises from incompatibility between standard ERP software and organizational processes. Hyvönen (2000 p. 46) has found in a study of Finnish companies that in 32% of implementations the ERP system was customized to meet business processes. In 14% of the cases organizational processes were rebuilt according to the system. A majority of the cases, 55%, had both customized parts of the system and re-organized processes.

Business processes are required to change in a majority of ERP projects. Balance between requirements to the organization and information systems has to be found case by case. Too little flexibility in business processes results in extensive system customizations that jeopardize many of the expected integration benefits (Adelakun 1999 p. 185)

Information systems offer possibilities by enhancing business processes in the ways introduced in Table 3. None of them enables alone radical process improvement but they can be used together to create strategic advantage. (Hannus 1994 p. 224)

Table 3. Information system potential in business process development (Hannus 1994 p. 224)

Possibilities provided by technology	*Importance and effects*
1. Transaction ability	Changes unstructured process to routine transactions
2. Overcoming distances	Processes are less dependent of time and place
3. Automation	Reduction or replacement of manual work
4. Analysis	Utilization of analytical models
5. Sequential approach	Possibility to re-sequence processes or carry out simultaneous process steps
6. Knowledge management	Gather and relay information
7. Tracking	Status tracking of individual transactions
8. Streamlining	Bypass intermediaries

The possibilities 1, 2, 5, 7 and 8 in Table 3 directly support BPR. They can be used as means to create more value in process change. The other possibilities can speed up process improvement but they are not often used themselves as the preliminary building blocks of the new processes.

3.3.3 ERP Contribution to Process Development

History of automated data processing is full of belief that the new systems would independently conduct business. Computer generated business models were seen as substitutes for executive tasks. Their importance in this sense was grossly overestimated, however. Nobody believes anymore that computers alone can run businesses but their importance to operational support has been tremendous. (Drucker 1995 p. 120)

The systems change the tasks they are designed to accomplish. Information system implementation is not just a matter of automating the old tasks, but fitting new tasks into the process and abolishing the obsolete ones. Concepts and tools are tightly interdependent and when one changes, the another has to adapt too. ERP projects are almost always combined of both information systems implementation and business process development. Due the complexity of the implemented software some revision of business processes is a must. A large system investment is built on shaky foundations if the underlying ways of working are outdated. (Drucker 1995 p.121)

Nelson (1982) has defined ERP as software for *automating organizational routines* and modeling corporate strategic processes with the purpose of integrating internal corporate information and sharing it between the firm and its partners. Organizations are built on a purpose of accomplishing a – more or less specific – task. Williamson (1975) considers companies as a set of transactions. It can therefore be seen as a tool to coordinate and reduce costs caused by business transactions. However, it should be noted that inefficiently organized business transactions rise business complexity.

Morabito (2000) defines complexity as

Complexity = Uncertainty x Interdependence x Vagueness.

ERP reduces the vagueness of transactions by providing the same information base for all process steps. One of the most distinct features of present ERP applications is that all their operations are based on a single large database. Since the data format is uniform, all the functions access the same kind of data with no need to convert it between different data structures. (Morabito 2000)

It is also suggested that decision-making process can be improved since uniform data offers better means for analysis. More reliable analysis lengthens and widens the scope of reliable predictions. (Morabito 2000)

Integrated ERP system lowers transaction costs because they

- favor the integration between the different phases of the value chain;
- consent to a more functional integration, allowing better integration of operative activities;
- favor division and coordination of work;
- favor integration of the programming and control systems;
- favor integration of knowledge, needs and expectations, during the development of the program.

All the listed characteristics reduce coordination costs and have an effect on the interdependencies, i.e. reducing the "governing costs" and improving their quality. They help people to coordinate themselves. (Morabito 2000)

3.4 Benefits Expected out of ERP

Underlying reasons for ERP projects can be categorized according to their position in business – technology axis. It can be suggested that technical motives are more inward facing and less strategic than business initiated motives. In practice the division is not very sharp but it is useful for understanding the initiative and goal setting of ERP projects. Problems in technical side can be invisible to business but sometimes they may become serious obstacles of daily activities. On the other hand, technical improvements are necessary for utilizing new business opportunities. These business goals usually require simultaneous actions in several fields, of which the technical implementation is one.

Miscellaneous other reasons that drive information systems investments relate unique events like the year 2000 and euro currency. Needs to upgrade information systems by the year 2000 and euro currency have similarities. They are both initiated by an external condition, which in these cases affects a majority of organizations. In general, normal IS design work includes preparations for external changes. (Hyvönen 2000)

Hyvönen (2000) surveyed enterprise resource planning systems use in Finnish industrial companies in November – December 1999. Of about 100 respondents 51% noted process development as an initiative for information systems investment. The other common reasons were problems with legacy systems (43%), standardization of IS (34%), change in organizational structure (25%). Some other high-ranking reasons were the year 2000 (63%) and euro currency (41%). These two differ from the other causes of investment since they occurred only once and were caused by a unique situation, though it could be argued that there is little difference with other external factors affecting information systems development.

Keeping up with technological development draws managerial attention. ERP investment does not have a payback period in a traditional sense, but it is required to meet needs of the tightening competition (Reijonen 1999). It might be reasonable to compare this kind of IS investment with similar investments in other parts of company. There is normally an existing way to handle a situation where payback is small but there is no option other than to invest.

3.4.1 Effect of ERP Investment Initiator on Expectations

Origin of ERP system project initiative has an effect on the most expected benefits. Function that starts promoting the system has certain objectives and expectations. These initial expectations affect the later phases of the project and are therefore important for its success.

According to Hyvönen (2000 p. 51) and Connolly (2000) finance, IT and manufacturing departments are the most active initiating ERP projects. Finance departments also support investment in non-integrated systems. In ERP projects the initiative often originates in corporate head office level, which is understandable because of the size of the investment. The scope of ERP acquisition often categorizes it as a strategic project.

Support from senior staff is critical for ERP project. Because of corporate head office participation, it can be assumed that senior executives will support their own initiatives and throw in sufficient resources.

3.4.2 Business Benefits

Reporting requirements are better met by integrated systems. A uniform database provides access to large amounts of relevant data about the business. Therefore capability to produce management information has been an important motive for ERP implementations. Inventory management costs, for example, can be drawn down considerably with the help of up-to-date information provided by ERP (Connolly 1999)

According to McVittie (2001) ERP software can provide a hefty payback by improving information correctness, e.g. order entry tracking through the system without a need for manual re-keying. Information transmission via email or interdepartmental mail introduces a risk of errors and information loss, which can be eliminated in integrated system. Another source of business benefits is enhanced ability to respond to customer inquiries. ERP systems are also designed to increase flexibility in cases of corporate restructuring. It is possible to reconfigure the systems with relative ease in cases of mergers or organizational restructuring.

Information systems can be used to build barriers for market entry. If the systems are complex enough, they are difficult to imitate and require long learning time. Being first in the market can therefore provide a cost advantage over later competitors. Also switching costs can be enlarged with IT. If business partners integrate their systems it increases the threshold to switch to another supplier. (Applegate et. al. 1996 p. 89)

New products can be based on information technology. They either contain IT or their design, production or distribution is based on utilization of information systems. (Applegate et. al. 1996 p. 89)

3.4.3 Process Development Expectations

Outdated business processes are a common reason for ERP investment. Hyvönen (2000 p. 41) claims that about a half of Finnish companies investing in ERP, have process development as a major initiative for project launch. Only the year 2000 problems ranked higher in the study conducted in September – November 1999.

Customer order decoupling point (CODP) is often subject to change in process development projects. CODP determines how much has to be done after a customer order arrives. Lower inventories and increased product customization can be achieved if CODP is moved upstream. Reduced inventories yield higher return on employed capital and product tailoring can be used to upgrade customer service.

A more modern look and feel to outside customers creates more business. Partly this is due to improved internal processes but the information system is a visible part of the company to the outside world. (Connolly 1999). Especially user-friendly add-ons like web-based interface and flexible connections to other systems are appreciated (Vijayan 2000). This effect is similar to image boost by new technology in general.

Productivity gains change balance in business relations. Reduced inventories expose weaknesses in other processes. Efficient internal processes can be further boosted by creative utilization of IT, creating cost advantage. (Applegate et. al. 1996 p. 89)

3.4.4 Technical Reasons

Every information system, and any other technical system in fact, finally reaches a point where maintenance is costly and support difficult to organize due to lack of people knowing either the used programming languages or the program logic. A high level of modifications and lack of documentation further complicate support. Often old systems fall short of expected performance measures or they cannot communicate with other systems at reasonable effort. (Adelakun 1999 p.183)

Maintenance and support are easier with integrated systems. Other reasons from more centralized license policy to user training are pro-integration as well. Particularly in ERP investment, systems standardization is a common justification. Compared to projects on separate systems, ERP projects are over three times more often seeking systems standardization benefits. According to Hyvönen (2000 p. 42) a half of Finnish companies investing in ERP systems expected benefits from decreasing the number of information systems.

3.4.5 Justification of Information Technology Investment

Ward (1996 p 498) presents the following categories of IT investment justifications. All of them apply also to ERP systems. Because of diversity of ERP functions and the number of systems they usually replace, many of them are normally used to justify the investment.

Application specific; Technology costs can be justified on the basis of the benefits delivered by the application, and so can form a part of the business justification for the application. The justification can often be based on efficiency savings alone, leaving the opportunity for further potential benefits by better exploitation of the technology at a later time.

To reduce costs of running and supporting existing applications, by using more efficient technology: most likely to arise in consideration of support or some key operational applications. The justification will depend on cost savings, based on the expected life of the application, against the cost of replacement, and any necessary modifications to the applications using the technology.

To replace obsolete technology: meaning technology that will no longer be supported, or technology that is no longer available because the vendor has ceased to trade or to supply the technology. As with any technology investment that involve support existing applications, it is prudent to question whether each application is still necessary to the business. If it is, there are several options:

Transferring the application to other existing technology already in use in the business, which may be a less efficient solution or through replacement with new technology, more in keeping with IT policies relating to nominated platforms and standardization across the business

Modifying or redeveloping the application to take advantage of more cost-effective technology, either existing or new ones

Cutting down the functionality of the application to the essentials and delivering these by one or other of the above means

Increasing the functionality of the application to increase the delivered benefits

As an enabler for the overall business strategy: by building an infrastructure designed to meet predicted business needs or to match the business style. The former may mean investment in a new set of development tools information library and desktop environments to enable more rapid and cost effective development in response to the pace of business demand. It can give users more local power and access to their information needs. The latter may mean a shift towards a more open networked environment, with greater standardization across the enterprise, to match the style and policies that are laid down at a group level.

To embrace growth in business volumes or swings in processing throughput: by ensuring adequate technology capacity to support both growth and change in business mix.

4 SYSTEM IMPLEMENTATION

After a decision to attain an ERP system is made a project can be launched. Due to size and complexity of the system, implementation has to be coordinated trough numerous steps before the new business system benefits begin to realize in full extend. This chapter discusses about ERP implementation project success criteria and tries to point out the most important factors that contribute to success. Matters that chronologically fall between the system project start and the finish are considered if they directly relate to project success. General business issues and project management are discussed from a system success point of view. Connection between ERP and business strategy has already been covered in Chapter 3.

The success criteria are defined in chapter 4.1. Several conditions of project success affect the overall result and an information system quality model is also utilized to assess project output. Success factor discussion begins in Chapter 4.2 that covers general implementation characteristics.

4.1 Success Criteria for Enterprise Resource Planning System Implementation

Determining criteria for ERP system implementation success can be complex if the project is large and involves many interest groups. Here a two-sided approach is used. Firstly, project outputs are analyzed and secondly, used resources, or 'input', are checked if they meets plans. Both relative ratios and absolute values of these two dimensions can be used to determine whether the project has been successful. Normally minimum requirements have to be met in order to qualify a project as a success. Surpassed goals are considered advantageous, especially if relative resource use is lower than expected. However, budgeted resources should not be exceeded, since it may lead to unexpected situation in corporate financing. (Koskelainen 1998 p. 8)

Output side criteria of project success consist of technical system quality, business quality and user quality. The model developed by Adelakun (1999 p. 76) is shown in

Figure 6. Balance between the three information system quality dimensions is important for the total system quality.

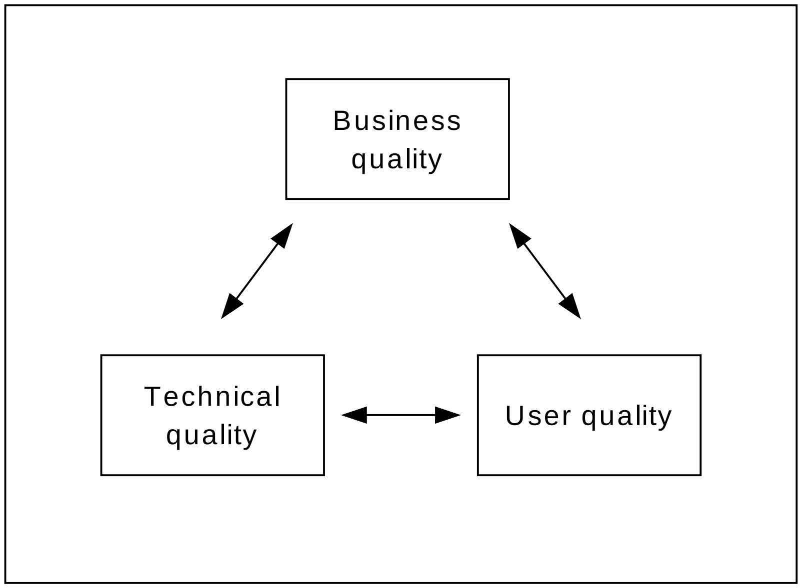

Figure 6. Information system quality dimensions (Adelakun 2000 p. 69)

4.1.1 Technical System Quality

Technical information system quality is the most used approach in software development and installations. Functionality is assessed by technical qualities. Computer program quality is described as compliance with specifications, maintainability, performance, etc. The primary goal of all actions taken to improve technical quality is to reduce costs and problems of computer solutions. A universal quality definition is missing but usually a high quality software meets a definition stated by the International Standardization Organization (ISO/IEC 1991):

"the totality of features and characteristics of a software product that bear on its ability to satisfy stated of implied needs"

The definition of quality is so broad that it includes many more factors that can possibly be taken into account. Implied needs are difficult to interpret to system characteristics and they may lead to confusion in the design stage. The technical quality view is normally based on system definition that is considered to be given from outside. The process pays little attention to how the definition is reached.

As a conclusion, technical view and its requirements are necessary for building a satisfying information system. It is, however, not enough. User and business dimensions must also be observed in order to achieve system success.

