A Guide to ERP

Benefits, Implementation and Trends

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A Guide to ERP: Benefits, Implementation and Trends
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Preface

One of the most influential IT developments of the past forty years has been Enterprise Resource Planning, or ERP. Thousands of organisations have used ERP to change their business models. Millions of employees in these organisations use ERP in their daily work. Tens of thousands of software developers earn their living with writing ERP software. Suppliers of ERP systems, such as SAP and Oracle, as well as ERP implementation partners, such as Accenture, realise multi-billion annual revenues in the ERP market.

This Guide to ERP is meant to be read at various levels in organisations. Board members and managers can use this book to gain an overview of the concepts of ERP, the benefits that can be obtained from it, and the link between ERP and other managerial trends and issues. At program or project management level, the book supports the development of ERP business cases, describes parties involved in a typical ERP implementation, and explains a number of ERP risks and pitfalls. For ERP users, who often only see a limited part of the ERP system in their daily work, the book offers the bigger picture.

The theoretical basis of the book is clarified by a large number of examples of ERP, from the public as well as from the private sector. The examples, and an extended case study, make the book relevant for higher education, especially for students in management science, financial management and information management courses.

This book consists of three parts. The first part is a general introduction. The aim of this part is to make the reader aware of the most important characteristics of ERP. An overview is presented of the reasons why companies and other organisations apply ERP, and what they expect from their ERP systems. The extent to which these expectations are realised are discussed, as well as the impact of ERP in practice. The most important ERP suppliers are listed, and the technical foundation of ERP systems is explained for a non-technical audience.

The two themes of the second part of the book are evaluation and implementation of ERP systems. The objective of this part of the book is to introduce the phases that can be distinguished in the ERP life cycle in an organisation, the most important decisions that have to be taken in these phases, and methods that can be used for evaluation and implementation of ERP systems. The first phase of ERP, the ex ante evaluation, is discussed in detail. This part of the books concludes with an extensive case study in which an ERP business case is developed for an example organisation.

In the third part of the book, ERP is viewed from the organisational and managerial perspective. The aim of this part of the book is to give the reader an overview of recent managerial trends, and how they relate to ERP. Trends that will be discussed are open source software, corporate governance and shared service centres.

Undoubtedly, ERP is one of the most important and influential trends in information technology. This, however, does not imply that everyone automatically subscribes to the advantages of ERP. The main characteristics of ERP, and their impact on organisations have been criticised. In a guide to ERP this criticism should not be ignored. The last chapter of this book is therefore dedicated to this criticism.

With this book I want to offer the reader a solid foundation for the use or study of ERP. In the book I combine theoretical aspects of ERP with a large number of practical examples and illustrations. I have only been able to do this because of the support and inspiration of a large number of people, some of whom I want to mention by name. I could never have created the theoretical basis of the book without the support of two of my Nyenrode colleagues, Prof. Dr. Ir. Jan Bots and Prof. Dr. Fred de Koning RA RE. I have acquired most of the practical experience with my ERP core team, and I want to compliment Vicky Aked, Jany Blaise, René Brouwers, Richard Cale, Henk van Deelen, Carlos Dias, Henk Haandrikman, Bianca Hendriksen, Julia Leladze, Vicky Rodgers, Pietro Trevisanato, Jan Vos, Johan Wempe and Wilmar Zwanenburg upon their perseverance and sense of humour. This English edition of the book has been peer reviewed by Klaas Brongers, president of the Dutch Computer Society Ngi-NGN; I thank him a lot for carrying out a very thorough review. Finally, I want to thank Fred Burgmans; without him I might have started writing this book, but I would never have finished it.

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Lineke Sneller

Part 1: What is ERP?

This first part of the Guide to ERP is a general introduction. The aim of this part is to make the reader familiar with the most important characteristics of ERP. It consists of four chapters.

The first chapter starts with an overview of the defining characteristics of ERP. After this, it gives an overview of companies and organisations that apply ERP systems, and the expectations they have before implementation of the systems. The chapter concludes with the extent to which these expectations are met, and the impact of ERP in practice.

In the second chapter the functioning of ERP is explained. This is done on the basis of two management models: the value chain and the supply chain. The origin of ERP is described, and an explanation is given of the first applications of ERP in manufacturing companies. After this, several extensions to ERP are presented: industry solutions, improvements and extensions, and the application of ERP in the supply chain.

In the third chapter the various parties that play a role in the ERP market are introduced. An organisation that plans to implement ERP will meet three groups of suppliers: software suppliers, implementation partners and application service providers. The roles of each of the three parties will be explained, their portfolios of products and services will be described, as well as the main developments in their parts of the market.

The fourth chapter introduces a number of technical aspects of ERP. Like any other computer system ERP is based on a so-called computer or IT architecture. The chapter starts with the three components of the logical architecture of ERP. After this, three physical architectures are described that have frequently been used for ERP in the past decades. This fourth chapter describes technology, but specialist terminology is avoided. The chapter is meant for a broad audience and not just for readers with a technical background.

1 Why ERP?

This chapter presents the impact of ERP on the management and operations of an organisation. It starts with an overview of the defining characteristics of ERP. After this, it gives an overview of companies and organisations that apply ERP systems, and the expectations they have before implementation of the systems. The chapter concludes with the extent to which these expectations are met, and the impact of ERP in practice.

1.1 The main characteristics of ERP

Enterprise Resource Planning (or: ERP) systems are computer applications that are being used by organisations in many industries. ERP is a mature concept: it has been there for more than forty years, tens of thousands of companies have implemented ERP, and millions of people world wide use ERP in their daily work.

ERP systems have two important characteristics: *data integration* and support for *best practice processes*. Data integration means that data only have to be entered once, after which they are available for use throughout the organisation. Traditionally, many organisations have had parallel administrations before they implemented ERP. In this situation, it would be possible that within one company the marketing department has a customer register, the warehouse has an order register, and the credit management department has a register of sales invoices. These registers could be electronic, in other cases they might still be kept on physical files in filing cabinets. The data in these registers will partly overlap: in each of them customer name and address will be registered. However, there will also be differences and inconsistencies in the data.

With an ERP system, one integrated register can be created, which satisfies the requirements of the the marketing, warehouse as well as the credit management department. Employees who need the data can be given access, and for one customer data like name and address can be combined with shipped orders or open invoices. The departments can agree upon the responsibility for the accuracy and completeness of the data, and in many cases the ERP system can automatically update the data. When for example the warehouse ships an order, the ERP system can automatically print an invoice and create an open invoice in the accounts receivable register.

As a result of data integration, ERP can make double work redundant and stimulate efficiency. But maybe more importantly, it can stop the search for and explanation of differences between the various registers and definitions, and make the organisation rely on one shared source of data.

Wolters Kluwer implements SAP-software in all European locations.

In the past few years Wolters Kluwer has grown mainly through acquisition of specialised publishing and software companies that fit in its market segment. So far, all acquired companies have used their own reporting and financial systems and applied their own definitions of rather essential terms in the financial statements. In order to standardise this, Wolters Kluwer has decided to implement SAP-software in all European companies. Through this the publisher hopes to realise integrated, transparent internal financial reporting. "SAP-software is our standard in Europe", says Ton Schoonderbeek, chief technology officer at Wolters Kluwer Legal, Tax & Business Europe. Even though ultimately all Wolters Kluwer companies in Europe will use the same financial system, the implementation is not carried out simultaneously in all countries.

In Italy, Sweden and Poland the companies already use SAP, while the software is currently being implemented in England. Belgium, France, Germany, Spain, Hungary, Austria and the Czech Republic will follow in later phases.

Figure 1.1 Data integration through ERP at Wolters Kluwer. *Source:* MD Business News [2003]

The second important characteristic of ERP systems is support for best practices. A best practice is a generally accepted way of working that has been adopted by many organisations and has proven its practical value. An example of a best practice is the use of credit limits to mitigate the risk of bad debt. Credit limits work in the following way: when a customer places a new order, a check is performed whether the total amounts on outstanding invoices plus the amounts of previously placed orders plus the amount of the newly placed order does not exceed a predetermined credit limit. If the credit limit is exceeded because of the new order, the goods will not be shipped before the customer has paid part of the outstanding amounts.

Modern ERP systems offer support for a variety of best practices. A brief example to clarify how ERP systems do this. In an ERP system that supports credit limits, it is possible to enter a credit limit for every customer. With every new order entry, the ERP system calculates the total amount of open invoices, the amount of already placed orders and the amount of this new order. If the total amount exceeds the credit limit, the ERP system automatically puts the new order on status “credit hold”. In the warehouse, the warehouse employees pick the orders, but they will only ship those orders that are not on credit hold.

Organisations can embed the best practices of the ERP system in their business processes. They can introduce best practices directly when they start using the ERP system, or they can let the ERP system support their current ways of working. They can also gradually improve their business processes by increasing their use of the best practices supported by the ERP system.

Figure 1.1 illustrates how the company Wolters Kluwer wants to standardise its business processes and realise data integration [MD Business News, 2003].

1.2 Organisations that use ERP

Because of their two most important characteristics, data integration and best practices, ERP systems can substantially improve business processes. In the forty years of their existence, the use of ERP systems has spread extensively.

From the start, ERP has been used by large multinational companies. Caldwell & Stein [1998] estimate that around forty percent of all US companies with an annual revenue of 1 billion US$ or more use an ERP system. The use of ERP is also wide-spread in Europe. In Table 1.1 an overview is presented of companies with a listing on the AEX, the main Dutch stock exchange, that worked on an ERP implementation between 1995 and 2005. During these eleven years, a total of 42 companies had a listing during at least one year on this exchange. Of these 42 companies, 26 have been working on ERP implementations during this period [Sneller, 2010]. This means that ERP has penetrated over sixty percent of the AEX listed companies.

At least one remarkable conclusion can be drawn from Table 1.1: many of the companies use more than one ERP system, which implies that they can only benefit to a limited extent from the ERP data integration characteristic.

In Table 1.2, an overview is presented of companies with a listing on the Belgian BEL20 stock exchange that were mentioned in press releases about ERP implementations between 1995 and 2009. In these fifteen years, 53 companies have had a BEL20 listing, 24 of which worked on ERP during this period. In Belgium, ERP has spread less widely than in The Netherlands. In Belgium, like in The Netherlands, companies tend to have more than one ERP system. It is remarkable that JD Edwards and Microsoft Business Solutions are not used by Belgian listed companies.