4.1.2 User Quality

User quality emerged after technical quality view was proved incapable fulfilling user requirements. The most commonly used view of user quality is system's fit for end user needs. Underlying idea is that individual good for large number of workers in the organization benefits the organization as a whole (Adelakun 1999 p. 60). Goodhue (1995) notes that the user quality cannot be judged based on just user questionnaires and interviews but the tasks that have to be handled by the user must also be understood.

End user satisfaction depends on numerous factors. Information content, accuracy, format, ease of use and timeliness are key measures of user satisfaction. Later added attributes contain precision, currency, reliability completeness, conciseness and relevance. The mentioned measures emphasize service and support for the system. Technical qualities fall short if training and support are insufficient. (Adelakun 1999 p. 66)

User quality measurement has been a problem. Management information systems research has relied on indirect measurement of systems quality via user satisfaction queries. According to Goodhue (1995b) interpretation of the results is conducted most efficiently by analyzing how well the available tools can be utilized to perform a particular task. Task-technology fit research is a goal directed way to analyze how tools meet task requirements. Enhanced individual performance results from two factors. Firstly, the technology must be utilized and secondly, it must be fit for use (Adelakun 1999 p. 65).

Plenty of research has been conducted about task-technology fit of software. Goodhue (1995) notes that results from utilization level studies have shown a considerable link between system's fit to a particular task and system use. This applies in situations when individual users have authority to decide what tools they employ. If software's fit for the task is poor but it has to be used, results suffer. Employees may also lose interest on the task if there are much better tools to handle particular tasks. In general, better task-technology fit yields larger benefits.

Besides technology's fit for use, support and service determine levels of perceived quality from user's point of view (Adelakun 1999 p. 66). Even though continuous support has to be organized during the project it is mostly covered in Chapter 5 that discusses about the post-implementation period.

4.1.3 System Business Quality

Business quality of an information system describes how well it meets business requirements. Systems have to be aligned with business strategy and they can justifiably be judged by their ability to support organization's strategic goals. The business quality of an IS can also be judged by its net value (Adelakun 1999 p. 74). Costs and disadvantages of the system are subtracted from benefits and the result is the net value of the IS for the user organization.

Net value = Total Benefits – Total Costs

Notable is that, as Adelakun (1999 p. 75) points out, business quality, user quality and technical system quality are interdependent and cannot be separated from each other. Business quality dependence of technical IS quality can be proved by considering a technically poor system. If maintenance costs are higher than expected, even though the benefits may stay near expected levels, the net value is lower and hence also business quality has to be lower. The same kind of positive correlation exists with user quality. (Adelakun 1999 p. 75)

Information systems have to be capable to support strategic needs, including analysis purposes. In practice this means that sufficient reporting and analysis tools must be available and data has to be easily extracted for external analysis. Especially key operational and support systems in Ward's (1996 p. 34) classification should be analyzed by these criteria.

Strategically significant role as an enabler of business concepts may increase system's strategic position. These key operational or high potential systems have to be managed accordingly. Sufficient resources and open-minded attitude are needed to manage such systems. Success can be judged by utilization level among business users.

According to Drucker (1995 p. 131) executives need four kinds of tactical information to manage business. He calls them foundation information, productivity information, competence information and resource allocation information.

Foundation information is the oldest and the most widely used tool set for management. Standard measures like cash-flow forecasts, liquidity projections and different kinds of ratios are like measurements that a doctor takes at a routine check. They do not tell much if the readings are normal, but abnormal signs indicate problems that have to be taken care of. (Drucker 1995 p. 131)

Productivity information deals with key resources. Originally productivity of manual labor was the most important but numerous other measures are also used. Economic value added (EVA) and benchmarking are examples of tools in this category. EVA has been developed to illustrate total productivity, to show whether the enterprise really creates wealth. Benchmarking and EVA should be used to find out what works. They point out which product, service, operation or activity is performing unusually well. Drucker (1995 p. 132) considers these tools good for diagnosis of total-factor productivity, if they are used together.

Competence information is needed for organizational core competence management tools. The first step in competence information management is to keep track of one's own and competitors' performance. Unexpected variation in performance, whether success or failure, should be noticed. Success indicates that the business is enjoying leadership advantage and failure may show the first sings of changing markets or weakening competencies. Innovation capabilities are subject to special attention among competence information (Drucker 1995 p. 134). Measuring does not give all the answers but it focuses attention to noteworthy matters. Right questions are raised if successfulness of new innovation, market standing, research results, etc. are monitored.

Resource allocation information is involved in decisions about which businesses a company is involved in. Also questions how the resources are allotted among the businesses utilizes the type of information. The decisions are of strategic nature and normally no single information system can give the decisive facts but a broader managerial insight is needed. (Drucker 1995 p. 135)

4.1.4 Success Measures Related to Project Work

Project work has some unique features that deserve some attention other than the three-dimension quality model. A project is founded to achieve unique objectives within a time fence by a certain organization. Three main goals of a project are contentual result cost effectiveness and schedule. To some degree they are opposed to each other. One of the factors improves if the other two are compromised. (Koskelainen 1998 p. 26)

Project results have to measure up to expectations and project plan. Fulfilling requirements seriously affects perceived success in ERP projects.

Cost effectiveness of a project consists of actual resource use vs. achieved results. This is clearly a matter that relates to early stages of project management and how well the resource need is controlled.

Schedule forms an important factor of systems net value. Faster schedules lead to higher net value because of quicker payback. Especially harmful are project delays that blight expectations and cause excess costs.

4.2 ERP Implementation Overview

The biggest difference between ERP implementation and any other information system implementation is the degree of organizational change. Projects are large and organizational politics normally strongly involved. Finance department and top management are the most common initiators (Hyvönen 2000 p. 54), but information technology department has a major role and it has to act as a change driver to overcome organizational resistance (Ross 2000).

Numerous problems have to be solved in successful ERP Implementation. Firstly, package implementation constraints the process design. Usually users cannot get everything they want. Process standardization is required at the lower levels in order to empower the higher levels. Lower level employees may feel that their creativity is stifled. Finally, process integration occurs especially in the global setting, which limits independence. It has been argued that faster implementation leads to less trouble. Aside from quick implementation, business benefits and fast payback are key indicators of success. The new system should start producing tangible benefits immediately, with payback occurring within a year or so. The investment ratio of consulting fees to software expense for phased implementation typically runs about 1.5:1. (Ross 2000)

4.2.1 Implementation Scope Taxonomy

Implementation scope affects many aspects of the project. Therefore a consideration of different project cases is needed. There is no such thing as generic concept of ERP installation. Every implementation has its own characteristics that represent fundamental decisions made during the implementation process. Parr (2000) has created a three-archetype category model for ERP implementations according to physical scope, business process re-engineering scope, technical scope, module implementation strategy and resource allocation. Implementations can be categorized according to combinations of these characteristics. Several combinations may place a system in the same category. The possible categories are comprehensive, middle-road and vanilla. The categories and their key attributes are presented in Table 4.

Comprehensive implementations are the most ambitious and they usually represent multi-national company cases where ERP is implemented in multiple sites across national boundaries. Not only the physical scope is large but also the full functionality of ERP is implemented and industry specific modules may be developed. Because of the multi-site structure, in which business practices have evolved in several directions, there have to be extensive process re-engineering. Complexity of the business requires a large number of legacy systems to be linked to ERP. This may be achieved in two approaches, either module-by-module or the whole ERP at the same time. The idea of integration by module is to phase out the ERP implementation over a longer period but more work may have to be done than by implementing the whole system and then linking it to the outside world.

Table 4. Range of ERP implementation characteristics and their values (Parr 2000)

Category	*Physical Scope*	*Business Process Redesign Scope*	*Technical Scope*	*Module Imple-mentation Strategy*	*Resource Scope*
Compre-hensive	Multi-site Inter-national	Local BPR International BPR	Minor modification Major modification	Full functionality Custom modules	over 4 years over USD 10M
Middle-road	Single Multi-site	Alignment to ERP Local BPR	Minor modification Major modification	Limited set	over 12 months over USD 3M
Vanilla	Single	Alignment to ERP	No modification (except reports and interfaces)	Limited set	6-12 months USD 1-2M

Vanilla implementation is the least ambitious and least risky approach to implementation. Typically the system is installed in only one location and the number of users is considerably small. Usually only the core ERP functionality is used and business processes are adapted to ERP rather than the other way around. As a result the implementation time is relatively short, 6-12 months and only limited resources are needed.

Middle-road implementation is a category between the already mentioned extremes. There may be multiple sites but normally the scope of the module implementation is narrower than in comprehensive implementations. Customizations in the system and business process re-engineering are needed but not as widely as in the comprehensive implementations. The time scale is normally 3-5 years.

Decision about implementation scope and complexity should be answered according to the company's business strategy. ERP can provide considerable benefits in performance but automated information systems inevitably stiffen business processes. Therefore flexible and intuitive parts of theprocesses that add value to customers, are doubtful subjects to systems. Several companies have faced to strongest resistance to ERP in research departments that have a tradition of freely evolving ways of working. They consist of high performance teams that are highly self-motivated and also want to decide their own work procedures. (Parr 2000; Drucker 1995 p. 97)

4.2.2 ERP Implementation Stages

ERP implementation is not a steady course. Instead of linear development there are dramatic changes in organizational performance. Ross (2000) explains the model illustrated in Figure 7.

Design – This is the stage of making the design decisions. Companies have found that they have to adapt to the packaged system rather than change the software to meet the current processes

Implementation – At a certain point of implementation inevitable problems arise. The scale of problems with technology, bad data and inadequate understanding are larger than in traditional systems projects.

Stabilizing – New roles and workflow have been learned and organization has re-stabilized. Typically this takes four to twelve months.

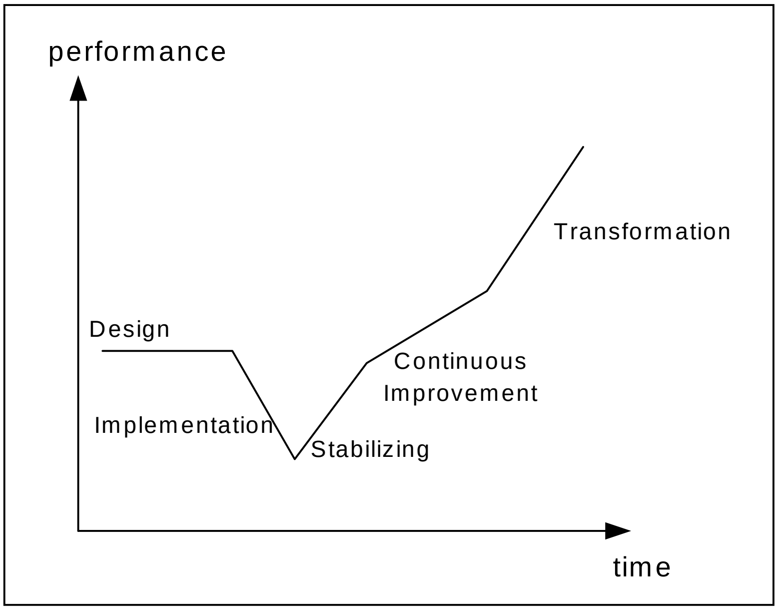

Figure 7. Stages of ERP implementation (Ross 2000)

Continuous Improvement – Expected benefits are starting to occur. Systems are continually improving as new capabilities are added and processes start to optimize.

Transformation – Organizational boundaries have been changed, the organization has developed ability to change rapidly with a changing environment, and management decision making processes have been redefined. A business transformation has occurred.

There is the inevitable pothole in the implementation course. The drop in productivity can be explained by radical changes that lead to short-term problems. There is always some degree of organizational redesign in ERP projects and controlling the downturn requires management involvement in several details. Change management is discussed in chapter 4.5.

4.2.3 System and Vendor Selection

Choice of ERP system should be based on functional qualities such as suitability to company's business and ability to meet requirements imposed by the business strategy in the long run. Technical qualities of the system are important and unsuitable solution can lead to disastrous results. However, even more important than selecting a technically superior system, is to match the system with the business needs. Using the latest technology but forgetting business-technology fit may lead to a situation with "a right answer to a wrong question", meaning that the fundamental assumptions of the system are wrong. (Romeo 2001)

The system selection process should start with a look at the business strategy. Understanding about the general business goals that are to be achieved should be clear. The second phase is definition of the system requirements - what must the new system do and how must it work. This phase requires extensive co-operation between all major functional areas in the company. The technology experts should have a very strong voice in the selection, as long as the technology does not become the overriding factor. (Brown 2001)

A Company with a clear technology vision is in a lesser risk of running into trouble in ERP implementation than others with less structured vision. External factors such as the year 2000 and euro currency have initiated ERP projects with tight schedules and superficially chosen systems. Large vendors have complex systems that can be configured for most situations and they have the most features to offer. Niche vendors on the other hand have specialized to supply certain industries and can provide software well aligned to their potential customers' business processes. If the selection is done solely on the basis of the system features, the largest systems usually will.

ERP system is its vendor's product, just like any other software. Vendors design their systems for specific market segments that are usually defined by customers' size and industry. Supplementary services that are offered with software are training, education, project consulting, best practices consulting, system configuration and system development consulting. (Enzweiler Group 2000)

Software price is not a very high ranking decision factor. Brown (2001) sums field experiences of ERP implementers. She argues that first time implementers rank software price and ease of implementation the most important decision factors but second time implementers consider vendor support the number one matter.

Several sources note the importance of ERP vendor selection. It is not just selection of a software supplier but a long-term business partner, implementation consultant and life cycle support provider (Enzweiler Group 2000). Vendors have differing perspectives to ERP systems. Some of them sell just one ERP suite while the others offer solutions consisting of components from several systems (Romeo 2001).

Procedure for finding the right system is likely to consist of several iterative rounds. Usually there are numerous potential vendors and systems, so it is reasonable to limit to number of systems that are studied in a greater detail. The first round should consist of relatively few high level criteria that the systems have to meet. More than a half of the systems should be ruled out, in order to keep the selection process fast enough. It is important to be careful not to rule suitable systems out but even more important is to limit the first round short enough that the project will not lose its momentum at the very beginning. (Kuipert, 1998)

The risk of getting the process stalled greatly increases if a large set of questions about a prospective system is addressed to each vendor. Kuipert (1998) points out a risk he calls a "candy store syndrome". If the systems are rated according to features they have, only the largest packages survive to following rounds. A good task-technology fit in the systems that are ruled out may be left unnoticed.