ERP is also used by governmental organisations and agencies. In The Netherlands, both the Ministry of Education, Culture and Science and the Ministry of Finance have used ERP for several years. Decentralised governments, such as the provinces of North Holland and North Brabant, as well as the Dutch Vehicle and Driving Licence body have implemented ERP systems. The Municipality of Hengelo implements ERP in order to allow the municipality to better anticipate information requests of other parties. The mayor of Hengelo explains his reasons for the decision to implement ERP in the following way: "because of this system, the transparency and the accountability for the city council's policies and resource usage towards the citizens can in the future be further improved." [Nieuwsbank, 2005]

AEX company	SAP	Peoplesoft	JD Edwards	Sage	Oracle	Business Solutions (Microsoft)	Movex (Intentia)	Geac	Baan	SSA Global	MFG Pro (QAD)	Other
ABN Amro	X	X			X			X				X
Aegon		X			X							
Ahold		X										
Akzo	X					X			X		X	X
ASML	X											
Corus	X											
DSM	X				X							X
Fortis								X				
Getronics	X											
Gucci							X					
Hagemeyer							X					
Heineken	X											
ING		X			X							
KLM	X								X			
KPN		X			X				X			
Numico			X									
Philips	X		X		X				X		X	
Polygram	X											
Shell	X		X		X					X		
TNT	X									X		
Unilever	X	X						X			X	X
Vendex	X											
Versatel						X						
VNU	X				X				X			X
Wolters Kluwer	X			X				X				

Table 1.1 AEX-listed companies that worked on ERP between 1995 and 2005

Some of the ERP implementations in government organisations have an enormous size. As an example: with the various ERP implementations at the Dutch Ministry of Defence an amount of around €400 million is involved; in five to ten years 12.000 users have to be trained [Hulsebos, 2008]. The ERP implementation that supports the full centralisation of the payroll and staff administration for the Dutch central administration has an estimated time to completion of seven years and involves 130.000 users [PR Newswire, 2004].

ERP is not exclusively meant for large organisations. Despite this, in the years before the Millennium, ERP penetration in medium-sized European companies was not very deep: not even thirty percent of them used ERP [Everdingen et al., 2000]. Recent developments however bring ERP systems within the reach of small and medium-sized businesses. Firstly, ERP has become less demanding for the computer hardware; in its early days, ERP could only be implemented on mainframes, whereas today a small server or even a personal computer is sufficient. Secondly, ERP has spread so far in large organisations that this market has become saturated and suppliers that want to grow have to adapt their systems to fit the requirements of smaller organisations. Lastly, knowledge of information technology is increasing also in smaller organisations, which means that the benefits of ERP are being recognised in this market. The growth of the ERP penetration in the next decades can therefore be expected to mainly take place in small and medium sized organisations.

BEL20-company	SAP	Peoplesoft	Oracle	Baan	MFG Pro	Other
AGFA	X		X			X
Anheuser Busch	X				X	X
Barco				X		X
Belgacom		X	X			
Cofinimmo	X					
Delhaize						X
Dexia	X		X			
D'Ieteren		X				X
Electrabel	X					X
Fortis	X		X			X
Gaz de France – Suez	X					X
Gevaert	X					X
IBA				X		
Interbrew	X			X		X
KBC	X		X			X
Mobistar			X			
Petrofina	X					
Recticel	X					
Soc Generale		X	X			
Solvay	X		X		X	
Telenet			X			
Telindus						X
UCB	X					X
Umicore	X					X

Table 1.2 BEL20-listed companies that worked on ERP between 1995 and 2009

1.3 Expected benefits from ERP

The two main characteristics of ERP, data integration and support for best practice processes, can potentially lead to several advantages for business management and operations. Below an overview is presented of answers that managers give when they are asked for the reasons for their ERP implementation. The overview is based on research by Bagranoff & Brewer (2003), Duplaga & Astani (2003), Lee (1998), Markus & Tanis (2000), and Shang & Seddon (2002). These authors carried out interviews and case studies in organisations that planned to implemented ERP, but had not yet started their implementation.

Firstly, the managers give reasons that result from the data integration characteristic of ERP. With ERP, one standardised source of information is created. The efficiency of data gathering can be improved: obsolete administrations and registrations can be abolished, and it becomes simpler to guarantee the timeliness and completeness of the data. The effectiveness of decision making can also be improved: because of a higher quality of the underlying data, a better understanding of the organisation's management and operations is created, and therefore a better foundation for decision making. Another important reason for the start of an ERP implementation is improved cohesion in the internal processes: when departments start using each others' data, they get a better awareness of the importance of their work for other parts of the organisation, which creates higher synergies between departments. Moreover, data integration is often seen as an important requirement for so-called *supply chain integration,* a form of far-reaching cooperation in the supply chain which aims to create synergies not only within an organisation, but also between organisations. ERP offers the capability to create data integration with customers, suppliers and other parties, and can therefore be the basis for supply chain integration.

Secondly, organisations select ERP systems because of their support for best practices. Many organisations use their ERP implementation as a starting point for a redesign of their business processes. This *business process redesign* (or: *BPR*) can lead to improvement of existing processes, or to completely new ways of working.

As an example: companies expect ERP to speed up processes and reduce processing times. Reduced processing times result in a number of clear advantages for business management and operations. Service to customers improves when customer orders can be shipped faster; this provides an opportunity for increased customer satisfaction. Moreover, faster processing of production orders improves the usages of manufacturing capacity; this improves productivity. Reduced processing times also offer financial benefits: when finished products or work in process inventory stays shorter within the organisation, less working capital is required. Less working capital means that cash can be used for other purposes or that less interest needs to be paid.

In addition to faster processes, companies want to create better processes or realise process innovation by an ERP implementation. ERP systems often offer several options for the design of a process. As an example: for a production planning process, most ERP systems offer several alternatives. The simplest option is manual order planning. A bit more complex is planning with the well-known *Material Requirements Planning* (or: *MRP*) technique: the planner enters the orders that need to be produced, and the ERP system calculates the required raw materials. Some ERP systems can plan automatically on the basis of preferred delivery dates of customers, or calculate production plans that optimise machine capacity usage. An organisation that implements ERP can select those best practices that best fit its business management and operations.

Other reasons that managers mention as the background for their decision to implement ERP are often more related to shortcomings of existing computer systems than to the two main ERP characteristics. ERP has been a solution for Millennium problems for many organisation in the late 1990s; this is no longer a valid reason today, but in many cases they still use ERP. Another reason for an ERP implementation can be reaping the benefits of a modern IT architecture; here, ERP can of course be helpful, but it is certainly not the only solution.

1.4 Impact of ERP

ERP implementations are costly, and they require considerable investments. ERP implementations with a budget of less than 1 million are rare, and larger implementations come with investments of tens or even hundreds of millions [FEI, 2002]. Is there, however, any evidence that the theoretical benefits that organisations expect are actually realised when they implement ERP? Or in other words: is ERP worth implementing?

Systematic attempts to measure the success of ERP have been few [Gable et al. 2003]. Given the large amounts of money spent on ERP this is surprising. One of the difficulties that academic researchers encounter when they carry out research in organisations is the limited availability of reliable data. For competitive reasons, organisations are generally not willing to disclose costs and benefits of ERP projects. Researchers therefore have to either base their research publicly available sources, such as annual reports, or on anonymous surveys.

The findings of a number of examples of research based on publicly available sources will be presented now. The first example is a study carried out by Poston & Grabski [2001], who analysed the effect of ERP implementation on costs. They followed the financial performance of fifty American companies from a variety of industries who had published a press release in which their ERP implementation was announced. Using statistical analysis, they found that three years after the ERP introduction announcement, ERP had a significant positive effect: direct costs of goods sold decreased and employee productivity as a percentage of revenue increased.

A second study based on public information, carried out by Hunton et al. [2003], studied the return on ERP investment. They carried out a comparison of economic performance of pairs of companies in the same industry. In every pair, one company was an adopter of ERP, and the other was a similar-sized company from the same industry that had not adopted ERP. The authors found that the adopting companies had a significantly better overall return on investment, three years after the adopter announced that it would implement ERP. A comparable result was found in a third study by Vluggen [2006] for Dutch companies that adopted the SAP ERP system. In this study, in which the performance of 69 adopters was compared to that of non-adopters, an improvement in operational measures such as productivity and inventory turn was found.

Several researchers have studied the impact of the announcement of an intention to implement ERP on the share price of listed companies. In 2001, Hayes et al. found a positive impact on the share price of US listed companies that issued a press release in which they announced an ERP implementation. Ranganathan & Brown [2006] carried out a similar study a few years later, and found the same positive impact. The impact of ERP announcements on share prices has been researched for other countries as well: Sneller [2010] studied Dutch and UK listed companies, and also found a positive impact of ERP implementation announcements on share prices around the day of such announcements.

Some research based on anonymous surveys is summarised now. Mabert et al. [2001] carried out a survey with a usable response of around 100 companies in the manufacturing industry in the US. Around seventy percent of the respondents classified their implementation as successful. This is despite the fact that more than fifty percent of the implementations had exceeded their budgets, and that the average excess was sixty percent. The average duration of the implementation projects in this survey was almost three years.

A survey by the Financial Executives Research Foundation of 500 financial directors confirms this picture: over seventy percent of the respondents classified their implementation as successful, while half of the implementations experienced an implementation budget that was exceeded by more than ten percent [FERF, 2003].

The research described above paints a positive picture of ERP. An ERP implementation requires a substantial investment, will take several years and may exceed its budget. However, once the implementation barrier has been taken, companies are positive about their ERP implementation and experience the implementation as a success. From a financial point of view, the implementation starts to pay out after three years: the company's productivity increases, as well as its profitability compared to similar companies hat have not adopted ERP.

1.5 ERP horror stories

Theoretically, the ERP characteristics data integration and support for best practices can be beneficial for organisations that implement ERP, and findings of academic empirical research on ERP support the theoretical benefits. However, there are also ERP *horror stories*, examples of ERP implementations that cost more than ever expected and even endangered the continuity of the organisation that attempted to implement ERP.

A well-known horror story concerns the large multinational pharmaceutical company Fox Meyer Drugs. With an annual revenue of around five billion US$ this was one of the five largest companies in its industry in the US. In 1993, Fox Meyer Drugs decided to implement an ERP system, as the company experienced rapid growth and the existing systems could not handle the increasing numbers of transactions. The project was carried out under high time pressure with the support of the company's top management. The shop floor, however, did not support the project, for fear of the loss of jobs that might be a result of standardised and more efficient processes. When the ERP system went live under high pressure, it could only handle ten thousand of the required forty-two thousand transactions per day. The failure to handle transactions eventually led to the bankruptcy of Fox Meyer Drugs in 1996 [Scott 1999].

The ERP implementation at Dell in the mid 1990s also did not progress according to plan. After two years of adaptations to the standard ERP system, CIO Jerry Gregoire decided to terminate the implementation project. In these years, Dell had introduced a revolutionary business model of direct distribution to customers via the Internet, without the dealer network that was customary in the industry at that time. ERP is based on the use of best practice processes, while Dell developed company-specific innovative processes. For Dell, ERP was therefore not the right strategic choice. In the words of the CIO:

> "I pray that our competitors are successful in their large ERP implementations – then we will drive them crazy with customer innovations using our own technology. Our competitors will find themselves vendor dependent for these innovations".