Information about offered systems should be sought from various sources. First hand experience about the systems is invaluable and it can be gained by testing the potential software in real situations. Ideally all user groups are represented. Normal users should carry out steps required by planned procedures. Tests reveal shortcomings of the system effectively, especially if documentation is adequate. Connolly (1999) argues that so far the biggest shortcomings of available systems are related to low technical quality and too frequent upgrades. Brown (2001) notes that ERP consultants emphasize the importance of documentation, not only in the testing phase but also in general during the whole ERP project. Many vendors tend to make over optimistic promises and extensive enough documentation may force them to show a more realistic attitude.

Besides testing, other sources of relevant information are companies using the product. Contacting also companies that are not in the vendor's reference list can be fruitful. (Brown 2001)

Importance of documentation exposes itself if supplier promises are required in writing. Extensive quizzing of a vendor can reveal weak features in software if the promises are documented and analyzed. Documented agreements also form a basis for legal claims if disputes arise.

Until quite recently, selection of an ERP system tied the company tightly to system vendor. According to Konicki (2000), previously it has been more desirable to wait until the system they contained the needed functionality. Now third-party component integration is a little easier.

4.3 Project Control

ERP system project is always a major effort in any company. The systems are complex and they are associated with high benefits, which increases expectations. The project management has take to care of certain key matters related to project success.

Some key issues are discussed in the following chapters. Project planning issues, staffing, use of consultants and software customization are unavoidably facing every ERP project. The common factor affecting all of them is support from the top management. If it is not strong enough there is little chance of success because there are always uncomfortable moments during the project as can be seen in the Figure 7 that is in the Chapter 4.2.2 discussing about implementation stages.

4.3.1 System Project Planning

Everything cannot be planned in advance. ERP implementation often includes considerable process redesign effort that is highly iterative. Hammer (1994 p.57) stresses that radical process change does not happen based on explicit and detailed plans. He considers iteration the key element that cannot be surpassed by planning. Good communication is much more important than fixing every detail in advance. Also a high-level progression plan can provide benefits (Koskelainen 1998 p. 15). It ensures that too fast or too slow progress can be spotted before serious damage has occurred.

Lack of planning is not good either. Brown (2001) points out a few common deficiencies in ERP project plans. Firstly, training and implementation time is commonly underestimated. Secondly especially first time ERP purchasers tend to overemphasis system price as a selection factor. Thirdly, they do not plan documenting principles in advance. Vendors promises should be documented to avoid too optimistic promises and keep track of the system that is being build.

MacVittie (2001) and Scheier (1998) stress importance of including costs of training, implementation, maintenance and customization in project plans. Two consequences arise from underestimating them. Firstly, budget overrun and late schedules harm implementation project and secondly, resource allocation is not correct, which reduces system quality.

A model for re-engineering and other radical process development programs can be found in research and development. The common factor between R&D and radical change incentives is their difference from traditional business improvement programs. There should be little emphasis on formal cost-benefit analyses and detailed project milestones in an effort to create a truly new way to operate. (Hammer 1994 p. 67)

Hammer (1994 p. 104) emphasizes several ideas in process change phase. Among other things he argues that there is no way of knowing in advance what will work if a truly new process is under construction. He is endorsing his re-engineering philosophy but the argument seems to make sense. Previously unknown matters cannot be thoroughly planned beforehand. Cliffe (1999) expresses a same type of opinion. She considers new ERP systems and processes as subjects of constant refinement from the moment they are first implemented.

Cliffe suggested that ERP projects should be planned and managed in the same way venture capitalists manage their investments. There should be little detailed planning but the general lines should be clear. If the project runs in trouble there is always an option to discontinue the project

4.3.2 Staffing

According to MacVittie (2001) experience from numerous ERP implementations shows that people time is the most overlooked project cost component. Many tasks have to be done and normally most of them are not included in budgets. Time used by the project staff is a major issue and therefore staffing and scheduling decisions are important project cost decisions.

The project team must be based on business people. There is plenty of experience suggesting that members should be selected to implementation team on basis of their importance to system operation (Romeo 2001). There has to be enough people with technical skills but the people who will operate the system have to have a central role. Their presence can ensure commitment to actual operation of the system if the change process is well managed. Favorable opinions towards the change will not appear without serious management effort and suitable actions (Hammer 1994 p. 136).

Romeo (2001) suggests that 60/40-thumb rule could be applied in ERP project staffing. There should be 60% representation from business functions and 40% from IT. A good blend of different disciplines is not enough itself. According to Romeo the team members must commit a full time effort to the project. Especially technical members are at risk of being assigned to the project only part time which can cause serious trouble and delays because they should be ready take actions when business solutions are drafted out. There is always plenty of experimenting with system proposals and if solutions cannot be tried out instantly the iterative loop looses effectiveness. The role of technical person is to provide support for experimenting phase and it can only be done if he is available.

Field experiences from ERP implementations (Romeo 2001) and from business process change projects (Hammer 1994 p. 201) clearly show that there has to be a project owner who is dependent of the project success. He or she has to be truly in charge of all needed aspects of processes that are going to be changed. The project manager has to be able to count on the project owner's support that should also be clearly expressed to everyone. Change that is needed in business processes and system architecture will not happen without sufficient communication between all involved parties. Hammer (1994 p. 136) argues that communication is the only effective way to start a change process.

After a successful project the ERP staff members are sought-after experts. MacVittie (2001) reminds that consulting firms search for people with ERP implementation experience. Therefore their compensation should be adjusted to appropriate level to keep the newly developed expertise.

4.3.3 Use of Consultants

Consultants can be used to speed up the implementation. Critical knowledge must be obtained from them before they disengage, to enable smooth operation of the system. Dependency on consultants should be avoided because ability to change processes is vital to organization's long term well being. (Hammer 1994 p. 73)

Consultants can provide valuable help bypassing mental barriers of change but they do not have responsibility like the own project staff does (Hammer 1994 p. 74). MacVittie (2001) reminds that consultant expenses are often underestimated. The cost tends to grow faster at later steps of the project when the most intense testing and system launch tasks are done.

4.3.4 System Customization

Business specific needs cause companies to alter ERP software to better satisfy their requirements. Most software packages offer plenty of tools for customization, thus facilitating modifications.

Recently customization issues have been considered under new circumstances. Every major ERP package has very extensive functionality and problems with software modifications have been observed in numerous companies around the world. Keeping the system standard seems to be the easiest way to avoid project escalation, budget overruns and late schedules (Gill 1999). Also Adelakun (1999 p. 187) and MacVittie (2001) affirm that there are serious problems with software modifications. Customization always takes time and prolongs the project. A more successful way is to create the processes on basis of possibilities the standard systems offer. Besides networking problems Connolly (1999) considers software customization and user training the most challenging implementation issues.

Competitive advantage can be attained with creative use of standard systems because customized components have little more to offer to the standard functionality. Development resources may be best spent on building new systems and interfaces on the outer perimeter of the company, on applications that provide completely new functionality to customers. Software modification is a poor tool for enhancing internal processes, as was already concluded in chapter 3.2.1. Strategic information system components are nowadays partly out of ERP's reach (Gill 1999). The newest trends are briefly discussed in Chapter 5.5.

4.4 Quality Issues During Implementation

Process development has to accompany the system development even in the smallest matters. Together they can provide complete solutions instead a set of tools that the customer, a business user can utilize.

Hannus (1994 p. 236) points out that development projects do not usually utilize the full potential of the available technology. A business process is not developed but an isolated technical solution is implemented without considering alternatives. Hannus (1994 p. 239) clarifies his statement with a famous example of Ford Motor Company's accounts payable department.

An automated data exchange was to be installed in Ford Motor Company to get savings of a few dozen percents of departmental costs, until someone noticed that a foreign corporation already took care of the task with a small portion of the resources needed in Ford. The competitor had streamlined its processes in a way that very few bills were ever received and no back order deliveries were accepted. Because of simplified process fever problems arose and much less manual work was needed. As a result the competitor had only a few people taking care of the tasks Ford Motor Company had 500 people assigned to.

Especially dangerous are projects that are initiated by technical staff. They may see that a manual billing procedure is obsolete from their point of view but they may not see the real alternatives from business point of view. The competing company in the previous example used information systems together with process changes to rationalize information flow in a way that the process step under consideration was abolished. Few technical people or few people in general, could see the potential of the process redesign. Extensive process development takes talent and sufficient resources to complete needed business changes.

Data cleanliness is a key precondition for successful system launch according to MacVittie (2001). All old data that is going to be transferred to the new system has to be checked for integrity. Usually the data quality problem is underestimated if no data is checked prior to implementation (Vosburg 2001).

4.5 Change Management

ERP software is designed to cover most organizational tasks. Integration of several functions is not easy to implement in the system because there should be close coordination between departments in the organization (MacVittie 2001). Therefore the change management effort should be an integral part of every ERP project.

Grover (2000) reminds that not all change in need of management is radical. He recognizes incremental change management important as well, even though lately most of change management research has concentrated around re-engineering.

Radical change proposals require more time on redesign human procedures, whereas structured process realizes with detailed process mapping and formal prototyping procedures. ERP projects seek high benefits from IT, which leads to a need of information requirement analysis and systems testing simultaneously with change management. (Grover 2000)

According to Senge (1994 p. 300) a shared vision is effective way to familiarize people with guiding ideas of organization. There are means to build this shared vision and organizational change depends on it. A key element in trustworthy project management is top management's personal commitment. The top management alone can make the project happen. If they show contradiction between what they say and how they act there is little chance of success. Grover (2000) argues that failures in re-engineering projects relate to companies' inability to manage changes and human resources.

Shorter project is always better than a long one from change management perspective. People stay focused in short projects. They do not have to worry about as many parallel tasks as they do in the longer ones. Signs of progress are visible and keep the project staff motivated.

The processes should be easy to understand by everyone. There should be obvious inputs and outputs for every process. Complexity is a sign of artificiality and it must be avoided. (Hammer 1994 p.19)

Hammer (1994 p.19) points out the most common mistake in re-engineering effort. He argues that in most cases there is far too detailed analysis of existing processes. The emphasis should be on creating new ones instead and a general understanding of the old ones is enough to accomplish it. He suggests that the problem is a result from process automation experience. In order to automate a process you have to analyze it down to a smallest detail. Lack of ideas is never the problem with re-engineering. Instead, lack of management support easily creates an atmosphere of self-censorship that causes creative ideas to fail (Hammer 1994 p.24).

Hammer (1994 p.1999) shows that general training about new process is necessary. Motivation is created by understanding, which also reduces involuntary errors. Conceptual training about the new processes should therefore be provided for all people using the system. Task specific information alone does not provide required understanding. Conceptual comprehension lowers uncertainty and change resistance but uncertainty is a major source of opposition. Therefore communication cannot be overemphasized. According to Connolly (1999) change management should be a full time effort of an experienced manager and should not be underestimated.

5 OPERATIONAL PHASE

After the system project is closed there is a shift in activities. Development effort does not stop but it re-focuses on matters that can be improved without disrupting the system operation. Operational support forms a majority of technical tasks and business has to learn how to utilize the system. In the long run an important success factor is how well the system supports changing business needs.

Key success criteria for operational systems are searched for in Chapter 5.1. The purpose is to find criteria how an ERP system can be judged as a success during its operation. User support issues are discussed in Chapter 5.2. Also system maintenance justifies itself worth an own chapter separately from continuous development. They are presented in Chapters 5.3 and 5.4. Finally some trends of ERP evolution are observed in Chapter 5.5.

5.1 Success Criteria for Operational System

Optimization is a major issue after implementation project. The information system must evolve with the actual business system and enable strategic plans. Adelakun's (2000 p. 110) three dimensions of system quality apply well also in continuous improvement of systems. Each dimension has certain criteria that apply when ERP system is operational.

Business quality has to be kept satisfactory to maintain organization's long term wellbeing. Achieving strategic objectives can be made easier by enterprise information systems that are designed to support pursued strategic advantages.

User quality problems may not constitute a major issue. Systems that fail to meet user requirements lower productivity and may lead to undesirable effects on employees.

Technically the system must be maintainable at reasonable cost with bearable risk of interruption in support. Not only maintainability, but also service availability must be predictable.

When these three criteria are met, an operational system can be defined as success. Due to the nature of business environment the success criteria constantly changes and there is no steady state in success factors.

The three quality factors in the continuous improvement consist of somewhat different matters than during the implementation project. Because of less intense development effort, consistency of development grows into a major factor. The progress has to be coordinated in all the mentioned dimensions. A development policy that is derived from the organizational strategy focuses the effort on the right things.

5.2 User Support

Forsman (1998 p. 215) summarizes state of end user support research in a few main facts. His research reflects views and experience from computing support in Nokia corporation.

- Need of professional support services is recognized.
- The interest in support services emerges from several directions: total cost of ownership, after-sales services, demand for productivity and from support business.
- Actual support solutions have evolved mainly from their contextual factors mainly as reactions to use demand.
- End-user support is technically oriented work, giving often only little attention to the customer service component of the work.
- Supporters possess significant power because of their practical knowledge, control of contextual links and their ability to prioritize their support tasks.
- Support service providers should know their market (customer needs) better and become more market oriented.
- The evolution of PCs and the networks connecting them have been the main technological reasons for the increase in support demand.
- Proactive strategy is recently emphasized in areas like user education, avoiding the demand for reactive support and knowledge management.

- Help desk is a popular approach for providing end-user support despite of doubts about its ability to create the required knowledge and the criticism of specialization.
- Recently it has been noted that users may be exposed to health problems while using IT tools and services.

Table 5. Typical features of reactive and proactive end-user support (Forsman 1998 p. 229)

Reactive, Demand driven	*Proactive, Strategy driven*
Fixes results of problems, not causes	Fixes problems at source
An information dead end	Gathers and disseminates information
A career dead end	A worthwhile career with prospects
Isolated	Integral
Passive – awaiting approaches	Aggressive – selling its services
Technically oriented staff	Customer-oriented staff
Struggling for resources	Justifies its own resourcing
A back-room function	IT/Customer services front line

McLean et. al. (1993) claim that key to success of end-user computing are adequate support and a strategic approach to the system development. Forsman (1998 p. 228) argues that the support has to focus on problem prevention instead of solving problems as they arise. He lists some features of the both approaches in Table 5 and concludes that the proactive approach defeats the reactive approach. The proactive approach actively seeks and distributes information whereas the reactive approach utilizes only a few channels and methods for co-operation with the other business functions.

Forsman (1998 p. 237) summarizes proactive functions in three classes. Education is aimed at people being in touch with the system. It contains general education, work related training and also the continuous updating of skills using bulletins, web information, user guides, etc. Protection is aimed at existing objects. Their existence, continuity and security are protected. Examples are computer rooms, back-ups, etc. Prevention is aimed at known risks whose probability will be reduced. Examples are thefts, sabotage, viruses, fires, power failures, etc.

Even though Forsman discusses about distributed computing environments in general, the above mentioned factors can be interpreted to ERP context. Users use distributed client software to access the central database and the systems replace many previous local applications.

A clearly supporting factor for proactive mode of support is a finding that trial and error method is the most effective way to learn software. Forsman (1998 p. 238) points out that experimenting is by far the most used learning method but there is a downside in it. A significant opportunity cost is associated to time needed for learning and solving problems. The biggest expense is the lost time, not measuring its direct cost but the lost opportunity to do something else. (Heikkilä 1995)

Forsman's model of risk in IS operation is illustrated in Figure 8. The inner circle shows interdependent parties that are involved in systems operation. Behind each party is a risk that may realize with problems in computing.

System problems can cause losses in two particular ways. Firstly, they can damage the business directly if outside communications are disrupted either with customers or suppliers (Forsman 1998 243). Such events could result from lost data or damaged supply chain functionality in ERP.

Secondly, lower productivity can result from user-related problems that were discussed earlier. Forsman (1998 p. 244) stresses the importance of using official user support procedure. It provides a learning opportunity for the organization as a whole. If the individuals who are affected by the problem always use the trial and error method there will not be any accumulation of knowledge at the organizational level. This applies to the peer support as well.

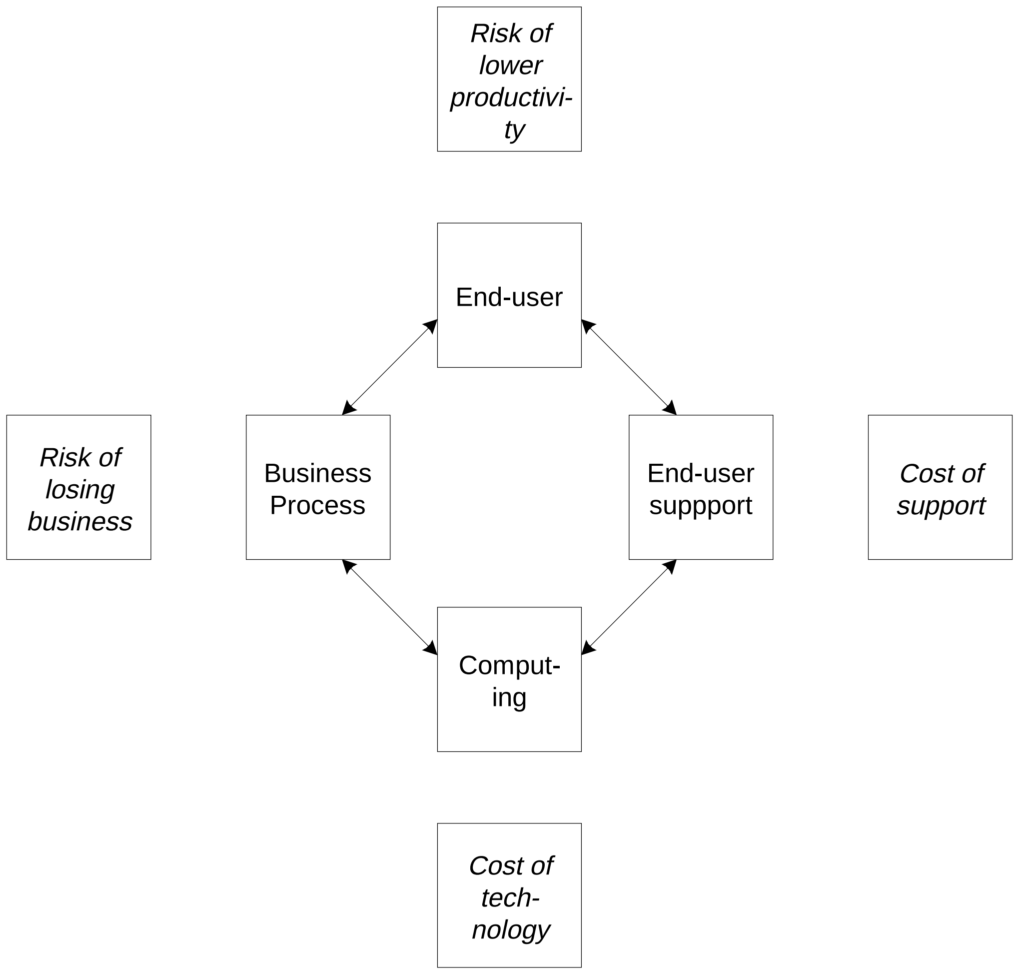

Figure 8. Problem sources and risk in computing. (Forsman 1998 p. 240)

Forsman (1998 p.249) argues that end user quality of any information system is inversely related to the amount of needed user support. Therefore the number of end user help requests could be used to indicate the user quality dimension of an ERP system. Frorsman (1998 p. 242) also notes that the optimum investment in preventive measures can be found at the point where marginal losses and support costs due poor system performance and marginal benefits of system quality investments are equal.

5.2.1 Help Desk

Help desk is a support organization that communicates between end-users and supporters, takes care of support task management in support organization, solves user problems and builds proactive support approach (Forsman 1998 p. 216). It communicates with users with telephones or other media, including computerized help desk systems. Often it is included in IT department even though majority of tasks are not very technical. Venkatraman (1997) proposes use of a value center model for managing information system resource use. Help desk activities should be assessed in terms of contribution to specific business, rather than in terms of operating costs.

Help desk's ability to accumulate relevant data has been questioned by Keyes (1997). She considers help desk incapable of collecting the required data for aid end user support because it has to start from the scratch. Instead she suggests use of problem databases. ERP applications are highly dependent of the installation due the large number of organization dependent parameters and software customizations. A problem database would be extremely difficult solution for such a system. Therefore her argument is questionable but currently there are some knowledge bases for ERP systems (SAP AG 2002).

Also Forsman (1998 p. 210) opposes Keyes's view and considers the help desk more like a focal point for user contacts. The most important function is therefore serving unstructured questions from the end-users. Forsman admits that the problem solving database would be an excellent tool but due the complexity of systems it might be impractical to realize.

Help desk staff specialization is somewhat problematic. It enhances productivity in problem solving, at least for a while. However, it may seriously harm future development. A strong emphasis must be put on communication between specialized parties in order to ensure organization's ability to innovate. (Forsman 1998 p. 210)

5.2.2 Training

Proactive user support relies greatly on user training. The users should have a general understanding of the systems and how they are applied to the business processes. They should naturally have also a detailed knowledge of the tasks they perform but it is not enough. Forsman (1998 p. 212) concludes that different levels of abstraction in user training are necessary. There have to be very general parts that locate the users in the business context and familiarize them with the main processes. With the contextual knowledge they can understand the requirements of their tasks. Not only the users but also the IT staff should receive training (Romeo 2001).

Training materials and methods should be managed accordingly. There has to be several media and several abstraction levels used. Web tools, self-service help, knowledge bases and manuals can be used to complement traditional training methods. They also provide a means to encourage the users to take a more proactive approach to their own competence development. (Forsman 1998 p. 212)

5.3 System Maintenance

People who know the system and have participated in the implementation project are important for the system future. MacVittie (2001) suggests that keeping them on the ERP team instead returning them to their regular duties is necessary. Also Hammer (1994 p. 66) argues that people who work for a significant organizational change project should not be returned back to their original position. Joining the team should result in progression in one's career instead of being just a sidetrack. Hammer discussed about business process re-engineering principles but the argument holds in ERP projects with lesser process change effort. There is always a considerable effort in ERP projects and without personal commitment chances of success diminish.

Outsourcing functions that have no strategic importance may be rational. Technical system maintenance, hardware maintenance, etc. are potential targets. New business benefits that are sought with the systems may require more control of resources. Ward (1996 p. 364) classifies systems in categories according to their strategic potential. Applications that can provide large benefits in the future but do not yet yield operational benefits must be managed differently from operational systems that have variable amounts of strategic potential.

Systems should be optimized to meet the most important business needs but over modification should be avoided. Software customizations add significantly costs on future maintenance and tend to cause technical problems. Instead of software modification the emphasis should be on continuous business process development. Tools that the systems offer can be used in a large variety of ways. Therefore a broader scope of business development with a toolbox approach to ERP is desirable. Suggested improvements in processes have to be discussed together with potential ways to carry out solutions with the system tools. If there is no interaction between business development and system maintenance, the solutions are likely to be expensive and some of possible benefits are probably lost. Information technology acts as an enabler for some business processes and there has to be knowledge of the available technology to leverage it.

5.4 Continuous System Improvement

During the system implementation radical change effects everything. The system that is being installed normally calls for radical improvement in actual business processes. As large scale re-engineering is involved, there is a need for change management and organizational promotion of the system. The focus shifts after the system is operational and the project is closed. The organization has to orient itself to optimize the newly installed system because without constant streamlining and developing there is little hope that the system will meet future demands and support changing business needs.

Patience is required from participants of an optimization program. Davenport (1993) considers needed time identical in length for radical redesign projects and continuous improvement plans. Both take several years to accomplish. Training and gradual change in organizational culture take the greatest part of time in system optimization. Cultural change and learning are related to the magnitude of change pressure and to volume of activities that need to be developed. Learning curve is a well-known phenomenon in industrial production, where productivity grows when the production volumes enlarge. Already Wright (1936) found that there is an inverse relation between produced quantity and unit costs.

Because of the learning effect, the number of processes that are used affects the time needed to master them. Therefore simpler processes are better even though they may not seem attractive at first. In ERP systems the number of used program sessions has the same kind of effect on efficiency as process complexity has in business processes.

User quality is heavily influenced by process complexity and by the number of process variations. Besides Goodhue's (1995) task-technology fit, complexity is also a psychological factor that predefines chances of information system success in user quality. Therefore the number of process variations can be used to analyze suitability of an ERP system for rapid learning. Simple system is quickly operated efficiently.

The newly defined processes, from the radical change phase during the ERP implementation, need monitoring and redefining from the moment they are implemented (Cliffe 1999). During the radical change, processes may be defined only at high level, and a more detailed look needs to be taken. Davenport (1994) argues that it is common to define process with only a single level of precision and to overlook the diversity of tasks that have to be accomplished in any organization. Major cross-functional processes are subject to radical improvements but small sub-processes are too numerous and often too vaguely defined for it. They naturally fall under scope of gradual improvement programs where the objective is to achieve a series of gradual improvements instead of dramatic upgrades.

An exact definition of process ownership is needed in order to meet customer needs. From process's point of view the customer is either internal or external but every process has one. Finding the real processes can be difficult due to functional orientation of an organization but for low-level processes the challenge may be smaller than for the main processes. (Davenport 1994)

5.4.1 Integrating Radical and Gradual Change

In contrast to radical redesign or process innovation, system development is mostly gradual, taking a small step at a time. These two approaches are not separate but they can be successfully integrated. According to Davenport (1993) there are four alternative approaches for integration of continuous improvement and radical innovation activities within firms: sequencing change initiatives, creating a portfolio of process change programs, limiting the scope of work design, and undertaking improvement through innovation. Improvement programs stress the rigor of statistical process control to minimize unexplained variation in a process. On the other hand, process innovation programs attempt to identify the technological or organizational process factors that will maximize variation and create fruitful changes.

Sequencing change approach is based on an idea that radical redesign and continuous improvement follow each other sequentially. Radical process innovation takes place during the ERP system implementation project and gradual changes are made after the system is stabilized. Davenport (1993) points out a problem with the approach. The full cycle of stabilization can easily take several years and its is often impractical to make plans for such an extensive period. The model is still useful for companies that are committed to systematic change over a long time span, but it cannot be planned in detail long time in advance.

Some leading companies use a portfolio of process change programs. The method consists of two steps. Firstly, processes are mapped at both broad and narrow levels. Secondly, they are categorized by the needed change. Radical process innovation may be needed if processes are not performing at satisfactory level and there is a strategic need for significantly higher performance. Continuous improvement may fulfil the needs of a process that has a direct effect on customer, but is currently working better than competitors' processes. Therefore gradual improvement that is a least as fast as competitors' maintains the competitive advantage. In general, processes that need rapid improvement are good candidates for radical redesign if they are strategically important and their current functionality is low. There has to be a favorable history of change in the area, as well. Otherwise continuous improvement may be more productive approach. (Davenport 1993)

The scope of work design to high level processes can benefit all kinds of improvement programs. The innovation team designs only the main processes and describes inputs and outputs for more detailed processes. Work teams design the detailed processes complying with performance objectives. The main goal of the approach is to increase employee participation and commitment. (Davenport 1993)

Undertaking improvement through innovation is an approach to integrate short-term improvement with long-term process innovation. Benefits from gradual improvement can either finance long term-innovation or they can be put in place for their own value. Company policy describes if the improvement initiatives can be launched when they are not inclined towards long-term objectives. (Davenport 1993)

5.4.2 Technical Aspects

Process and system development takes time and patience. According to Applegate et. al. (1996 p. 67) information system maintenance faces two serious problems. Firstly, most professionals are less aligned with the maintenance than with new designs because they consider it less creative and uninteresting. Secondly, running old systems can be very complex and demanding task that requires competent experts to overcome the technical difficulties within aging solutions.

New systems are aimed to give users more power to customize the system for their own needs. This so-called end user computing approach has gained plenty of support and presently many software development tools support it to some extend (Applegate 1996 p. 67). According to Forsman (1999 p. 151), end user computing can greatly boost user satisfaction but it introduces some risks as well.

5.4.3 System Risk Management

Forsman (1998 p. 241) identifies four methods for managing risks associated with information systems. They should be applied according to needs identified in risk assessment. The methods are general risk management tools and there is nothing IS specific in them.

Avoiding risk means lowering the probability of unwanted incident. It can be achieved by discontinuing dangerous processes and practices or modifying them.

Diminishing risk means lowering the probability of the risk and reducing the sphere of the incident. Splitting the object in smaller pieces, that are not affected simultaneously if just one risk realizes, diminishes the consequences.

Keeping as own risk means accepting the consequences of the risk event.

Risk transfer means shifting the risk by an agreement to someone else

Risk management requires categorization of risks by their frequency and severity. Options for managing different types of risks should be studied systematically. In practice most problems are caused by high frequency risks could have severe consequences. The four tools introduced above should be the applied according to risk management strategy. (Forsman 1998 p. 241)

5.5 ERP Development Trends

ERP is extending its reach outside a single organization (Grover 2000). Supply chain management, e-commerce, customer relationship management, etc. are logical extensions to internal process development effort. Hammer (1994 p. 313) argues that outward facing process redesign is a natural successor to support process development.