Figure 1.2 Dell's CIO on ERP *Source:* Finney [1999]

ERP horror stories also occur in Europe. Hagemeyer was a Dutch listed trading company that was founded in 1900 by the Hagemeijer brothers [Sluyterman, 2001]. At the company's centennial in 2000 the company changed direction: the company wanted to focus on business-to-business markets and supported the new strategic direction by a world-wide ERP implementation [Hagemeyer, 2001]. After initial successful go-lives in various countries, the implementation in the largest market, the UK, did not work out. Insight into inventory positions was lacking because the information in the integrated ERP system was unreliable, which for a trading company of course is an untenable situation. The company's revenue shrank with 34 percent in four years [Hagemeyer, 2005], and the company had to write off at least one hundred million Euro of its ERP investment. In 2004 bankruptcy could only just be avoided. A new CEO was appointed, the company deviated from the new strategy, but it was only in 2006 that it became profitable again. This was too late to guarantee the independent future of the company: in 2007 Hagemeyer was acquired by its long-time competitor, the French company Rexel [Sneller & Bots, 2009].

Hagemeyer is not unique in The Netherlands. A few examples of companies that also had to write off tens of millions of their ERP investments are Wessanen [Wessanen, 2003], KLM [FD, 1999] and Vopak [Vopak, 2002]. Office furniture manufacturer Samas had to issue extra shares in 2007 when its ERP implementation failed; on the day that the public offering of the new shares was announced, the Samas share lost twelve percent of its value [FD, 2007]. In other countries ERP is not always successful either: in 2004 the Belgian company D'Ieteren had to accept a write-off of forty-five million Euro of the ERP investment of its subsidiary Avis [Tijd, 2004].

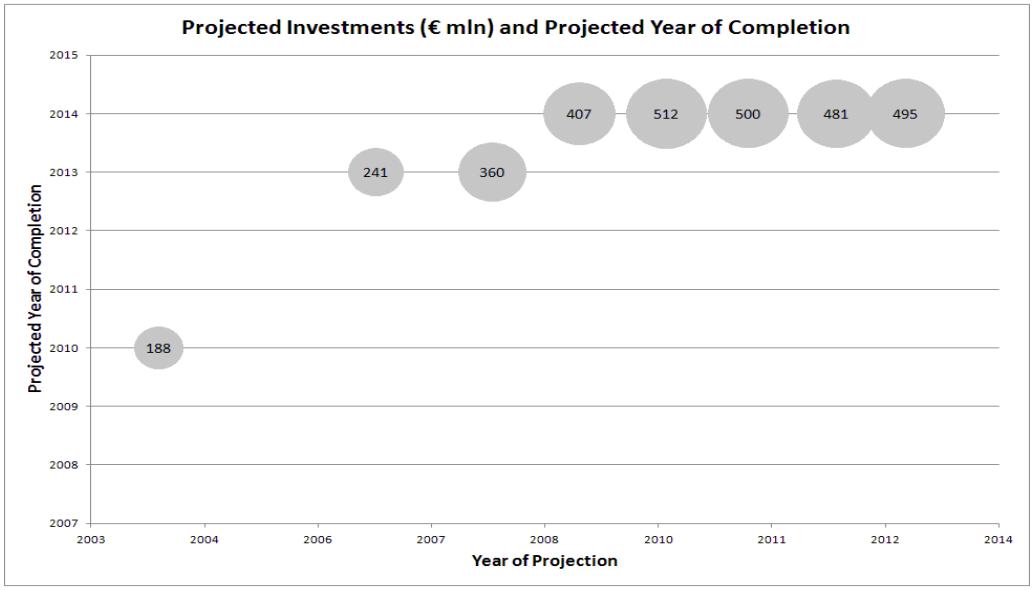

Figure 1.3 SPEER – ERP project at the Dutch Ministry of Defence. *Source:* Parliamentary Documentation

Horror stories do not exclusively take place in the private sector. The ERP implementation at the Dutch Ministry of Defence has sadly become a famous case. The implementation of ERP started in 2004, and initially, the project was estimated to require an investment of 188 million Euro [Tweede Kamer, 2004]. In 2006, the minister had to announce a revision of the ERP project. As the revision showed that a considerable extra investment of sixty million Euro was required, and that the completion of the implementation project had to be postponed with three years, the Dutch parliament demanded progress reports twice a year for the project [Tweede Kamer, 2006]. In Figure 1.3 key numbers from these progress reports have been summarised.

On the horizontal axis of Figure 1.3 the years are given in which the total investment requirement and the planned completion of the project are projected. On the vertical axis, the projected year of completion is given. The circles indicate the size of the required investment. The figure shows that in 2004 a required investment of 188 million Euro was estimated, with a planned project completion year of 2010. The most recent estimate in 2013 projects a considerably higher investment of 495 million Euro, as well as a considerably later completion year of 2014 [Tweede Kamer, 2013].

The above horror stories have news value and therefore attract attention of the press. Probably, there have been overwhelmingly more smooth ERP implementations than horror stories; these, however, are less interesting from a journalist's point of view. Nevertheless, the horror stories show that an ERP implementation should not be started lightly. ERP implementations are complex, and they involve financial, operational and reputation risks. No organisation wants to be the next ERP horror story.

1.6 Summary

Enterprise Resource Planning (or: ERP) systems are computer applications with two important characteristics: data integration and support for best practice processes. ERP is a mature concept: it has been there for more than forty years. ERP systems have been implemented by many organisations, initially mainly by large multinational companies, later also by governmental organisations, and today in small and medium-sized businesses as well.

Organisations that implement ERP expect that the data integration characteristic will improve the quality of their decision making as well as increase their efficiency. By using the best practice processes that are supported by ERP, organisations want to speed up their processes, and improve the quality of those processes. In this way, they expect that ERP will improve customer satisfaction and at the same time reduce working capital requirements.

In practice, ERP requires large initial investments, and ERP implementations take considerable time. In about half of the implementation projects the budget is exceeded, and there are some well-known examples where a problematic ERP implementation even endangered the continuity of the organisation. However, in most cases companies are positive about ERP and consider their implementations successful. According to academic research, ERP adds financial value as well: productivity in the organisation will increase, as well as the return on investment compared to similar organisations that have not implemented ERP.

2 The functioning of ERP systems

This chapter explains how ERP supports the management and operations of an organisation. The explanation is based on two well-known management models: the value chain and the supply chain. Firstly, the predecessors of ERP are presented. After this, the early applications of ERP in manufacturing companies are discussed. Finally, several extensions to ERP are given: industry solutions, improvement of best practices, and data integration in the supply chain.

2.1 The value chain and the supply chain

Modern ERP systems support all management and operations processes in a company. How this functions is explained in this section on the basis of a strategic management model that has been developed in the 1980s by the famous American strategy researcher Michael Porter: the *value chain* [Porter, 1986].

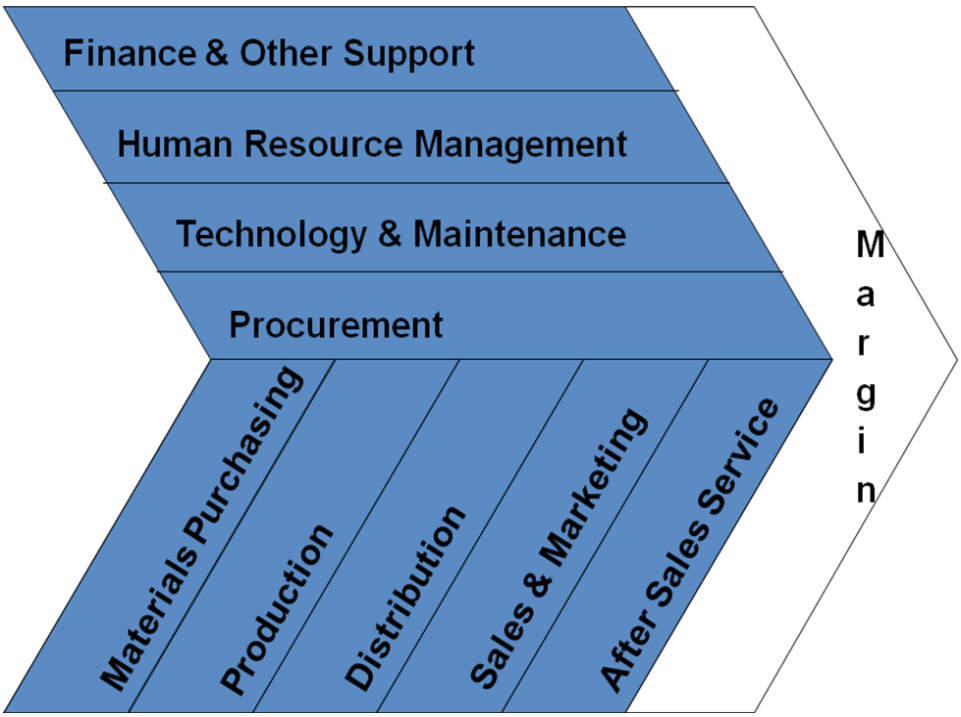

Figure 2.1 The value chain for a manufacturing company

The value chain is depicted in Figure 2.1. The model assumes a simple manufacturing company. The processes in this company are split in two categories. The first category consists of *primary processes*, processes that are characteristic for the type of organisation. In a manufacturing company, primary processes are purchasing of raw materials, manufacturing, distribution of finished products, sales & marketing, and after sales service. The second category of processes consists of *secondary processes*, processes the existence of which does not depend on the type of company but that occur in most organisations: procurement, technology & maintenance, human resource management, and finance & other support.

Business management and operations of an organisation add value by combining primary and secondary processes to create a profit margin. The primary processes, starting with purchasing raw materials and ending with after sales service, form a chain of consecutive links. These two aspects of the model, adding value and a chain of processes, have given it its name: the *value chain*.

The value chain was originally developed for manufacturing companies. It can however simply be adapted for other types of organisations. In a consultancy company for example, the primary processes raw material purchasing, manufacturing and distribution will not exist, while advisory service will be the most important primary process. In a trading company, procurement is most likely a primary rather than a secondary process.

The value chain describes processes within the boundaries of one organisation. A related concept is the *demand & supply chain* (or: *supply chain*). The supply chain consists of two or more organisations that have a supplier-customer relationship or an other form of cooperation. A supply chain can be considered a chain of value chains. In the next sections of this chapter, the history and current functioning of ERP are illustrated by using the concepts of the value chain and the supply chain.

2.2 The predecessors of ERP

ERP has its origins in manufacturing companies. In the late 1960s and the early 1970s of the last century powerful computers became affordable for large manufacturers. They used the computers to automate their production planning.

The first planning technique that was automated was *Material Requirements Planning* (or: *MRP*). MRP calculates the amount of raw materials required to manufacture a customer order. The calculation method is best explained by means of an example. Suppose that a manufacturing company produces and sells tables. The raw materials for the tables are purchased. For every table the following raw materials are required: four legs, a table top and eight screws. The company does not have warehouses for raw materials or tables. The supplier of legs has a lead time of two days, the other suppliers have a lead time of one day, and the production of a table also takes a day. In Table 2.1 the MRP production plan is presented for the company when the demand on four consecutive days is 2, 1, 7 and 3 tables.