Simpler interfaces are needed to help new users to learn the system and also to let managers utilize the data. Confidence in data correctness and reliability grows only if the users feel comfortable with the system. Most ERP providers have developed web browser based user interfaces for a few years. Originally web browsers were intended for self-service applications but they have proved to fulfil user needs better than old interfaces. (Stedman 1999a)

Enterprise systems are widening their territory from a single company to larger supply chain management. E-commerce and customer relationship management applications are integrated to the recently installed ERP systems. Especially American manufacturing companies have been quick to install systems before the millennium turn. Three out of four were running them already in late 1999 (Stedman 1999b). Therefore the emphasis has shifted away from green field installations to optimization and integration projects.

Ease of integration is becoming a major goal in ERP systems development. Vendors are investing in modular software development that allows faster and more flexible configuration of enterprise systems as a whole. In the early 1990's systems were evolving towards fully integrated all-in-one solutions. Electronic commerce and integration of logistical chain across company boundaries require new ways to integrate ERP systems with external software. Blanchard (1998) sees the greatest potential of ERP in its capability to be a part of integrated information flow between separate business entities. He claims that the actual size of participating company has much less importance in integrated information environment than it has now.

5.5.1 ERP and Business Collaboration

The idea of E-commerce is based on functional back-end systems. There must be consistent data about products and customers in order to be able to provide automated systems for customers to acquire products. According to Copeland (2001), the benefits of business portals depend on the level of integration with basic business systems.

Automated trade exchange is the biggest promise that is based on ERP. The problem with one-to-one or one-to-many integration schemes is that they are not attractive enough for all the parties. Supplier's incentives to join e.g. an EDI scheme are normally fairly negligible because the system offers a connection to just one client. Usually the stronger party has to force the smaller members to join since the benefits are often one-sided, benefiting directly just the designer party of the system. (Stevens 2001; Stedman 1999c)

Many-to-many exchange offers the same automating benefits than the simpler integration schemes but it also offers superior liquidity in the market it creates. According to Applegate (1999 p. 184) and Konsynski (1990) the general trend is shifting away from building vertical connections in value chain towards establishment of alliances and partnerships. Applegate sees the potential of information systems in their ability to provide support for new types of inter-organizational co-operation. There are four types of partnership defined: joint marketing partnership, intra-industry partnership, customer-supplier partnership and IT vendor partnership. (Appelgate 1999 p. 186)

Joint marketing partnership is formed between companies that offer complementary services. They may be rivals in some area but mostly their products are not direct substitutes. Co-operation offers improved channel to customers at lower unit costs and it also widens the market to new customer groups. Also customers benefit from higher utilization of the supply channel because fewer separate contacts to suppliers are needed.

Intra-industry partnership is the most important but also the most difficult co-operation scheme. It is formed between direct competitors. The incentive may be staying in business by offering better contact to customers. Mid-sized companies may face a situation where their own power is not sufficient to provide strategically sensible services and the most enticing alternative is to pool up some resources with competitors. Numerous third-party networks exist because a non-stakeholder led scheme may seem safer choice to participants. In some cases legislation requires co-operation between competing parties. TradeNet system in Singapore is a well-known example of a partnership arrangement that it is legally required. (Applegate 1999 p. 187; Singapore Trade Development Board, 2001)

Buyer-seller partnerships are set up by sellers to support and service their customers. Under these contracts supplier often controls inventories and cost reduction is achieved through better utilization of total inventory levels in the value chain.

Technology vendor driven partnerships in IT are often arranged between a system supplier and a customer who is willing to test new technology products in a close relation with the supplier. The vendor gains knowledge about practical problems with the technology and the customer acquires skills and the technology that could be out of reach otherwise. (Applegate 1999 p. 188)

E-procurement, in general, offers high potential. According to Aberdeen Group (2001) savings over 70% in transaction costs, 70-80% reduction in purchase order processing time and 5-10% reduction in purchase prices can be achieved by utilization of internet technologies.

So called e-sourcing – electronic identification, evaluation, negotiation and configuration of products, suppliers and services – offers also significant benefits. 25-

30% reduction in sourcing cycle times, a 5 to 20% reduction in paid price and 10-15% faster times to market are achievable. (Aberdeen Group 2001)

5.5.2 Other Extension to ERP

Portals offer rapid process change possibilities. They act as collections of gateways to other systems and therefore enabling rapid changes in business processes. The approach requires that ERP systems are more modular than they currently are because most benefits would come if modules were changed if a business need changes. Presently the integrated system approach does not allow this. (Copeland 2001; McKeefry 2001; Waltner 2000)

Business quality of ERP critically depends on reporting qualities. Data warehousing is a tool for improving business intelligence dimension of the systems. The concept has changed slightly over the years, however. Not only refined and uniform data is inserted into storage but everything the company and its parties produce is considered valuable enough to be saved. Therefore powerful tools are needed to utilize the data that consists of documents in heterogeneous formats. (Hoffman 1998; Waltner 2000)

6 CASE STUDY: A MULTIPLE SITE ENTERPRISE RESOURCE SYSTEM IMPLEMENTATION

A major machinery manufacturing company was studied. The corporation had two main business units and a few smaller one as illustrated in Figure 9. An ERP system in one of them was studied. At present the corporation employs about 30000 people, mostly in Finland, Sweden, USA and Western Europe. Sales and service network covers much of the world.

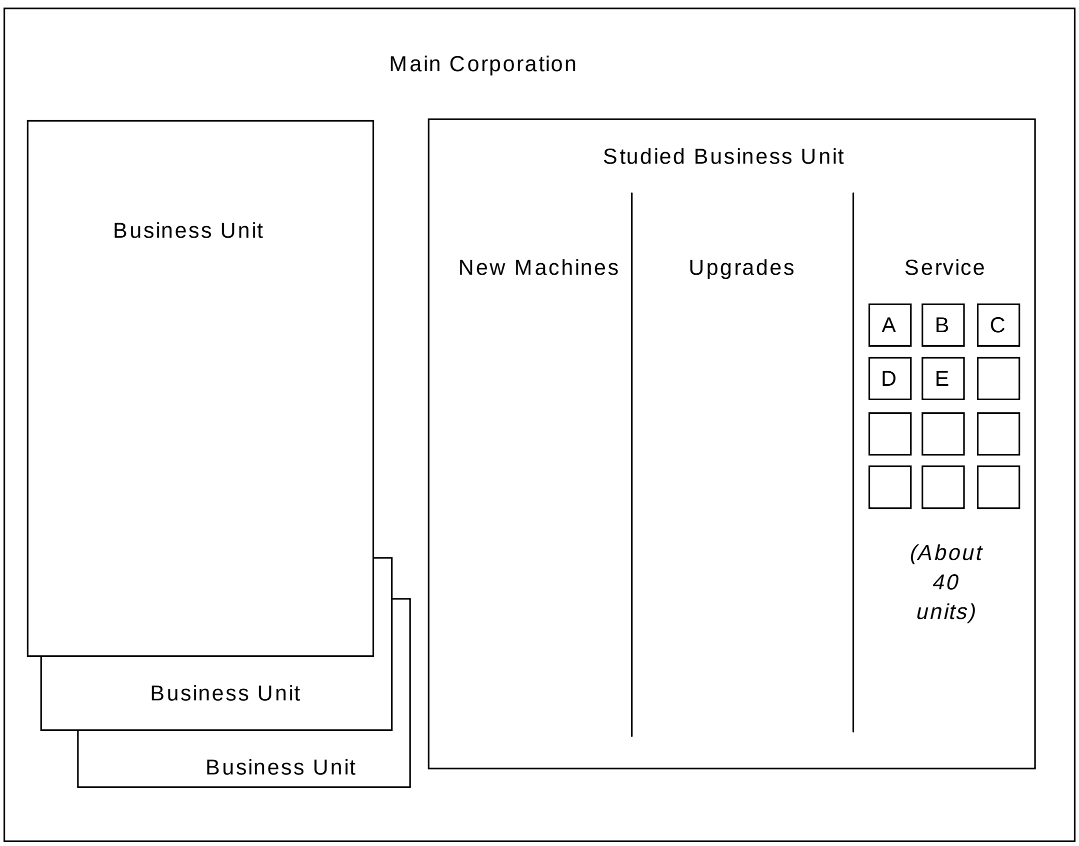

Figure 9. Case company structure

The studied business unit consisted of three business lines. They were large projects to build new equipment, smaller upgrade projects and continuous service to customers. The company unit had organized itself according to these three lines. There was considerable difference in the way the customers acted at each line and who was the actual customer. New machinery investment was always a major decision for customers and could be done only if top management was involved. Regional management or mill managers could decide some upgrades. Spare parts and process fine-tuning that belonged to the service line could be purchased at mill or production line level.

The service business was rapidly gaining importance and accounted for over 30% of unit's turnover. Because of the business characteristics, the units were relatively small but numerous and dispensed around the world. Some manufacturing activities are done in the service organization to provide replacement parts to customers locally. The corporation insisted on deeper involvement of the customer processes. This was to be achieved through selling availability of customer's production line instead of spare parts. The transformation from selling physical objects to selling availability as a service was in its infancy by the time of the study. There were some changes in the organization but the products and operational routines had not changed much.

Five service units were investigated in detail and their ERP systems were analyzed. In Figure 9 they are labeled A, B, C, D and E. Because they were corporate members, they had to be treated as such and possibilities to compare them as independent units were limited.

6.1 System Project Background

There were plenty of changes in the corporate structure throughout history. Several large mergers had been carried out in the previous years and their effect was clearly visible. Different kinds of traditions and operating principles made operations quite diverse and customers had to contact a number of different corporate units to maintain their projects. Corporate management therefore launched an effort to provide a more uniform and standardized way to deal with customers and to build a single contact channel for them. ERP system project fitted into the situation because of its promise of improved operational efficiency and powerful management reporting capabilities.

The corporation sought further globalization of its business operations. Customers were growing larger and they were also global companies. Operations needed global co-ordination in order to meet new strategy demands. The idea had been to offer globally standardized products and services for global customers and also to stay competitive for locally acting customers.

Global coordination was to be achieved with help of a new operation control system and product modeling. The operation management system was planned around an ERP software. Main business processes were defined with some more detailed processes within separate business lines. Also organizational structures were changed to enable the new processes. Additional accounting units were set up for internal accounting purposes, though legal company structures were left unchanged.

The product modeling scheme was intended to utilize the vast product knowledge in the company to a more productive form. The goal was to make the product data available to all in need of it in an organized form. Modeling was not considered just a part of engineering but an important part of all operative processes that formed a global network capable of delivering unified products from all companies in the corporation.

6.2 The ERP System Project

The ERP suite had been selected at an early project stage. Functionality had been the decisive factor, since not all vendors could offer a suite that fulfilled project industry requirements. Not all the asked functionality had been available in the selected software, however, and extensive customization had been launched. Therefore an ERP module had been tailored for the company among hundreds of smaller customizations.

Initially there were going to be extensive business process modifications, but the project scope seemed to grow and process development was scaled back. The changes were focused on an internal billing scheme. Corporate units were split into smaller entities that traded with suppliers and customers. It did not matter whether they were internal or external. Each entity had to be able to produce a complete financial statement, even though they were not legal entities. In practice this meant that there were several manufacturing units that traded with each other but there were also units with no manufacturing capacity that bought everything from the internal suppliers and sold the products further to external customers.

The arrangement had been realized together with the ERP implementation. Therefore it was closely associated with the system. Operational problems had arisen soon after the scheme was put in place. Users had argued that there were simply too many complex transactions between the internal parties. Also the system maintenance had became more difficult. All possible transactions had to be tracked and checked to produce the financial statements for each reporting entity.

The internal billing scheme was quietly dismantled. It had taken several years, however, to experiment with the complex system setup. The new model was more straightforward. Only legal units were asked to produce comlete financial statements, which eased maintenance and system use.

Project business showed problematic for the product modeling initiative. Products were engineered to order and development cycles were long. Information from customers had to be collected and interpreted from all phases of product lifecycle. The modeling project was disengaged from the ERP project and postponed for several years.

6.2.1 System Scope

The largest two sites both had over a thousand user accounts. Sizes of a few dozen smaller sites varied from a few to a few hundred users in over a dozen countries. The system was used in three continents, Europe, North America and Asia. An implementation project was also started in South America and another prospect was studied in Australia.

As discussed earlier, there was some business development effort during the early stages of implementation. It did not seek real re-engineering benefits but rather it was the finance function that led the project for internal invoicing.

Installed system packages included sales, purchases, inventories, manufacturing, project control and finance functionality. The logistics packages created transactions in finance modules, e.g. a purchase resulted transaction in accounts payable module, product delivery in accounts receivable module and inventory adjustment in general ledger. Project control was in a central role because of the business characteristics. Some functions were tailored to meet the business demands. In general, a quite extensive functionality was installed. Used system components are listed in Appendix 4. The effort to build a worldwide ERP had lasted almost six years by the time of the study.

Table 6. The case company fitted into the ERP scope taxonomy model.

Category	*Physical Scope*	*Business Process Redesign Scope*	*Technical Scope*	*Module Implementation Strategy*	*Resource Scope*
Comprehensive	**Multi-site** **Inter-national**	Local BPR International BPR	Minor modification **Major modification**	**Full functionality** **Custom modules**	**over 4 years** **over USD 10M**
Middle-road	Single Multi-site	**Alignment to ERP** **Local BPR**	Minor modification Major modification	Limited set	over 12 months over USD 3M
Vanilla	Single	Alignment to ERP	No modification (except reports and interfaces)	Limited set	6-12 months USD 1-2M

Comparison to scope taxonomy summary in table Table 6 proves that the ERP system belongs to the comprehensive category. The system categories according to the five criteria are presented in bold in the table. The only aspect that was not clearly proved to be in the comprehensive category, was business process redesign dimension. There were process development activities but they were not globally coordinated and some evidence suggests that few processes were truly redesigned. The overall category is still clearly comprehensive.

6.2.2 Corporate ERP Template

The corporation had decided to use only the selected system for all new implementations. No other ERP systems were allowed for new installations, but use of existing systems could continue. Sites had to their own choice to install the new ERP or keep using their old systems.

Corporate system management team had built a model for new implementations. The template was designed to speed up implementations and increase compatibility and maintainability of the systems. It answered various questions that arose during an ERP installation project. In practice it consisted of:

- the standard ERP software
- customized software components
- system setup parameters
- database table sharing rules
- coding rules (suppliers, item codes, etc.)
- master data (countries, currencies, SI and standard units of measurement, etc.)
- work instructions
- enterprise models
- implementation project phasing guide

The first component was the standard ERP software. The versions are maintained at corporate level. Secondly, there were system customizations that were used throughout the company. Further development and updates were centrally managed. Customizations included interfaces to other systems that were used with the ERP software. Reporting tools were also partly outside of the standard ERP system, so they and also other report content development was included in the category.

System parameters were set and tested at certain recommended values in the firm's business environment. There were hundreds of parameters that needed to be set correctly in order to avoid system malfunction.

Because of complex company structures, there were benefits to be achieved in data maintenance by database table sharing. Several ERP-companies that belonged to the same legal entity could share database tables and ease data maintenance.

Coding rules for certain database fields like supplier, customer and item codes were defined to provide a basis for information exchange between companies in the corporation. There existed about 200 coding rules, though not all of them applied to the whole corporation.

Master data was uploaded to systems during installation. It was not changed in daily operations and it did not contain any site-specific elements.

Work instructions were included in the template in two variations. There were process and session instructions. Process instructions described business processes from the system point of view. Session instructions, on the other hand, were more detailed guidelines of how to use specific ERP programs.

Process models were distributed with the template and could be modified to suit local requirements. There were model processes and model user roles for each of the company's business lines.

Implementation project model provided a framework for rapid implementation projects. The idea was to clearly separate development activities from system implementation work and to provide a solid model for project phases and tasks. The model consisted of four phases: planning, design, realization and implementation. Before an implementation project launch there was a separate project definition phase and at the end an evaluation and closing phase. The model was used for all corporate ERP projects and it had clearly contributed to rapid implementation schedules that were achieved. It had also greatly reduced implementation costs because of fewer resources were needed in the projects.

6.3 Corporate Level ERP Quality

The three ERP system quality dimensions, technical quality, business quality and user quality are discussed here. They are considered at the corporate level and the discussion is more general than in the later chapters where site specific cases are covered. The purpose of the chapter is to provide on overview of the ERP system at the corporation by the time of the study.

6.3.1 Business Quality

Business managers were surveyed to collect information about the state of the ERP system. Questions were about reporting, development and support (Appendix 1). Some problematic areas clearly showed up in the answers of 43 managers that answered out of 81 who received the questionnaire. 11 locations using the ERP system were represented along with some area management people who were responsible for several units.

Problems with system development and reporting capabilities were the most serious factors reducing business benefits of the ERP system. A few systems were even blamed of not being able to produce any information in the right format. Periodic reporting was acknowledged as timely and reliable but the information was not formatted according to the business needs. The information was fairly sufficient for managing business, however. This may suggest that the real problem was slow development of the reporting systems. Especially location managers had a negative impression of the development speed. Ad-hoc reports were asked to satisfy changing needs and to analyze data for "what if" purposes.

Business benefits from the system were considered moderate. There was considerable variation between units. A large Finnish unit had quite high rates for benefit-cost ratio, but another same sized Finnish unit was ranked the worst. Results from smaller and foreign units varied, but there was a trend that benefit-cost ratio of American systems was lower than elsewhere. It may be explained by higher costs of the system maintenance. It was several times more expensive in America than in Finland. An overall grade of the system was at the same level with the perceived benefit-cost ratio.

As the most serious problems with the system were related to reporting, there was a need to improve data extraction capabilities. At the time of the survey, reporting software was in use to extract data from the operational system database. Standard reports for sequential business tracking were implemented. Confidence to the report data was slowly growing after problems with early report versions were solved. The feel of the reports did not assure everyone in the management of their usability, especially because no training material was available. Some improvement was achieved through a separate data warehousing system that offered consolidated logistical and financial data.

The data warehouse imported data from various ERP systems daily. The imported data was converted into a uniform format to a single database that provided a basis for reporting. There were two types of applications utilizing the database. A management information software provided standardized data in graphical format. The measures were predefined to make them comparable between business units. It required the basic data to be reasonably correct but no perfect quality was assumed. Due the graphical presentation small variations and inaccuracies did not matter.

Regular business reporting was also extracted from the data warehouse. The reports were used for internal business management. There were multiple advantages over the reports printed directly from the ERP. Consolidated data was available, which was not the case with the ERP reports. Technical performance was better in the reporting system and also the ERP load was expected to decrease.

The data warehousing concept was at very early stages and the service units were the only ones using it. The pilot effort proved it very successful and expansion to other business units was planned.

6.3.2 User Quality

In general, users were partly unsatisfied with training during the implementation. Documentation effort was quite extensive at the first stages, but some end-user manuals required too much updating and their maintenance was discontinued. Originally there were two kinds of user instructions, process level and detailed program session manuals.

The process instructions ones described how a particular business process e.g. purchasing was to be carried out in the system. Needed program sessions and their order were listed. Accepted process variants were described and each of them contained additional information. If there were applicable session instructions, a link to them was inserted to appropriate step within the process instruction.

Session instructions explained how each field in the program forms had to be filled in. Each field was provided some background information. There were links to coding rules if one existed for the particular field. The total number of fields in the needed sessions was very large and soon the maintenance activity was called off. The original help files existed at the time of the study but they were partly obsolete.

Some units also prepared own manuals for their particular setups. The most common solution, especially in foreign locations, was to prepare a manual that described the whole process and all its details. Updating problems were present with them also. E.g. just a purchasing manual in a North American location contained over 50 pages, which made the maintenance laborious.

User training was organized during the implementation projects in form of lectures. Processes were demonstrated in the systems and the users had their chance to try out the system. Group sizes for lectures varied between the sites but were generally under a few dozens. Subjects were broken down by business process.

6.3.3 Technical Quality

Support staff was organized as competence teams according to the responsibility area. There was a team for system development and others for site support. The support and development staff numbered several dozens but due the organization they worked in much smaller groups. As new implementations were rolled out continuously, there was also a need for project staff.

The company had created teams that combined expertise both in information systems and process development. The teams worked fairly independently to develop procedures for their customer businesses. In the service organization the system and process development team worked together with the corporate-level business management. Therefore chances were good for knowledge transfer and co-operation between the bodies.

A formal strategy for process development principles was not clear. Implementation projects had been carried out with a respectable pace but in many cases there were just a few process improvement proposals that had been actualized. It suggests that the development strategy did not state whether the emphasis should lie in process development or in technical fine-tuning. A large number of system changes were initiated to fulfil the end-user requirements but the ability to respond to the development needs had decreased.

It took at least half a year to get even small program changes done because of the only supplier's very limited capacity to handle modification requests. At the same time system modification budget was not completely used. The problem with other possible suppliers was the system vendor's unwillingness to give the source code of the system to other software companies. Without the source codes only limited system changes were possible. However, some potential new partners were screened for future needs.

As a conclusion, the system was fairly stable and there were no immediate technical threats. Most program errors had been corrected and unplanned downtime was low. Many problems related to the customizations that were done in the early stages of the project. They made some maintenance task more difficult and lowered system performance. Also interfaces to other systems were complicated by the modifications because available standard interface modules could not be used.

6.4 Company A

Company A was a service unit located in central Germany. Several other corporate units were located at the same city, but Company A was the only one with the ERP system. About 20 white-collar employees worked at the location. A legacy enterprise system had been in use but it was a non-integrated system that did not require as strictly disciplined use as integrated ERP systems do.

There was corporate pressure to replace operation management systems other than the selected ERP. The site had a reasonable amount of business and there were already some quite successful implementations by the time, which obviously convinced global management to support project start.

6.4.1 Implementation Project

The implementation project had been started in 1999. The first documentation had been written in the early summer and the actual start date was in the fall. A thorough project plan considered numerous factors affecting implementation success. Planning was very detailed, e.g. there were 24 project milestones specified and the project staff was divided into six categories, which were used to accomplish the milestones.

Project goals were derived mostly from finance needs and requirements. Namely they were:

- to get the ERP system up and running for site
- to have good and fast control of the costs
- to make bookkeeping and reporting easier by installing finance module
- changes in way to operate to improve quality
- several business lines can use the same system

These were rather general objectives that could not accurately be followed or measured. The project did not satisfy all necessary success preconditions that were described in the theory of project and change management. Quality improvements were to be achieved by changes in procedures but there were no signs of business process development activities in the project documentation.

A big bang approach was used for the system launch. All open transactions were closed in old logistics and finance systems before the launch. The totals were transferred to the new system as opening balances.

Process streamlining had a seemingly low priority in the project. This might have related to heavy involvement of site finance people and to the corporate system template as a model for the implementation. Therefore the project can be viewed as a technical system replacement.

Originally, the normal template system was installed and set up but soon problems with German accounting standards appeared. An outside consultant had convinced the project management that standard functionality of the ERP system would satisfy legal requirements. Later auditors found deficiencies that forced the system to be re-implemented and the schedule was exceeded by over a year. The project was re-planned to exceed original budget by 65%.

There were somewhat differing views if the system re-implementation was necessary. The whole episode may have related to weak project ownership by the site. It may be suggested that there simply were not enough management incentives to push the project through problems. A consultant later commented that a controller at the site was highly skeptical about the system just a week before the original launch. This kind of attitudes almost certainly had an effect on people's willingness to solve problems. Re-implementing the system may have seemed an easy solution but later it caused plenty of additional problems.

The project was not officially closed by the time of the study. The system was operational, however, but there were many poorly performing parts in it. Operations were tracked in ERP but many manual practices continued. Coding systems, e.g. item codes were poorly implemented. Therefore inventory management was inefficient, which resulted problems also in purchasing and other operations. No material requirements planning, or other similar ERP features that enhance material flow, were used. Mainly the system was used to run accounting, sales and purchases.

6.4.2 System Status

A few people used the system and the most active user was an assistant who took care of accounting and sales data. Most Finnish expatriates in the location had no interest in the system and successful salesmen were allowed to do business outside of the ERP system. The problems with accounting standards had caused a bad reputation for the system and it was actively used as an excuse not to study it. Other corporate units that operated in the same building without an ERP also slowed down adopting the system by being examples how to manage without one.

Reporting was poorly handled. Only two licenses of the report software were purchased, and neither one was used. There was nobody knowledgeable of them, except a former system expert who worked as a salesman in the company. He did not have an active role in the system development.

Of all the factors inhibiting system success, inconsistent business management may have had the most significant effect in this case. The unit manager was fairly new to the company and he also left the company during the study. Even though there were no signs that he somehow prevented system success, his short stay in the company may have drawn his attention to matters more closely related to daily business. Also the decision not to accept the first installation may be questioned, since many other locations stretched the limits of local accounting standards with their systems. The project manager had had problems keeping things under control, which resulted in poorly implemented features in some system modules. User training was unsatisfactory as far as technical system data could be interpreted. There were a large number of signs of system misuse. Because of the second installation that differed from the corporate model, support was not as effective as elsewhere.

Help desk cases consisted mostly of technical system problems. The number of difficulties related to the German localization, which was taken into use in the second installation, was particularly high. Conceptual difficulties were few compared to the number of named users but the lack of actual system use may explain this. Also the strong position of the main user in the site potentially filters some difficulties from reaching the help desk.

6.5 Company B

Company B was a sub-assembly manufacturer in the corporation. It also maintained products for the final customers. A few dozen employees were working in production and less than ten in administration and sales combined. The subsidiary was acquired half a decade earlier and its position had changed from an independent machine shop to an internal supplier. Cultural change from a small firm to being a part of the corporate entity had been extensive.

6.5.1 ERP System Pilot

Company B had been used as a pilot site to test the corporate ERP model and to demonstrate early benefits of the selected ERP system. There was no operation management system in the unit by the time and such a system was desired. Therefore conditions for an ERP launch were favorable, which justified the role as a testing site. Some preconditions were defined for the pilot project with a well-known consulting company:

- one site
- limited process scope
- low risk
- stable environment
- ERP functionality supports piloted process well
- people at pilot site are ready to accept ERP
- enough resources are allocated to do detailed preparation
- conversion data easily obtainable

The conditions were satisfied sufficiently and the effort was launched. Prior to the pilot the corporation had chosen the ERP system and some consultants that were to be used. Also a statement concerning ERP selection was given shortly after. All new installations in the corporation had to be based on the selected ERP system.

Objectives for the project were:

- product standardization
- systematization of quotation process
- cost based pricing
- cost control and management
- decreased cycle time
- manufacturing load rate management
- inventory management
- automated cost accounting

Business needs formed the objectives and there were no specific IT goals in the list. Measurement of the targets was not explicitly defined in the project documentation. There was a time frame of seven months for the project, which can be considered relatively fast for the first implementation, even though the site was small.

6.5.2 Implementation Project

The start was postponed for a few months but the duration did not significantly change. The project was to be accomplished in seven months.

Site's needs were a central factor in the decision of the setup structure, because by the time the system was installed there was no corporate model for implementing ERP. Global reporting needs had to be fulfilled but many parameters and settings were decided during the implementation project. System details in inventory and procurement control were adapted to the local needs.

There was no operation management software in use prior the ERP implementation. Therefore no data conversion needs existed, which speeded up the project. No customization was accepted but the standard system functionality had to meet business requirements. Only some displays and reports were modified locally to better satisfy users.

27 modules in total were considered during the implementation and 14 of them were included into user training. A few of them were never really launched and use of some

others was later discontinued. It should be noted that the concept of module in the selected ERP package was quite narrow. E.g. production planning was a separate module from production control. Some parts of the ERP suite did not meet expectations and they were not used in later implementations nor included into the corporate ERP template.

At first technical responsibilities of the system hosting were left to the site. Central support was organized trough a main user who contacted either ERP support people in the corporate systems team for software support or a local external partner in case of hardware problems.

Later the system was updated to a version managed by the corporation. Technically the system was moved to the same server with the other case companies. Centralized support was organized and the site started to utilize the corporate ERP helpdesk. The setup was copied from the corporate template, which resulted in a loss of the original small modifications in reports and interfaces. Some technical problems were also solved by a new version of the software.

6.5.3 System Status

The number of help desk cases was moderate compared to the number of users. The experience gained during the years using the system did not significantly limit the number of conceptual misunderstandings and user errors. New employees triggered many of the cases, however. They either questioned the way the system worked or encountered problems in their daily tasks. Noticeable was that, after six months employment, a production manager still had very distorted image of several important system functions. At the same time the same person offered many valuable insights, showing capability to quickly acquire knowledge. This seemed to suggest that the system set-up was complex compared to the real processes and the number of employees in the firm.

Relatively few technical problems ended up in the help desk during the year 2001. Besides miscellaneous issues, there were clearly difficulties with invoice handling. Program errors complicated invoice matching with purchase orders. A great deal of invoice processing was done for inter-corporation trade where no actual payments were made. Invoices served only as a means to decide the final value of a transaction.