Tables	***day 1***	***day 2***	***day 3***	***day 4***	***day 5***	***day 6***	***day 7***
Demand	2	1	7	3	0		
production			2	1	7	3	
Distribution				2	1	7	3
Legs	***day 1***	***day 2***	***day 3***	***day 4***	***day 5***	***day 6***	***day 7***
purchase	8	4	28	12			
raw materials received			8	4	28	12	
distribution to production			8	4	28	12	
Table tops	***day 1***	***day 2***	***day 3***	***day 4***	***day 5***	***day 6***	***day 7***
Purchase		2	1	7	3		
raw materials received			2	1	7	3	
distribution to production			2	1	7	3	
Screws	***day 1***	***day 2***	***day 3***	***day 4***	***day 5***	***day 6***	***day 7***
Purchase		16	8	56	24		
raw materials received			16	8	56	24	
distribution to production			16	8	56	24	

Table 2.1 MRP production plan for tables

The example in Table 2.1 represents a very simple production process for one finished product that is assembled with three raw materials. Even this very simple process already requires quite a few calculations, and small changes in demand require a complete recalculation.

In reality, such very simple processes rarely exist. Production of a range of finished products using more than three raw materials, several production processes, and intermediate inventories can be planned with MRP, but the manual calculation of the MRP schema becomes too time-consuming for realistic planning purposes. The advent of the powerful computer created flexibility and speed in the calculation of alternative production plans, and allowed manufacturing companies to plan their more complex production processes with MRP.

MRP was a step forward in production planning, but the technique has some clear shortcomings. Firstly, in order to use MRP effectively, customer demand has to be known in advance. Secondly, MRP does not take production capacity restrictions into account and implicitly assumes that every customer order can always be produced. In order the remedy these shortcomings and make the planning technique more widely applicable MRP has been extended with capacity planning. As of that time the technique became known as *Manufacturing Resource Planning* (or: *MRPII*).

Both MRP and MRPII are best practices for planning of production processes. The MRP and MRPII systems on the market can therefore be considered predecessors of ERP. They are not yet full blown ERP systems because their application remains within the manufacturing link in the value chain. By implementing MRP or MRPII systems companies do apply best practices, but they do not realise the other important characteristic of ERP systems: data integration.

2.3 The first ERP systems – data integration for manufacturing companies

The first fully-fledged ERP systems became available in the late 1970s [Boot, 2003]. They allowed data integration in one computer system for both the primary processes and the secondary financial processes of an organisation.

In order to clarify how this data integration was realised in the first generation of ERP systems, the example of the table manufacturing company is taken further in this section. Firstly, assume that after the production process the tables are stored in a warehouse next to the shop. The sales people in the shop sell tables from the warehouse to customers. Customers always pay cash and carry the tables home with them. The physical flow of sales transactions therefore only consists of tables and cash. The administrative flow consists of data in the inventory records and the financial records.

Before the implementation of an ERP system the physical and administrative flows of the sales transactions were the following. The physical flow was straight-forward: after having received the cash from the customer, the sales person handed over the table to the customer.

The administrative flow was significantly more complex, as several people had to carry out a number of administrative actions. The first action was carried out by the sales person: writing two copies of a sales slip with the number of tables and the price, one for the customer and one for the financial department. The second action was executed by the financial department: for each sales slip the corresponding number of tables was processed in the inventory records, and the increase in cash and the profit of the transaction in the financial records[1]. This was mostly done periodically, for instance weekly, which meant that the administrative processing of transactions was always lagging behind the physical flow of transactions.

After the implementation of the ERP system the physical and administrative flow of sales transactions are integrated. The physical flow remains unchanged: after having received the cash from the customer, the sales person hands over the table to the customer.

Because of the data integration characteristic of the ERP system, the administrative flow becomes much simpler. The sales person enters the sales transaction into the ERP system. The system processes the transaction in both the inventory records and the financial records, which are both part of the integrated ERP system. Once entered and processed, the new data are immediately available for all processes in the value chain of the company.

This stylised example demonstrates the benefits of the data integration characteristic of ERP. The example shows that ERP allows more efficient processes: the data of the sales transaction can be entered on the spot during the transaction, en the second data entry by the financial department is no longer needed.

However, more benefits of data integration can be identified. ERP eliminates the elapsed time between the physical transaction and the corresponding administrative transaction, which means that the inventory records are always up-to-date. This leads to lower safety stocks levels while the number of out-of-stock situations does not increase. The manufacturing department in the value chain can realise better coordination between demand and production, which enables better use of MRP and MRPII. The procurement department can negotiate better deals with the suppliers of table tops, legs and screws because manufacturing can be planned better. Marketing has access to more accurate data and can therefore anticipate market developments. Finance can report on revenue and profitability at any time.

In real companies, the management and operations are much more complex than in the stylised example presented above. The potential benefits of data integration increase in realistic settings where the company's processes are more complex. The first generation of ERP systems, which were relatively simple and only enabled data integration between the primary processes and the secondary financial processes of manufacturing companies, already allowed significant improvements in the management and operations of organisations that implemented these systems.

2.4 ERP extensions – Data integration for other value chains

The early ERP systems realised data integration between the processes in the value chain of manufacturing companies, and focused on the integration between primary and financial processes. It is therefore not surprising that in the early 1980s ERP was mainly implemented by manufacturing companies.

During the 1980s ERP expanded over the full value chain including all secondary processes of manufacturing companies. Important steps were set to enable integration of the various secondary processes. Examples of this data integration are:

- Human resource management with Finance: the automated entry of salary payments in the financial records realises higher efficiency in payroll processing.
- Human resource management with Manufacturing: the integration of time and attendance data with manufacturing processes enables a higher efficiency, and also creates a better insight in capacity, productivity and capacity utilisation, which allows better decision making on human resources.
- Technology & maintenance with primary processes: the integration of machine maintenance with primary processes allows better production planning. In order to guarantee shipment of customer orders, safety stock production can be planned before a longer period of preventive maintenance that leads to machine unavailability.
- Procurement with Finance: ERP supports data integration between the raw material purchasing process on the one hand and the financial records on the other hand. Dispatch of purchase orders, booking of goods received, and payment of invoices are activities that do not exclusively take place for raw materials, but also for other goods and services. When ERP usage is extended to all procurement processes, this does not only make purchasing more efficient, but can also create a better understanding of price differences, supplier performance and purchase volumes per supplier.

In addition to extensions for manufacturing companies, ERP suppliers also adapted their systems for companies with value chains other than manufacturing. Four examples of value chains are presented in Figure 2.2. The first example depicts trading companies, which can be considered simplified manufacturing companies, namely without production processes. This implies that ERP can be implemented by trading companies if they leave out the modelling of production processes.

The second example covers service companies. Primary processes in service companies differ considerably from those in manufacturing companies. As an example: in a temporary labour agency time and attendance registration is not a secondary process, but an essential element of all primary processes. An ERP system that supports time and attendance registration processes and integrates them with the financial records improves a temporary labour agency's insight into capacity, productivity and idle time.

Financial service providers have fundamentally different value chains. An insurer can be modelled as a company with two types of primary processes: policy processing and claims processing. ERP can realise data integration between these two primary processes and the financial records.

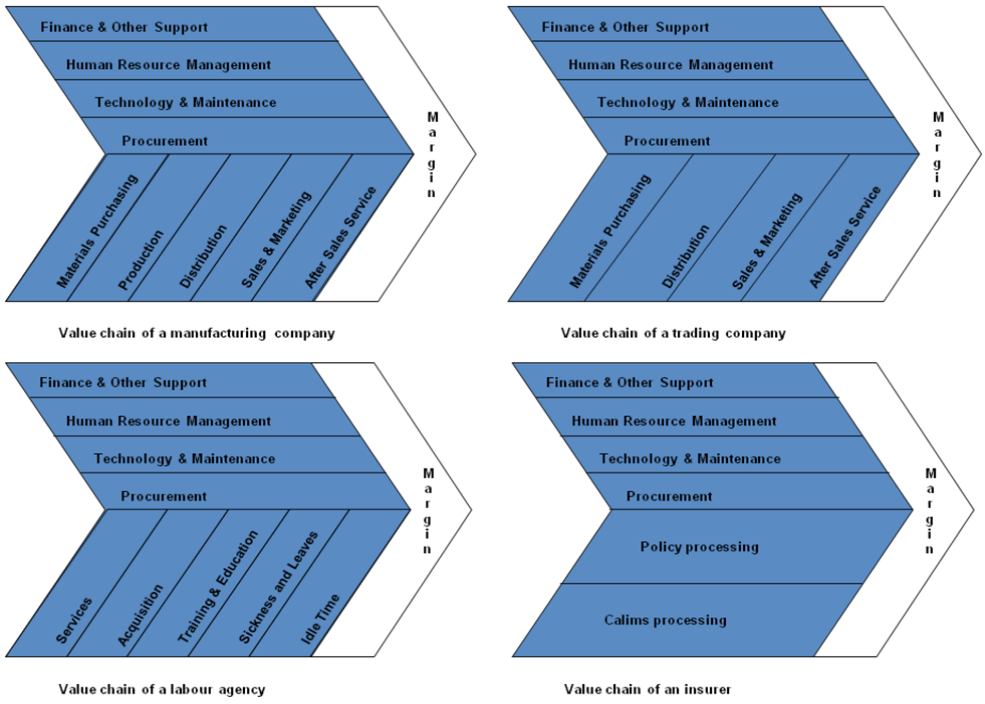

Figure 2.2 Value chains for four types of companies

The ERP systems that have been developed in the 1980s have been extended to support a variety of processes in organisations with different types of value chains. During this decade, ERP mainly expanded by offering increasing levels of data integration between primary and secondary processes for a wide variety of value chains.

2.5 ERP extensions – Sophisticated best practices

In the late 1980s and the early 1990s of the last century the best practices offered in ERP systems became more and more sophisticated. In addition to the traditional MRP and MRPII methods, other planning algorithms were built in to better support production processes. Examples of these algorithms are *Available to Promise* (or: *ATP*) and *Capable to Produce* (or: *CTP*). When a customer order is entered, both algorithms check whether the ordered product is in stock or will be in stock on the shipment date requested by the customer. If the product will not be in stock, ATP checks whether a production run has already been planned that will manufacture the product on time for the requested shipment date. CTP goes even further: if the forecast is that a requested product will not be on stock, the algorithm automatically checks the availability of raw material, issues raw materials replenishment orders if required, and plans a production run in which the product will be manufactured.

Support for production processes has also improved considerably because ERP was adapted for application of new developments in information technology. Bar code recognition, Radio Frequency Identification (or: RFID), integration of automated warehouses, management of machine instructions and many other IT possibilities are available in the ERP systems that are currently on the market.

Originally, ERP systems mainly supported manufacturing processes. In recent years this has changed. Today, ERP also offers support for best practices for Sales & Marketing in *Customer Relationship Management* (or: *CRM*) modules: sales order analysis, product portfolio analysis, customer profitability analysis, support for special offers, bonuses and discounts, and sales forecasts. The support for Finance is no longer restricted to transaction processing, but also covers *Business Intelligence* (or: *BI*): the ERP systems can provide profitability analyses, detailed reports, and consolidated financial statements for companies and their subsidiaries. Human resources departments use ERP for payroll processing, but also for recruitment, training and education, promotions and succession planning. Some ERP systems also support the so called *Employee Self Service*, which enables employees to enter holidays, sickness leave and expense claims into the ERP system themselves. This leads to higher efficiency in the human resources departments.

ERP also became more suitable for multinational organisations. Originally, most ERP systems were based on the English language, while nowadays the screens are available in almost any language, including those that use a different character set, like Russian, Japanese or Chinese. All financial transactions can be processed in multiple currencies. Country-specific habits and requirements, such as the drafts payment method that is still very common in Southern Europe, or VAT rates that vary per country have been embedded in ERP. The most extensive ERP systems even support payroll accounting in all countries, which is quite complex as a result of continuous changes in national labour and tax legislation.

Altogether, modern ERP systems offer sophisticated best practices and data integration for the primary and secondary processes of organisations in a variety of industries. When a business process is designed according to one of the standardised best practices enforced by the ERP system, the whole management, execution and information processing of the process can be supported efficiently.

2.6 ERP extensions – Data integration in the supply chain

In the last decade ERP has offered increasing options for data integration beyond the boundaries of the own organisation. ERP systems no longer only support the value chain of one organisation in isolation, but also offer data integration and best practices between organisations in supply chains.

The oldest and most frequently used form of transaction processing integration over several organisations in a supply chain is *Electronic Data Interchange* (or: *EDI*). EDI is based on so-called messages, coded transactions that are exchanged between organisations in the supply chain. The messages are characterised by a specific standardised format that depends on the coding schema that is applied. In The Netherlands, a commonly-used coding schema is EDIFACT, which also has several extension tailor-made to the needs of certain industries. The exact content of a message depends on the type of the transaction that is being processed. Frequently-used message types are orders, invoices, packing slips, tracking-and-tracing messages and proofs-of-delivery. In Figure 2.3 an example of a packing slip for a box of carpet tiles is presented.

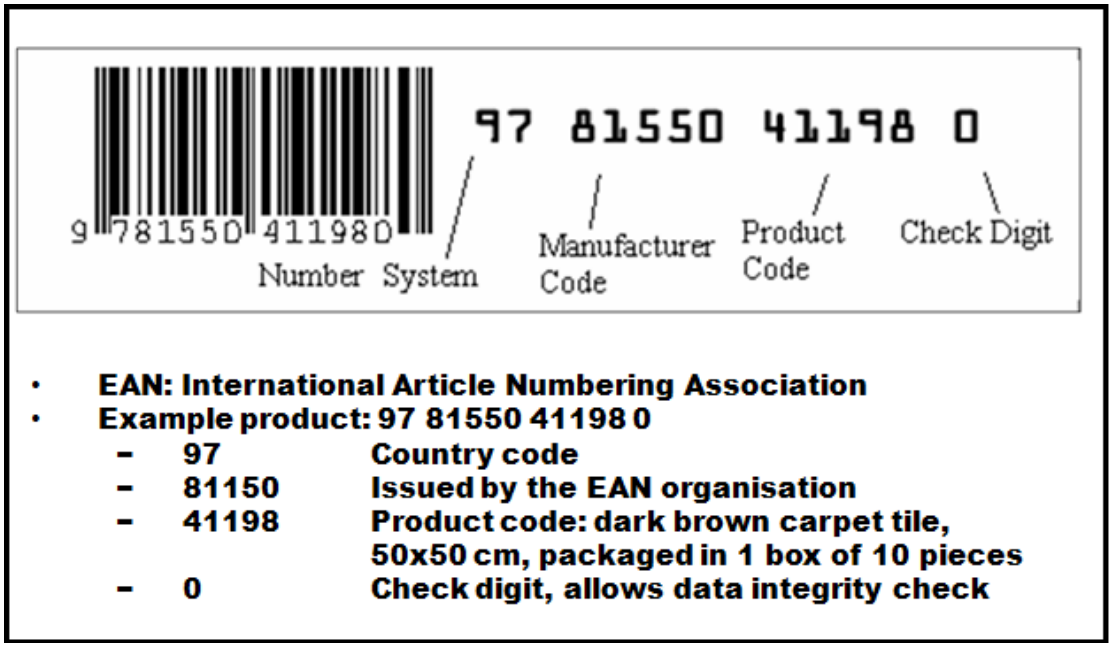

Figure 2.3 Example of an EDI code

Data integration between a customer and a supplier that use EDI is executed in the following way. In order to place an order at the supplier, a purchaser at the customer creates an order in the customer's ERP system. The ERP system then creates a file, writes the coded EDI order message to the file, and sends this file to an EDI processing company. This company checks the accuracy of the message and the origin of the message, and then forwards it to the supplier. The supplier interprets the message, manually or automatically, for instance by importing it into its own ERP system. Finally, the supplier processes the order.

Another example of data integration in the supply chain is information exchange between a company and its bank. For the automation of payments and receipts the term *Electronic Fund Transfer* (or: *EFT*) is used. For EFT, country-specific standards exist, just like for EDI. In Belgium, most banks use the ISABEL standard, and in many Anglo-Saxon countries most banks employ BACS. In The Netherlands, there is not yet one standard, as most banks have created their own coding schema. ERP systems normally support several different coding schemas for payments and receipts.

In addition to EDI and EFT the *Extensible Mark-up Language* (or: *XML*) has gained ground for the coding of various types of messages in the supply chain. The development of the XML standard is coordinated by a dedicated world-wide organisation, that monitors and stimulates world-wide standardisation of the coding schemas. Tax authorities have adopted XML extensions to enable electronic filing of tax returns, and the expectation is that within a few years, companies will also have to file their annual reports in *Extensible Business Reporting Language* (or: *XBRL*), an XML-based coding schema that was designed specifically for financial reporting. XML will probably also become the standard for electronic invoicing.

In the coming years, data integration between customers, suppliers, distributors, banks, government agencies and other parties in the supply chain will be extended more and more. ERP systems currently already support several standards for data integration in the supply chain, and in the next few years, this support will become more and more powerful.

2.7 Summary

The value chain is a model for the processes within the boundaries of an organisation. In this model, business management and operations of an organisation add value by combining primary and secondary processes to create a profit margin. Primary processes are characteristic for the type of organisation or the industry in which it operates, while secondary processes do not depend on the type of company but exist in most organisations.

A supply chain consists of two or more organisations that have a customer-supplier relationship or an other type of cooperation. A supply chain can be considered a chain of value chains.

The predecessors of ERP offered support for the primary production processes in manufacturing companies. Traditional techniques used were MRP and MRPII, which are best practices for production planning. In addition to best practices for manufacturing, these first fully-fledged ERP systems realised data integration between the primary production processes and the secondary financial process.

The later ERP systems realised increasing data integration in the value chain. Moreover, support for a wider range of best practices was added, which allowed more and more organisations to improve the business processes in their value chain with ERP. ERP may have its origin in manufacturing, today however it can be applied in practically every industry.

In the coming years, data integration between customers, suppliers, distributors, banks, government agencies and other parties in the supply chain will be extended more and more. ERP systems currently already support several standards for data integration in the supply chain, and in the next few years, this support will become more and more powerful.

3 Parties in the ERP market place

An organisation that intends to implement ERP will meet three parties in the ERP market place: software suppliers, implementation partners and application service providers. In this chapter, the role of each of these parties will be explained. For each party, products and contributions are presented, as well as the main developments in their part of the market place.

3.1 ERP software suppliers

Hundreds of companies claim they can offer ERP systems [ERP, 2014]. The market is however dominated by a limited number of software suppliers that have large market shares. These software suppliers provide systems that comply with the characteristics of ERP: they realise data integration and offer support for best practice processes.

Before an ERP system can be offered in the market place, thousands of software developers have spent their programming hours during a number of years on designing and building the system [K & K, 2006]. ERP suppliers normally offer their customers a *licence agreement*, that is a right to install and use the ERP software. The licence agreement is usually valid for an agreed number of users, computers, locations or legal entities. The licence is mostly purchased for an indefinite period of time. In addition to the licence agreement, the customer usually signs a *maintenance agreement*, in which the licence for new versions of the system is included. In new versions, ERP suppliers incorporate technological innovations, changes in legislation, new functionality and error corrections. A maintenance contract is in fact indispensible, as the ERP systems looses its value when new versions cannot be made available to the users.

Originally, licences were acquired for the ERP system as a whole. In recent years, the ERP software suppliers have split their systems into modules for which separate licences can or must be purchased. As an example: a manufacturing company could decide to buy licences for the manufacturing and financial modules for all its employees, while it purchases licences for the payroll module for its employees of the human resources department only.

In Figure 3.1 a top ten of ERP suppliers is presented. In the graph the revenue per company is depicted, in billions of US dollars. In those cases where the name of the supplier does not equal the name of the ERP system it supplies, the name of the system is used. In the graph, revenues for 2002, 2007 and 2012 are given. The information is assembled from annual reports. For two of the companies, namely Oracle and Microsoft, ERP is not the only source of revenue, as they also offer other products and services. For the other companies, ERP is their only or by far their largest source of revenue. The ERP revenue comprises licence revenues for all suppliers, and revenues from ERP services for some of them.

The figure reveals the main competitive trends in the market. Firstly, it shows that SAP is by far the largest ERP supplier. In 2002 this German company realised a 7.7 billion US$ revenue; in 2007 this revenue was almost doubled, and in 2012 almost tripled. SAP is not only growing in absolute revenue, it also absorbs most of the growth of the total market. In 2002 the company's market share was 56%, in 2012 this market share had grown to 69%.

A second trend in the market is consolidation of suppliers. In 2002, Peoplesoft, Oracle and JD Edwards were top five players in the market. In the years thereafter, a fierce acquisition battle was fought between these three American suppliers. Peoplesoft first acquired JD Edwards, and Oracle subsequently acquired Peoplesoft [Oracle, 2006]. The three companies now all operate within the Oracle conglomerate. Despite the large acquisitions, Oracle has not been able to seriously challenge the number one position of SAP: the combined company realises less ERP revenues in 2012 than the individual companies did in 2002.

Not only Oracle has acquired other ERP suppliers in the years between 2002 and 2012. The smaller players in the market experienced decreasing revenues and lack of profitability during those years, which made them vulnerable for takeovers. The Dutch pride Baan was sold three times between 2005 and 2012, first to Invensys [Invensys, 2003], then to SSA Global [SSA Global, 2005], which consequently was acquired by Infor [SSA Global, 2006]. In 2005 the Swedish Intentia, owner of the ERP system called Movex, had to allow financing and far-reaching influence of a venture capitalist after a series of loss-making years. After this, the company was acquired by Lawson Software [Lawson, 2006], which was in its turn acquired by Infor in 2011 [Infor, 2013]. Until 2005, Geac was an independent Canadian company that supplied the ERP system JBA and was listed in the US. In 2005, the company was also acquired by Infor [Cowley, 2005]. After these series of acquisitions, Infor now offers a variety of ERP systems, such as Baan, Movex, Lawson and JBA. In 2012, the company realised a 2.7 billion US$ revenue and became number two in the market. The only smaller company that was not affected by the series of acquisitions was the American ERP supplier QAD, with its product MFG-Pro.