There were relatively few interfaces to other systems and none of them were designed in the site. Their maintenance did not cause significant problems and users mostly perceived them reliable. Only a manufacturing hours entry system sometimes caused trouble because of unreliable Windows system it was based on.

Reporting was considered to need the most attention in the system development in the near future. There was a new CEO in the site and he demanded more efficient manufacturing and logistics to be designed. Several aspects of the existing reporting system needed improvement and some of them had an effect on data input in the system. Anyhow, apparently there were no major needs to change the ERP setup itself.

6.6 Company C

The subsidiary had been bought to the corporation in the early 1990's. It manufactured large components for the parent company and sold maintenance services and replacement parts to end customers. Human resources consisted of about 40 blue collar and ten white-collar workers. The corporation invested into company C to increase its manufacturing capacity and to diversify technology portfolio.

The company had about 500 sales order lines a year, which is quite many, considering the large physical size of its products. A relatively large number of raw materials were needed for manufacturing. Most of the purchase value consisted of relatively few items.

Installation of the corporate ERP was suggested after the successful pilot tests in Company B. An effort to build an own operations management system was stopped and plans were aligned with the new system.

6.6.1 Implementation Project

ERP project was started in August 1998 and completed in the end of 1999. No previous integrated system was in use but legacy systems consisted of general ledger system and sales-invoicing software, which had no vendor support. A customized designing program was used for sales quotations and product design. A corporate-level reporting tool required input from ledger and sales systems but the output from them did not satisfy requirements and manual work had to be done with a spreadsheet program.

Products were found to be in a need for redesign to more modular structure as were business processes too. Standardization of product structures was a primary concern in development effort. Process-oriented manufacturing environment was seen as a problem for product standardization. Some financial processes were unnecessarily complex and posed a challenge to the ERP project. (Whiting 2001)

Expected benefits consisted of direct business profit and some technical improvements. Business benefits were dominant in number but the distinction between them and IT benefits was blurry at some points. Customer satisfaction was to be enhanced with higher percentage of in-time deliveries and by increasing product quality. Better reporting systems and more effective inventory controls were requested to improve competitive position along with better utilization of manufacturing capacity. General business benefits were expected from shorter cycle times and technology transfer from other units. The new system was to provide a solution also to problems with euro currency and the year 2000, besides easing system maintenance burden.

The project objectives were realistic and reasonable. Most of them were easily understandable and measurable. Technology transfer was difficult to connect with the particular ERP setup but the other goals were likely to help focusing the project effort.

There were three project management parties involved. The project was steered by a site project management team that consisted of site managers. A corporate development management team acted as an outside sponsor. The site leader was a member in it. Direct project control was given to a project manager who also was a member in the corporate steering group.

Installation of the corporate ERP template was not considered an easy task. The project manager commented that Company C had so deeply rooted routines that any change in the existing processes was extremely hard to implement. There was also some resistance to the system because the company had planned its own solution and had been negotiating with a potential supplier. Then the corporation had decided that all the new installations have to be based on the chosen ERP system.

Company C's system proposition had been tailored for them. The definition documents influenced attitudes towards the packaged ERP solution. Numerous very detailed functions were requested at first. This seemed to originate in an assumption that work processes were fixed and the information systems had to cope with them. The attitude hampered proposed process improvements and the system was considered a low performer in the corporation.

Reporting system was somewhat different from other units. A local data warehousing solution had been set up during the implementation and it provided various kinds of operational information. There were quite many potential ways to build new reports but the own data mart was the most flexible. Because of its location at the site, it provided short response times and it was also very reliable. The corporation maintained a global reporting database that was built on older technology. Its use has been limited and only a few employees mastered the tools it was based on. It also posed significantly lower technical performance than the local solution. The most notable downside of the local data mart was that the site got only a little help for development from the corporate systems support.

Purchasing and manufacturing timing were controlled with the local data mart that reported material needs and inventory levels. Standard material requirements planning and production timing functionality were therefore bypassed. The process performed at an acceptable level and the arrangement lowered the number of needed ERP program components.

Manufacturing activities were based on about 200 model engineering items that could be modified for specific need in each case. Bills of materials were modified and the items could be turned into manufacturing items that had manufacturing data attached. This data contained suggestions of how the manufacturing resources should be utilized to produce the item.

6.6.2 Continuous Development

Company C had invested into system development since the ERP was launched. Some existing pieces of software were integrated with it and a few new ones were designed to replace some functions of the ERP. Most development was done without corporate involvement.

New connections were built between external systems in manufacturing control and technical design. A production planning system fed materials to be used in manufacturing to the ERP that took care of higher level direction. The material estimate provided the base for cost accounting and operations development. The engineering system provided manufacturing information and cost data for customer quotations and orders.

Reporting continued to be a problem despite the local data mart. There was only a limited amount of information available and it was designed for manufacturing and purchasing needs. Sales people were dissatisfied with the information they could get from the system.

A simplified project reporting was implemented. Warranty and rework project costs were originally traceable only if a setup was done for every project. In practice it caused data recording to be postponed until someone had time to establish the setup. Since need for rework often arose outside office hours, there were difficulties controlling the cost structure in time. A number of projects were left without the definitions, causing quality cost tracking to fail.

The subsidiary was growing and it had two production lines that required separate monitoring. Business management wanted not only logistical information but also financial statements separately for both production lines. ERP system provided the information quite flexibly, though technical limits of the system did not allow all solutions at the originally proposed form.

6.6.3 System Status

Technical problems were often encountered in the company. They only slightly outnumbered conceptual errors and misunderstandings but their relative number (55%) was the second highest among the five studied sites.

Conceptual problems in process handling caused much of the help desk cases. A main user created majority of the cases but there were other authors too. Many of the cases reflected a serious lack of understanding of how the system was supposed to work. Some problems were corrected with additional training but clearly conceptual misunderstandings hampered some of the system functions.

The system was still under development two years after the implementation project's go-live date. Substantial benefits had arisen despite the needs still to be satisfied. Procurement fulfilled manufacturing needs better than ever, enabling a drop of late deliveries from 30% to 10%. Problems with supplier contracts kept the number up but more resources were available to deal with problematic suppliers, since automation of routines was in effect.

The site history that included own system design seemed to cause problems with the ERP. There is a reason to suspect that a "not invented here" reaction arose against the system. This caused plenty of features to be implemented into the new system, even though there could have been an option to redesign the business processes and apply leaner operations. Complexity of the processes caused the project to last over a year, which has to be considered a long time for implementation of that size. During that long implementation there was a significant risk of losing momentum and concentrating on negligible details.

6.7 Company D

Company D was a recent acquisition to the corporation. A partial ownership was still hold by the entrepreneur who had started the business just over a half dozen years earlier. The unit produced consumable parts for machines manufactured by the corporation.

Total staff was about 20 of which about a half were white-collar workers. The unit was highly profitable and business processes were fairly simple. Products were supplied in variable quantities and the number of production runs was high. The products themselves were fairly simple but almost all items were customer specific. Item codes therefore identified the item and its application in a particular customer machine. Technical differences between the products depended of attachment with customer's machine. There were about 2300 sales order lines a year but average order backlog was only a few weeks long.

6.7.1 Implementation Project

Project objectives were similar to those of the other units. There were business-driven goals that included:

- more reliable and faster order fulfillment process
- optimization of intra-corporate processes
- improvement in customer satisfaction
- improvement in quality
- flexible way to operate
- optimization of purchases and inventories
- business reporting

There were also two technically oriented objectives. Customer register was to be automated and the year 2000 related problems solved. Project documentation did not contain measures for surveying accomplishment of the goals.

An outside accounting company had done bookkeeping. An accountant was hired to take care of the tasks that had to be taken care of in the ERP finance. The finance setup was planned with corporate finance controllers.

Training had been phased into four steps. All site employees were introduced to the company operations change plans in a half-day general training. Everyone was also shown the new order fulfillment process. Only after that was task specific training started as hands-on practices. The last step was to introduce auxiliary systems that were needed to smoothly operate the business. They included corporate-level code handling applications and master databases for customer and supplier data.

Product coding could be decided to a large extend by Company D, because it was the only supplier of most items it manufactured. Most of the decisions were done swiftly and the project was kept on schedule. Only minor modifications were made in the system interfaces.

The project was completed within a planned time frame and slightly under budget. System functionality was considered quite good and the startup was relatively easy, even though the site staff worked long hours to get all needed data in the new system. Some problems occurred during the finance module startup. Books from the system did not seem to match with the accounting firm's books but the differences were worked out.

6.7.2 System Status

Company D system accounted the lowest number of help desk cases per user. Over a half of them related to system use and misunderstandings but there were only a few wrongly understood system functionality features. Technical problems made up only 28% of the cases, which shows high reliability of the system setup. Only one technical problem persisted several months but it affected the whole corporation and was not triggered by the site.

The simplified system setup caused much above average functionality, even though some users had only a limited training to the system. The lack of technical problems suggests that a straightforward setup significantly reduces technical risks and eases maintenance.

A few shortcomings of corporate system template affected the system. Technical setup was still fairly complex because it was copied from units with extensive project management needs. Some signs of the template origin were visible also in user interfaces that reflected business processes. Users had plenty of unnecessary tools visible on their desktops, which impeded familiarizing with the actual work process.

The situation was still bearable from end-user point of view because many of the unnecessary functions were hidden in menus that were not needed at all. A mixture of necessary and unnecessary tools might have caused more trouble.

There were signs of own initiative in business system development. A link to distributed warehouses at customers' premises was developed as an own project. It significantly speeded up information flow from customers to the company and offered hefty cost savings. The system informed sales people every time when a product was extracted from storage device located in a customer mill. No automated link to the ERP was initially built but the system enabled better scheduling of customer visits. Earlier over 30 mills had to be visited periodically to check if the inventory level was sufficient. The system was used only with some customers but it offered large potential benefits.

ERP sales and purchasing reports had been used to some extend. Figures matched well with the reality but the demand for the information was not very high. Perhaps the entrepreneurial past of the unit had led emphasis on a simpler form of reporting and detailed data was not considered a high priority. This can be suggested also by interpreting the unit manager's comments that profitability is the key indicator. The CEO had a deep understanding of the business and he could link variations in financial results to actual business events. Other people needed more detailed reporting, and the need increased as the company grew.

Physical process simplicity eased the use of the system. The ERP in Company D was much less project oriented than any other system in the corporation. Despite that the corporate system development had been aimed at system's project support capabilities the site had built a workable solution. Some complaints of the system complexity could still be observed but generally the staff and the business management were satisfied with the ERP.

6.8 Company E

Company E had been acquired about a decade earlier. The former owner had been in charge of the company for a while, until a part of it was sold. Company E coated manufactured machine parts with hard metal coatings. The manufacturing process was done either in their facilities or at customer site.

There were about 4-5 white-collar workers and about a dozen production-workers. Because a half of the manufacturing was done at customer mills, project management was important. There were two sets of coating equipment of which one was set up in the factory and the other one was moved around Europe for large customer projects. Besides large object coating, also smaller spare parts were coated at the Finnish factory.

There were about 300 sales orders a year. The sales orders consisted mostly of just a single line. About 20 different items were sold to customers. Purchase logistics consisted of acquiring about 20 different kinds of raw materials for the coating process. Six items made up 80% of annual raw material issue. All raw material purchases were controlled with inventory levels. Consumable parts for the manufacturing process were not handled as system items but as overhead purchases.

The inventory management procedure satisfied operational needs but there were problems with inventory levels in the ERP system. Inventory corrections were not always made accurately, which resulted in gaps between physical and system inventory levels. This proved that the system was not used to determine material requirements but it was done manually.

6.8.1 Implementation Project

The implementation project was carried out in less than four months. The small size of the company enabled the fast schedule, especially because customizations were discouraged.

Project objectives were defined in common business terms and consisted of:

- increases in throughput
- optimization of intra-corporation processes
- better customer satisfaction
- more accurate deliveries

- more flexible way to operate
- better competitiveness
- solving the year 2000 problems
- optimization of purchases and inventories
- customer base management
- more efficient reporting

The goals were clearly business oriented, except the millennium turn problems. Some of them were so general, however that interpreting them to ERP system project requirements may have been difficult. Especially the desire to increased process flexibility could have been difficult to translate into the system. Automation generally decreases flexibility while improving performance.

6.8.2 System Status

The very small size of the site showed also in the help desk. A majority of the cases were related either to invoicing or finance and initiated by an accountant. Implementation and the system launch were dependent from a main user who quickly adopted the system logic. The person with sufficient system understanding resulted in almost complete avoidance of conceptual misunderstandings in daily operations.

Two people took care of the customer delivery process in the system. Processes were extremely standardized from the system point of view. E.g. sales orders always consisted of the same steps and no process variants were used.

For two years the site had had a well functioning system that satisfied most of the needs. A large part of the success seemed to relate to the swift project schedule and competencies of the site people. The small size of the unit had enabled a quick schedule that was fully utilized and the site staff could swiftly take responsibility of the system. The objectives in reporting were met and some improvements in operational efficiency also resulted, even though there were some problems in the logistics. By the time of the study there were little signs of efficiency improvements in operations between corporate units.

7 RESULTS AND CONCLUSIONS

The objectives of the study were to identify ERP system key success factors, to validate Adelakun's model of IS success dimensions and to discover development possibilities in the case systems. Numerous factors contributing to success were found and they are discussed in Chapter 7.2. Also a model of their interdependencies is presented for utilization in the case system development. Adelakun's model was valid in the case company and it is discussed in Chapter 7.1.

7.1 Validity of Adelakun's Model

The IS success model by Adelakun was valid in the case corporation. The three dimensions of quality, technical, business and user, could be applied to the studied systems. The distinction between the different qualities helped categorizing the factors that contribute to success.

There are suggestions that the most important decisions concerning the business quality dimension are done before any kind of a project is launched. The most important expectations and attitudes towards the ERP system are formed then, just like Adelakun notices. Of course they are not final expectations but it is unlikely that they change much later. Therefor the cost of quality intervention is at its smallest before there is any kind of a formal project. Management decisions about the system scope and functionality affect greatly the outcome. The case corporation managers did a critical mistake when they decided to implement a complex organizational change for reporting purposes together with ERP system.

Adelakun's model holds also in the technical quality dimension. It has a definitive role during the implementation phase. Technical matters have to be taken care correctly but the expectations also have a central role. In the case corporation a technically functioning system did not assure good user quality because the complex reporting requirements hampered the system operation. The user quality dimension also depended on non-technical factors like training, level of user support and management's attitudes towards the system.

The case also proved that the three quality dimensions are interdependent. Not only does business quality affect technical and user qualities but there is a strong feedback loop to business quality. Managers expressed clearly that system performance affects expectations they put on it and business benefits depend on the view the employees have of the system.