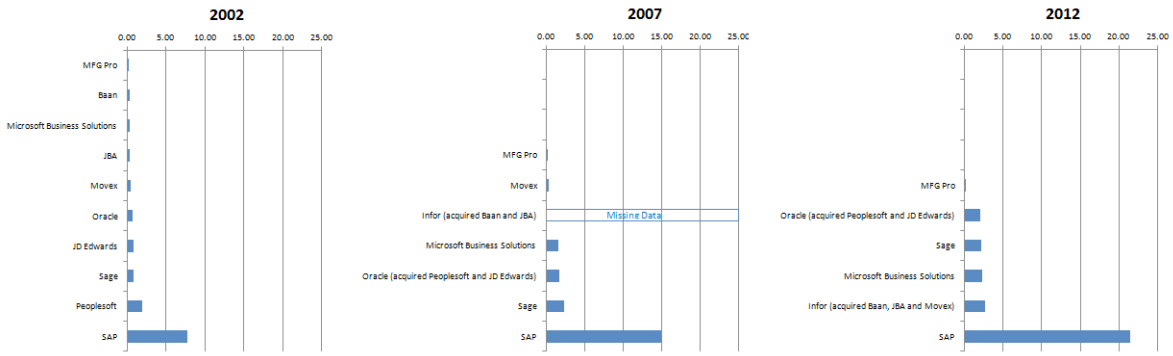

Figure 3.1 Annual ERP Revenues per Supplier (billion US$). *Source:* Annual reports

A third trend in the market is the saturation of the market for ERP in larger organisations, that has forced suppliers to focus on other market segments. ERP supplier Sage is an English company that targets the small and medium-sized enterprises (or: *SME*) segment in the market. The company is successful in this segment, and both its revenue and its profit have grown significantly over the past ten years. Microsoft entered the SME market segment in 2001, using the large profits it realised in other markets for investments in ERP. Initially, Microsoft did not succeed in setting up a profitable business. In 2002 the company realised a revenue of 308 million US$ in its ERP business, and a loss that was almost as large, namely 301 million US$. In 2003 the company realised a revenue of 567 million US$ and a loss of 309 million US$, in 2004 the revenue was 667 million US$ and the loss amounted to 255 million US$. In the years after 2004, it is hard to follow what happens, as Microsoft changed its organisational structure and the company no longer reports transparently about its ERP revenue and profitability. In Figure 3.1, the revenue for the company's total business segment is presented for 2007 and 2012; ERP constitutes only a small portion of this revenue.

Competition in the ERP market is fierce. An example of this can be found in Figure 3.2. Via its subsidiary TomorrowNow SAP offered maintenance contracts for the ERP systems supplied by Oracle. Customers of JD Edwards, Peoplesoft or the Oracle-owned CRM application Siebel can buy their maintenance contracts for a fee that is fifteen percent lower than the fee they have to pay when they deal directly with Oracle [TomorrowNow, 2007a]. When a customer agreed a maintenance contract with TomorrowNow, SAP gained access to the Oracle software and documentation through the customer's licence. This gave Oracle occasion for accusing SAP of computer intrusion and copyright infringement and for taking its competitor to court [Volkskrant, 2007]. After the lost court case SAP decided in 2008 to cease the TomorrowNow operations [TomorrowNow, 2009]. Oracle claimed damages of 1.3 billion US$ [FD, 2010], of which SAP agreed to pay 20 million after several court cases[US-DOJ, 2011].

> Founded in 1998, TomorrowNow, Inc. is the most experienced third-party provider of software maintenance and support for PeopleSoft, J.D. Edwards, and Siebel applications. TomorrowNow, Inc. offers the TomorrowNow Support Services program that replaces vendor Annual Maintenance and Support Services. As a wholly owned subsidiary of SAP since January 2005, TomorrowNow can also provide our support services as an integral part of the SAP Safe Passage program.

Figure 3.2 SAP competes with Oracle via TomorrowNow. *Source:* TomorrowNow [2007b]

One of the reasons for the fierce competition in the market is the fact that each of the suppliers offer mature and complete ERP systems. Despite this, differences do exist in the various offerings. Firstly, the licence fees can vary. Exact prices depend very much on the specific situation of the customer, but in general the smaller suppliers are cheaper than the larger ones. Differences also exist in the breadth of the best practices that the ERP system supports. Some suppliers have refined best practices in manufacturing, while others excel in support for human resource management processes.

In recent years, some suppliers target specific market segments or industries. They try to expand their position in the SME segment, or aim for specific industries. With so-called *industry solutions* they try to dominate industries like automotive, textiles or government.

In the forty years of its existence, ERP has become a great commercial success. Thousands of companies decided to purchase an ERP system. By implementing an ERP system they want to improve the management and operations of their business.

It is of course well possible to improve organisational processes without a computer systems. Best practices can also be implemented without the support of computer systems like ERP. However, data integration these days does not make sense without the support of computer systems. Data integration becomes more ad more important, not only between customers and suppliers, but also with other parties in the supply chain, such as service providers, distributors and regulatory authorities. Data integration can also mean competitive advantages, if large amounts of data are integrated intelligently. Organisations therefore do not really have a choice, they will have to develop an approach for data integration.

One of the approaches is the implementation of an ERP system available on the market, but this is not the only way to realise data integration and implement best practices. Organisations can also build their own ERP system, and traditionally many organisations have done this. However, this is a very labour-intensive approach, and there will not be many organisations that can afford to employ the large teams of software developers that are required for this approach.

It is also possible that an organisation has such unique processes that a best practice approach would destroy a competitive advantage. For companies that beat their competitors with their sophisticated manufacturing processes, using the best practices of ERP may not be a wise decision. For such companies ERP is not the obvious solution. Building a tailor-made solution, integration of a specialised module into a standardised ERP system, or procurement of a specialised application may make more sense.

For those organisations that do decide to buy a commercially available ERP system, it is essential to build a good relationship with the ERP supplier. The relationship will last several years: the implementation horizon of an ERP system is at least one to three years, after which the maintenance phase will follow. This maintenance phase will normally last at least five years. Once the ERP system of a specific supplier has been implemented, a *vendor lock in* has been created. Because of the long implementation horizon it is not possible to change ERP supplier overnight [SAP 2000]. Once the decision to implement ERP has been taken, a diligent ERP supplier selection process is therefore strongly recommended.

3.2 Implementation partners

After the procurement of licences for an ERP system normally its *implementation*, that is the preparation of its operational use, follows. Both a completely new ERP system and a new version of an already operational system require implementation. ERP systems are large and complex, and in the organisation that plans to implement ERP the required knowledge and experience is not always available. In that case the organisation can hire the support of *implementation partners,* consultancy firms on the market that have specialised in ERP implementations.

Implementation partners offer various services related to ERP. In the first place, they can advise on the best practices that the organisation can implement to improve its processes. After this, implementation partners can model these best practices in the ERP system. Three ways of modelling exist: *configuration*, *localisation*, or *adaptation.* Configuration is setting parameters in the ERP system to suitable values. These parameters can be very simple; an example of a simple parameter is the number of days between the expiration of the due date of an invoice and the creation of a reminder. They can also be very complex: the configuration of several screens and functions of the ERP system can lead to hundreds of different user profiles.

Localisation is changing the system to comply with requirements for a certain geographical or legal area. An example of a localisation that is almost always required is the lay out of invoices. Local legislation often requires that an invoice contains certain mandatory information, like in The Netherlands the complete name of the legal entity sending out the invoice, or in the United Kingdom the company number. An example of a localisation that is not mandatory but often desirable, is adding a company logo to a purchase order or an invoice.

Adaptation is extending the functionality of the ERP system by programming. Adaptation can be the only solution when the ERP system does not adequately support the requirements of essential processes. However, adaption has the downside that it complicates the implementation of a new version of the ERP system, as the programs will not automatically be compatible with the new ERP version and may have to be rewritten.

In addition to advising on selection of best practices and modelling, implementation partners can also provide the training for the future users of the ERP system. Lastly, they can build the interfaces between the ERP system and other applications, and support the data migration from the existing information systems to the ERP system.

Several contractual forms exist for implementation services. One of the extreme forms is *time-material*. In this contractual form the principal, that is the company that wants to implement ERP, hires ERP implementation consultants for an agreed hourly rate supplemented with reimbursement of travel and other expenses. The implementation partner provides its services on the basis of best effort and has no incentive to finalise the implementation as quickly as possible. The risk of exceeding the implementation budget or going beyond the planned implementation time lies completely with the principal.

The other extreme contractual form, which puts the risk completely at the side of the implementation partner, is the *fixed-price-fixed-date* contract. The implementation partner agrees to finalise the implementation before a certain date and for an agreed fixed sum. This contractual form has one important downside: in order to be effective, the exact outcome of the implementation has to be specified in advance and agreed contractually, which for an ERP implementation is complex.

Mixed contractual forms, such as a time-material scoping study followed by a fixed-price implementation, are becoming more and more popular. Another form that is gaining popularity is the *bonus-malus* contract. In this type of contract, a target date and a target budget are agreed between the principal and the implementation partner. If the implementation is carried out cheaper or faster, the implementation partner can claim a bonus. If on the other hand the implementation becomes more expensive than the target budget or is delivered late, the principal can claim a malus. In this way, the risks of a deviation from planned costs and delivery date are shared between principal and implementation partner, and both parties have an incentive to finalise the implementation on time and within budget.

Several categories of implementation partners exist. Firstly, some ERP suppliers offer implementation services in addition to their licences; Intentia used to do this for Movex, Oracle does this for Oracle Financials, and SAP has experimented with this. Secondly, the large consultancy firms that employ thousands of management consultants often have their practices for implementation services for one or several ERP systems. Examples of these companies are Accenture and IBM Business Consultants. Thirdly, there are smaller consultancy companies that have between ten and one hundred consultants specialised in implementation services for one specific ERP supplier. Examples of these companies in Europe are Magnum Management Consultants, who are specialised in SAP, and Quistor, who are specialised in JD Edwards. Finally, there are many one-man's businesses who implement ERP systems, sometimes directly for companies that are implementing ERP, but more often as subcontractors for one of the larger parties.

At first sight, the organisation's external auditor is a promising candidate for ERP implementation services. The auditor knows the organisation well and the implementation can be an obvious extension to the portfolio of services already offered. However, because of the increasing stringency of auditor's independence rules, most auditors will not be willing to carry out an ERP implementation for customers where they also do the financial audit.

Implementation partners differ in both quality and price. The price depends on the breadth of the required services. For international ERP implementations it may be relevant that the implementation consultants use a uniform implementation approach and at the same time make sure the implementation is compliant with local requirements. Parties than can manage these world-wide implementations are not the cheapest in the market. For large implementations, sizeable teams of consultants are required that are only available at the large consultancy firms. Parties that can manage large implementations generally also have higher fees.

The quality of the services often depends more on the experience and knowledge of the individual consultant than on the company by which this person is employed. If there is a good fit between an individual implementation consultant and the implementing organisation, it may be worthwhile to close a longer term contract.