7.2 Interaction Model for System Success Factors

A success factor interaction model based of the ERP systems studied in the case company is presented. It summarizes the observations in a drawing format developed in systems science to express interdependence. The purpose is to provide an insight for further ERP development. Effects of corrective actions can be estimated on the basis of Figure 10.

Relations between the most important factors affecting success in the case ERP system are suggested in Figure 10 The model is build as a system, which means that there is no single starting point but multiple factors are effective simultaneously. Causality between the selected factors is indicated as positive (+), negative (-) or dependent of a particular situation (+/-).

The factors and the point of view are selected on basis of the case findings. There could be a much larger number of factors presented but many of them would not have a significant effect on the overall system. The model suggests how management should focus their attention in change and project management actions. There may be other significant factors that affect the model under some conditions. However, findings in the particular case study suggest that the factors included in the model are the most prominent. Other organizational settings and different technical solutions for information systems are not included in the model.

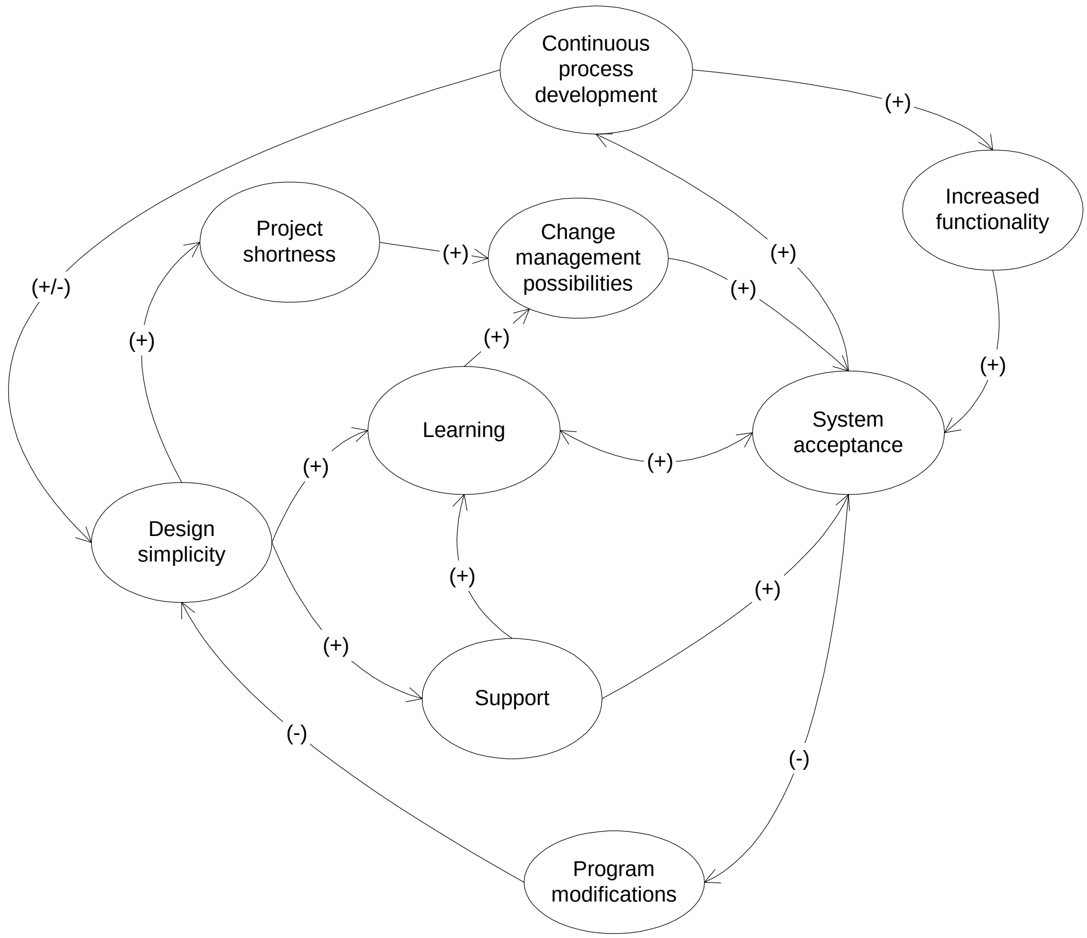

Figure 10. Success factor interaction model

The model does not try to provide particular actions that lead to an occurrence of the described success factors. Management actions can affect many of the model factors directly or indirectly and there is always variation in magnitude of causalities and number of actual success factors. As was stated in earlier research by Parr in Chapter 4, there is no generic concept of an ERP implementation, just efforts that vary by size, scope and objectives.

The factors presented in Figure 10 are discussed in more detail in Chapter 7.2.1. Potentially useful interdependence mechanisms between the factors are suggested in Chapter 7.2.2 that describes each closed loop in the figure. They might contain useful starting points for the systems development.

7.2.1 ERP Success Factors

Design simplicity includes both the business processes and the information systems that enable and support them. They have to be complex enough to satisfy the needs but the overall simplicity should be kept in mind at all design stages. System simplicity makes the implementation project less complex and shorter. A simple system is also faster to learn and support than a more complex one. Simplicity has direct benefits. Fewer resources are needed in detailed planning if the overall concepts are simple.

Project duration strongly affects project success. Short projects tend to be easier to manage and resources are better utilized if there are fewer simultaneous projects. A project refers here to a radical change project. An implementation of ERP or re-engineering of business processes belongs in the category but continuous improvement programs affect the model differently. In a project setting change management possibilities depend of the project momentum. Evidence from the small sites and Hammer's (1994) suggestions support causality between project shortness and increased change management possibilities.

The learning factor consists of all aspects of learning associated with the new ways to handle organizational processes. Not only the system users learn but there is a continuous feedback to the management and to the system support as well. The learning curve should be as steep as possible because then most benefits are realized from the newly launched systems and processes. Learning is tightly connected to the change management, because a culture of constant learning and experimenting supports change and development better than a more static organizational sentiment. A two-way connection exists between learning and the system acceptance.

System support enhances learning. It also creates more favorable sentiment towards the systems and processes, which are supported. If the users feel that they are left alone without support, they are less likely to accept the situation. Effectiveness of the support function is critically dependent of design simplicity. A complex process that has to be supported either requires a large amount of support resources or the support quality drops.

System acceptance consists of all attitudes towards the systems and the processes. The management and the operational users may have different views of it but there are implications of dissatisfaction. A poor end-user system performance easily leads to costly system customizations that do not necessarily solve the underlying problems. Discontent of managers and technical staff may lead to an introduction of custom modules and external systems. A positive attitude towards the system tools enables constructive criticism and process development that concentrates on improving the business process as a whole, not fixing deficiencies in the technical solutions.

Continuous process improvement should focus on streamlining efficiency of existing processes. Normally the overall design can be simplified and the desired functionality can be achieved with the standard system parts.

Improved process functionality results from gradual change. It further increases the system acceptance and forms a simple closed loop in the system. Continuous improvement looks for gradual process improvements. If something is fundamentally wrong, the loop does not give the best possible benefits for the effort. Then a redesign project should be started to form a new process and needed systems to support it. The project shortness factor becomes active in that case. If the continuous development tools are used when there is a need for more radical redesign, the design simplicity begins to deteriorate. Business requirements keep piling up and they are solved with added features that complicate the process design. The left-hand side of the system map in Figure 10 then suffers from the weakened positive loop and system performance gradually erodes. Old system users who are familiar with the added features are likely to be happy with them but new users will find it difficult to absorb the logic.

Software modification is a well-known result of a poorly accepted system. It seems to result from distrust to the potential of the available system. Reasoning behind the system customization is related to the belief that more functionality is better and standard functionality cannot be utilized in the particular case. Strong evidence from previous knowledge supports the case findings that the existing processes can be seen unique and highly performing if there is no serious effort to redesign processes and to support the change.

Software modification should be strongly discouraged in systems that offer little strategic advantage. Normally a system becomes more complex as a result of tailored parts but there may be exceptions. In the cases covered in this study, there are no signs of modifications simplifying the system as a whole. Gains in usability and interfaces often degrade maintainability and reliability.

7.2.2 Closed Loops in the Model

There are several loops in the model that are critical to ERP system success but two factors are present in all of them. System acceptance and design simplicity appear as important starting points and results. Because the model describes the factors in a causal relation network, it should be observed that all the factors are present simultaneously. All factors are evident during implementation project and project shortness is the only factor that cannot be present if there is no radical change going on. The loops can be utilized under different conditions but there are obviously limits in the model since there are no balancing factors included in it.

The loop between learning, change management possibilities and system acceptance can be utilized during all stages of the system life cycle. Management actions that promote any of the factors are likely to boost its success and enable changes in ways to operate the business processes.

Closely related to the previous one is "acceptance – continuous development – improved functionality – acceptance" loop. The reasoning behind it is rational and successful utilization of it requires good coordination of the development effort and participation of different kinds of staff members.

The branching loop "system acceptance – continuous process development – design simplicity – multiple choices – system acceptance" covers much of the matters that depend on the people working in the organization. Besides the contents of each factor alone, participation and security of the employees affects the strength of the loop. The company culture may act as a catalyst for the benefits that can be attainable.

The last loop in the model is the lower part that goes through the software modifications. A poor system acceptance leads to modifications, which usually compromises overall simplicity. This leads to slower learning and less efficient support that reduce system benefits.

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APPENDIX I, 1

SUBJECTS COVERED IN USER THEME INTERVIEWS

BASIC DATA MANAGEMENT

- Item control
- Customer control
- Supplier control

QUOTATION MANAGEMENT

- Quotation history utilization
- Sales history utilization
- Pricing
- Deciding delivery times
- Utilization of customer data
- Preparing a quotation
- Managing existing quotations
- Quotation reports

SALES ORDER MANAGEMENT

- Sales history utilization
- Pricing
- Deciding and confirming delivery times
- Utilization and maintenance of customer data
- Preparing a sales order
- Managing orders booked
- Sales reporting

PURCHASING

- Determining needs
- Management of time critical items
- Preparing a purchase order
- Purchase follow-up
- Receiving and acceptance

APPENDIX I, 2

- Reporting
- Purchase contracts prices

MANUFACTURING

- Creation of production orders
- Designing bill of materials
- Manufacturing routing
- Production planning/ timing
- Shop floor documents
- Work hours tracking
- Materials issue
- Semi-finished products
- Reporting production completed
- Cost accounting
- Manufacturing reporting

DELIVERING

- General control of deliveries
- Shipping documents
- Reporting

INVENTORY CONTROL

- Inventory transaction control
- Item control in warehouses
- Inventory item management
- Cycle counting/ inventory
- Reporting

FINANCE

- Determining operation rates

APPENDIX I, 3

- Determining absorption rates (USGAAP)
- Project accounting
- Integration transactions from logistics
- Purchases without order
- Overhead cost control
- Accounts payable control
- Accounts receivable control
- Reporting

INTERVIEWED PERSONS BY COMPANY AND FUNCTION

Company A

- System finance responsible
- Accounting/ controller
- Production manager
- Unit manager
- Salesman

Company B

- Accounts payable/accounts receivable clerk
- Accountant
- Production manager
- Salesman

Company C

- Accounts payable/ accounts receivable clerk
- Production manager
- Product engineer
- Manufacturing foremen (2)
- Finance/ Controller
- Purchaser

APPENDIX I, 4

- Salesman
- CEO

Company D

- Production manager
- CEO
- Salesman
- Accountant

Company E

- An engineer responsible of purchases, manufacturing and sales
- Unit manager

APPENDIX III

ERP questionnaire for business managers in the case corporation

A. PRODUCT	answer type (Y/N, scale)
1. Is the information ERP produces ________ for managing your business?	
- sufficient?	Y/N
- in the right format?	Y/N
- reliable?	Y/N
- timely?	Y/N
2. Does ERP reduce unproductive work in your business?	Y/N
3. Does ERP increase interacion with other corporate units?	Y/N
4. How satisfied are your employees with the ERP as a system?	scale 1-5
B. DEVELOPMENT	
5. Are your business needs taken into account in ERP development?	Y/N
6. Is ERP development carried out with a schedule required by your business	Y/N
7. How do benefits correspond with your investment in the ERP?	scale 1-5
C. SUPPORT	
8. Is ERP support sufficient?	Y/N
9. Is ERP support swift enough?	Y/N
10. Are ERP support persons competent enough?	Y/N
11. Your grade about the ERP as a whole?	scale 1-5
12. Is ERP development proactive?	Y/N
13. Comments	text

APPENDIX III

Classification of help desk cases in the five case companies

220 cases were reported between Jan 1st 2001 and Feb 1st 2002.

Classification of cases:
C = Conceptual problem, user error, etc.
T = Technical cause, error made during setup or by support staff
A = Request for additional hardvare devices, software components or a development suggestion
C/T = Charecteristics of both C and T

Company	C	T	A	C/T		Number of named users, excluding system supporters and technical user accounts
A	20	36	4	6	66	10
	30 %	55 %	6 %	9 %	100 %	
B	25	19	5	4	53	11
	47 %	36 %	9 %	8 %	100 %	
C	25	27	6	6	64	24
	39 %	42 %	9 %	9 %	100 %	
D	14	7	2	2	25	10
	56 %	28 %	8 %	8 %	100 %	
E	5	5	2		12	4
	42 %	42 %	17 %	0 %	100 %	
total	89	94	19	18	220 cases	

C-cases/ user	T-cases/ user	A-cases/ user	Total
2,0	3,6	0,4	6,6
2,3	1,7	0,5	4,8
1,0	1,1	0,3	2,7
1,4	0,7	0,2	2,5
1,3	1,3	0,5	3,0

APPENDIX IV, 1

ERP PACKAGES AND MODULES USED IN THE CASE CORPORATION

COMMON (package)

- Common Data (module)
- Electronic Data Interchange

DISTRIBUTION

- Inventory Control
- Purchase Control
- Sales Control

FINANCE

- Accounts Payable
- Accounts Receivable
- (Cost Allocation)
- Cash Management
- Financial Statements
- General Ledger

ORGANIZER

- Enterprise Modeler

APPENDIX IV, 2

PROJECT CONTROL

MANUFACTURING

- Bill of Materials
- Cost Accounting
- Engineering Data Management
- Hours Accounting
- Item Control
- Product Configuration
- Project Control System
- Routing
- Shop Floor Control

TOOLS

CUSTOMIZATIONS

- Packing Plan
- Queue functionality in deliveries, manufacturing and purchases

GLOBALLY SHARED DATA

APPENDIX IV, 3

- Suppliers
- Customers
- Items
- (mostly) A Chart of Accounts