Organisations can also choose to implement ERP themselves, without the support of an implementation partner. This approach is viable only when employees themselves are highly familiar with ERP implementations in general and the selected ERP system in particular. It is also an option to carry out a first implementation with extensive implementation partner support, and implement later versions or additional modules with own staff. It is also possible to have own employees carry out the implementation while an external implementation partner is available on call.

For companies that contract an ERP partner it is very important to have crystal-clear conditions. The costs of the implementation partner constitute fifty to ninety percent of the total ERP implementation costs. These costs are also hard to control, and ERP implementation costs often exceed budgeted amounts. [Stefanou, 2001, De Koning, 2004]. Moreover, the quality of the implementation partner has a large impact on the success of the implementation project. It is therefore important to make a well-considered choice for a specific implementation partner, based on costs, continuity, personal fit and quality.

3.3 Application service providers

After the implementation the operational ERP system has to be kept up and running, to enable the employees of the organisation that has implemented ERP to use the system in their daily work. Companies on the market that offer services to keep ERP systems up and running are called *application service providers* (or: *ASP*'s). ASP's provide organisations with *available* and *reliable* ERP systems for a predetermined group of users. Availability is often measured as a percentage. An example of a required availability could be: the ERP system has to be up and running during 99.99 percent of the time during office hours, measured over fifty-two weeks per year. This means that in every work week the system can only be down for less than one minute, otherwise the availability requirement is not met. In order to be able to guarantee the availability, application service providers can implement a variety of measures, such as redundancy in components, back up and restore of data, a maintenance and repair organisation, service windows for preventive maintenance and disaster recovery. Nowadays, the norm for availability is 99.999 percent (or: *five nines*) during 7 times 24 hours per week.

Next to availability, reliability is an important aspect of the quality of application services. Information security measures can be taken in order to ensure the reliability of the ERP system. The application service provider has to make sure that the information in the ERP system is only accessible for users that have been authorised by the organisation that owns the information; in addition to this, some users are only allowed to view information, while others can also update or add new information. The application server provider can stimulate information reliability by security measures, such as username and password-protected access, user profiles, or encryption of data that are transported via an external network.

Users that have access to the ERP system will often be employees of the organisation. With the growing importance of supply chain integration, access will be distributed to more parties, and organisations will more frequently allow their customers or suppliers access to their ERP systems.

The contractual form that is most suitable for application services is a *service level agreement* (or: *SLA*). In a service level agreement, norms for the quality of the services that the supplier will provide are agreed. Mostly a fixed price is agreed, potentially with a penalty clause when the supplier does not meet the contractually agreed service levels.

In addition to the service levels, often a *service catalogue* is agreed, in which a description is given of the additional services the application service provider delivers with respect to the ERP system. Examples of such service are the authorisation of a new user, the installation of a new workstation, the installation of *patches*, corrections of errors provided by the ERP supplier, or the provisioning of extra disk space for data. For these service the reimbursement often is a minimum annual amount with a fixed fee per executed service on top.

Traditionally, the providers of application services are the very large computer services companies, such as EDS, CSC or IBM. These companies have a long experience in these kinds of services. They often already provided application services for large administrative processes, such as payroll processing for governments.

New entrants on the ASP markets are brokers, who connect a European customer to an application service provider based in countries with lower wages. With the advent of reliable and cheap data communication it is possible nowadays to develop application services in countries where the cost of labour are considerably lower than in Western Europe or the United States.

With the growth of the Internet also smaller players have entered the ASP market. In most countries, hundreds of internet service providers are active. Some of them offer e-mail and Internet access only, but others have extended their portfolio with ERP services. These application services are also known as *Software as a Service* (or: *SAAS*); when they are offered via public Internet, they are called *cloud computing*.

It is not strictly necessary to outsource application services. Many organisations have their own IT department that can provide the application services for the organisation's ERP and other systems. In order to do this cost-effectively a certain scale is required. A survey with 600 responding organisations showed that around 7.5 percent of those organisations outsourced their application services. Around forty percent of these outsourcing arrangements included ERP, the other sixty percent consisted of other application services [Bakker, 2006].

In selecting an application service provider it is important to focus on costs as well as on quality. It is unwise to focus on costs only, given the fact that a disruption in the services often has a severe impact on the organisation. In many organisations the ERP system is essential for taking orders, which implies that down time of the system immediately leads to missed revenue. It is important to evaluate the costs of non-availability, and to make a trade-off between these costs and the costs a service provider calculates for guaranteed availability of the application services.

It is also important during a selection to take into account that switching application service providers is expensive and time consuming. For this reason, ASP contracts often have a duration of several years. Both the provider and the customer will have to invest in the relationship.

3.4 Summary

Organisations that intend to implement ERP will meet three parties in the ERP market place. Firstly, they have to select an ERP supplier. The ERP market is dominated by a limited number of very large companies, of which the German SAP is the largest. Although each large supplier has a complete ERP offering that includes broad functionality, some of the suppliers have better solutions for certain industries than others. In general, a licence agreement as well as a maintenance agreement is agreed with the selected ERP supplier.

Secondly, most organisations also use implementation partners, consultancy firms that are specialised in ERP. Implementation partners offer a variety of ERP-related service. The advise on the use of best practices, model the ERP system, train future users and support the migration, import or export of data from other information systems. Implementation partners can be practices within large consultancy firms, or smaller firms that have specialised in ERP. In general, a contract on time-material basis is agreed with the implementation partner. Fixed-price-fixed-date and bonus-malus contracts are still rare.

Finally, an ERP system can be kept up and running by an application service provider, which guarantees the availability and reliability of the ERP system for a predetermined group of users. The application services can be outsourced; in that case, a multi-year contact is often agreed on the basis of a service level agreement. Not all organisations outsource the application services; they can also be provided by the internal IT department.

In Figure 3.3 an example is presented which mentions the potential ERP suppliers, implementation partners, and application service providers that could be selected by the Dutch Ministry of Defence for their ERP project.

Final phase ERP-project Ministry of Defence has started

Still in the race: Baan or SAP and CSC, IBM or Cgey/Logica CMG

The new erp system for the ministry of Defence will be Baan or SAP. Candidates for implementation partnership are three parties: CSC, IBM and the combination Cap Gemini Ernst & Young / Logica CMG. Early this summer the ministry intends to finalise the selection.

At the end of last year four parties were still competing in the European tender for the erp package: Baan, SAP, Oracle and the Swedish IFS. The ministry decided to continue with the two long-time competitors Baan and SAP. In April or May the two parties can present their systems, after which a decision will be taken this summer, according to a spokesman of the ministry.

A selection process for the coordinating partner runs in parallel: the system integrator that will implement the erp system. The spokesman reports that three candidates are competing: CSC, IBM and Cap Gemini Ernst & Young with Logica CMG. These candidates have presented themselves. On the basis hereof one party will be turned down. After this, the ministry will negotiate with the other two. In March a final selection will be made.

Standardisation

The ministry developed the ambitious plan Bitsdef (policies IT standards defence) in 1998. Objective: implement a standard ict-architecture that ends the wide range of systems that currently exist in the forces. This will allow better management and easier implementation of new applications. One of the programs that has been launched is the implementation of an overarching erp-system, with five linked subprograms. The ministry wants to use new information systems within the erp environment for human resources, military medicine, finance, education and materials logistics. The ministry postpones the start of these until it is clear which erp package is selected. The development of the new payroll system P&O2000+ in cooperation with Accenture continues, and the delivery is planned for 2005. The delivery of the first version is slightly delayed and is now planned for the end of this year. The standardisation of the various human resources processes within the Navy, Air force, Land force and Military Police took more time than expected.

DTO

The role of the internal ict division DTO in this project is still unclear. Doubts about the organisational ability to manage projects of this size was one of the reasons to consider outsourcing. After this plan was abolished end of last year, the ministry now designs a Defence ICT Execution organisation (Dictu) that will supervise the ict policy development of DTO. A cost-saving operation is also threatening DTO: the political council for defence will discuss the the plan in the next few weeks. ←

Figure 3.3 Players in the ERP market. *Source:* Sanders [2003]

4 ERP and IT architecture

Every computer system is based on a so-called *computer architecture*. The formal definition of a computer architecture is the fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution [IEEE, 2011, p. 2].

This chapter gives an explanation of this formal definition of computer architecture, as well as an introduction to the relationship between ERP systems and the underlying architecture. The chapter starts with the three components of the logical architecture of ERP. After this, three physical architectures are described that have frequently been used for ERP in the past decades. The fourth chapter describes technology, but specialist terminology is avoided or explained. The chapter is meant for a broad audience and not just for readers with a technical background.

4.1 The logical architecture of an ERP system

The logical architecture of an ERP system has three elements: the *interaction*, the *database* element and the *business logic*. Each of these elements is explained in this section. A logical architecture consists of conceptual elements only. It is intangible, you cannot point at these elements or touch them.

The first element, the interaction, takes care of the exchange of information between the ERP system and its environment. An example of such interaction is data entry by a human user of the system. The interaction element also looks after the exchange of information with other systems, such as the Electronic Fund Transfer with the computer system of a bank. The interaction in such cases is often based on messages that are coded with the EDI or XML standards mentioned in the previous chapters.

The second element, the ERP database, takes care of the storage of all data that are required for the correct functioning of the ERP system. All data-related operations, which are designing, adding, updating, selecting and deleting data, are managed by the ERP database [Weber, 1999].

In an ERP system, various classes of data can be distinguished. Firstly, the system contains *configuration data*, also called *parameters.* These are set during implementation and are hardly ever changed afterwards. An example of a parameter is the default language in which the various screens of the system are presented to the users. A second class of data in an ERP system is *master data.* These data are changed infrequently and certainly less than daily. Examples of master data are addresses of customers and suppliers, product data and general ledger accounts. The final class of data is *transaction data*; they are changed continuously and also constitute the majority of the data. Transaction data can be customer orders, goods receipts, purchase orders, payments and production schedules.

The ERP database handles each of these data classes, and is therefore fundamental to the first characteristic of ERP: data integration.

The third element of the logical architecture of an ERP system, the business logic, makes sure that business processes are properly supported by the ERP system. This element consists of a large number of best practices, that are either programmed in the system or can be configured.

The execution of a best practice by an ERP proceeds in the following way. First, the required data for the execution of the best practice are gathered, either from the ERP database or by the interaction. Then, the data are processed, calculations are made, and data are combined, transformed or sorted. Finally, the results are stored in the ERP database or presented via interaction. Examples of best practices are the recalculation of a production schedule using the Available to Promise method after new orders have been placed, or closing a financial year and creating a balance sheet and an income statement according to French accounting rules.

The ERP business logic realises the second important characteristic of ERP systems: the support for business processes through best practices.

4.2 The elements of a physical IT architecture

Every IT system is designed for installation on a physical IT architecture. In order to describe physical architectures for IT systems this section uses a simple classification that exists of six elements: *permanent storage* (mostly disk space), *temporary storage* (also known as internal memory), the *central processing unit* (or: *CPU*), *data entry devices, data output devices,* and the *data transportation network*. Unlike the logical architecture of an ERP system, the physical architecture is not only conceptual. Permanent and temporary storage, CPU's, data entry and output devices, and networks are tangible.

Two elements in a physical architecture take care of data storage. Firstly, there is permanent data storage, which secures that data are kept without the need for electricity or other power sources. In general, data are stored on disks, but tapes, CD's, DVD's and USB devices are also suitable for permanent data entry.

The enormous growth in permanent storage capacity in the past decades, combined with a fast price decrease has been remarkable. As an illustration: a hard disk with a capacity of 15 MegaByte cost €750 in 1986, while a USB stick with a capacity of 16 GigaByte cost €8 in 2014. This means a price decrease from €50 000 to €0.50 per GigaByte.

In addition to this substantial price decrease, the speed of storage on and retrieval from modern media has also increased enormously. However, for the fast storage and retrieval of data, permanent storage is not sufficient. Here, the second element of a physical IT architecture is applied: the temporary data storage.

Temporary data storage, also called internal memory, consists of memory cards. An enormous technological development has also taken place here: the first personal computers that were available on the market in the 1980s had an internal memory of 640 KiloByte, while a modern personal computer has at least a thousand times this amount. When compared to permanent storage, internal memory is fast, but also expensive. It is also more vulnerable for intentional and unintentional power interruption, as the data are lost when the computer is powered down.

The transaction processor in an IT architecture is normally indicated with terms like processor, central processing unit or CPU. A CPU processes information by applying calculations to it or by rearranging it. CPU's consist of semiconductors on silicon wafers. The processing power of CPU's has increased exponentially in the past decades. In 1965, Moore formulated his well-known law, which says that every year the processing power of CPU's doubles [Moore, 1965]. This law still holds today, despite the fact that specialists have repeatedly announced that the end of the development is within sight. World-wide, the market leadership in the development and supply of processors of the company Intel is undisputed.

The input and output devices are those elements in an IT architecture that take care of the exchange of information between people and computers. In the early years of computerisation this exchange was realised by means of punched cards. On the data entry side, this inefficient way of data exchange was soon replaced by keyboards. Since the introduction of Windows the mouse has become an indispensible device for data entry. In the past years, a variety of data entry devices has been developed, such as bar code readers, text scanners, iris scanners, and electronic pens. In the future, these devices may all become obsolete, when speech recognition has become more sophisticated and data will be entered directly via the human voice.

On the data output side, that is information exchange from computers to people, punched cards were in the first instance replaced by a computer monitor on which green characters were displayed on a black background. Today, computer monitors can display an infinite number of colours in very high resolutions. Other output devices that are available are printers, plotters, blackberries, smart phones and smart watches.

With the current technological level of devices, it is already possible to realise advanced data integration with customers, suppliers and other parties. Because of opportunities offered by technological innovation, data entry and output will be realised more and more without human intervention, which means that data entry and output devices will be used less in the future.

When the various elements of a physical IT architecture are on different locations, information has to be transported between those locations. Data networks take care of this. The capacity and speed of such networks have gone through enormous growth. It is not so long ago that a speed of 9.6 Kilobit per second over a telephone line was acceptable, while today a speed of 11 Megabit is not unusual. In parallel, the cost of network capacity have come down dramatically. A private company network with an availability of considerably less than 100 percent used to cost millions of Euros annually, while transportation of data over the Internet is now already possible for less than one hundred Euro per year. In Figure 4.1 the Internet access per country in continental European countries in 2012 is presented [Seybert, 2012]. In some countries, more than 90 percent of individuals already use the Internet. If Internet access continues to grow, European citizens will be *always on line* in the near future.

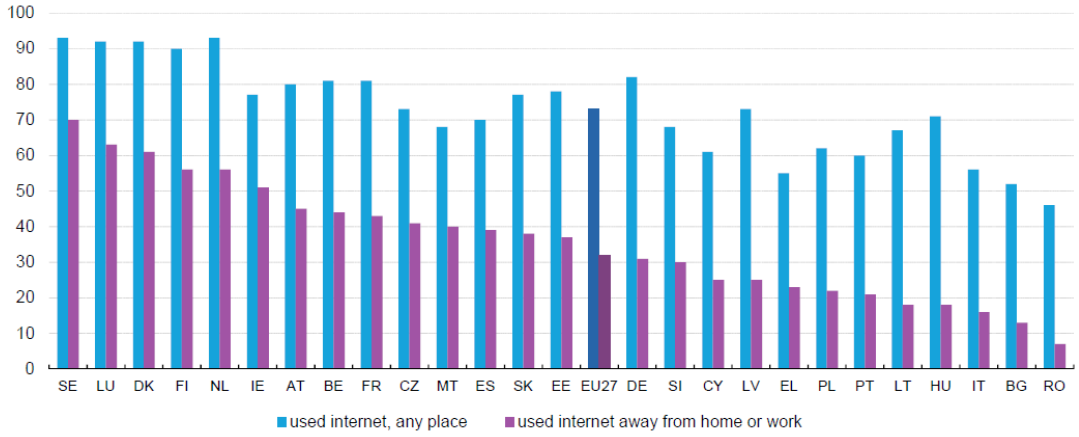

Figure 4.1 Percentage of individuals who used the Internet, at any place and away from home or work, in 2012.
Source: Seybert [2012]

As a result of enormous technological innovations, physical IT architecture with high capacity, quality and speed is available today at low prices. However, the computer applications that are installed on this architecture have also become more demanding. This certainly holds for ERP systems. It is therefore still relevant for every ERP implementation to make a well-designed mapping of the logical elements of the ERP system on the elements of the physical IT architecture.

In the next three sections examples are presented of three well-known IT architectures and the way ERP can be represented on them. It has to be noted that the physical architectures are described in their purest forms. In reality, these pure forms do not occur and mixtures of architecture types are being used.

4.3 ERP on a mainframe architecture

The *mainframe architecture* was the only physical computer architecture that was available in the 1960s, 1970s and 1980s. With the procurement of a mainframe computer at least several millions of Euros were involved, and as a result only large industrial companies, financial institutions, governments and universities could afford the use of these computers. IBM was the undisputed market leader in mainframe computing.

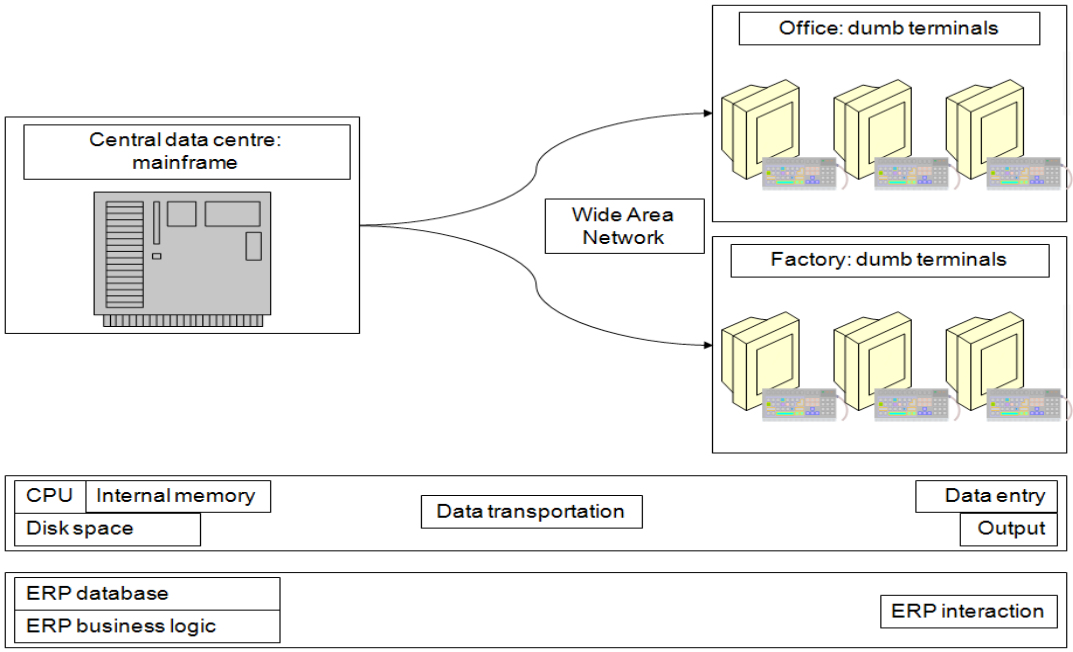

Figure 4.2 Logical ERP elements mapped on a physical mainframe architecture

A mainframe architecture is characterised by maximal centralisation of the elements of the architecture, with minimal decentralised elements and limited network traffic. The mainframe itself is a large central computer, that is based in the data centre of the organisation. The mainframe houses all disk space, internal memory and processing power. The only architectural elements that are installed decentrally, on the locations where the users of the system carry out their work, are data entry and output devices. These devices are so-called *dumb terminals*, simple monitors without graphical capabilities, and keyboards. The terminals have no processing power, no disk space, and very limited internal memory which is just sufficient to display characters on the screen. In the early days of mainframes even printers were only available centrally, in order to minimise network traffic. Prints were treated like traditional mail: they were delivered once a day to the pigeon-holes of the users.

When an ERP system is installed on a physical mainframe architecture, the principle of centralisation has to be followed. The ERP database is installed on the disk space of the central mainframe, as well as the software in which the business logic has been programmed. The calculations and data manipulations in the ERP business logic are carried out by the centralised internal memory and the central processing unit. The only decentralised architectural element is the interaction, which is present at the site of the individual users with their dumb terminals; all other elements are installed centrally and are shared by all users. In Figure 4.2 a schematic drawing of the elements of a mainframe architecture is presented. At the bottom of the picture, the elements of the physical architecture are named, as well as the mapping of the logical ERP elements on the elements of the physical architecture.

The main advantage of a centralised mainframe architecture for ERP is the ease with which the database and the business logic can be shared. When for instance a change in the business logic is required, either via configuration or via a new version of the software, these change can be installed centrally and will be available instantly for all users. The main disadvantage is the susceptibility to peak usage. When all users request access to the same element at the same time, an overload may occur, and the mainframe may become the bottleneck in the organisational processes. Instances of peak traffic can occur during a financial month end, or when a successful marketing campaign results in an unexpected high number of orders.

The mainframe architecture has already existed for many decades. This does not mean that it is outdated. The principle of sharing disk space, internal memory and processing power is still valid today, and centralisation of architectural elements in a one data centre location has regained popularity in the past few years. For ERP, a centralised architecture is very suitable, because the ERP database and the ERP business logic can easily be shared by all ERP users. The decentralised dumb terminal however have limited functionality for modern standards, and because of the availability of cheap network capacity and the efficient graphical options of modern input and output devices it is no longer necessary to limit network traffic. Dumb terminals and keyboards have therefore been replaced by more advanced monitors, printers, mice and scanners.

4.4 ERP on a client-server architecture

In the 1980s a new architecture arose: the *client-server* architecture. Two technological advances in information technology made the purchase of computers affordable for almost every organisation.

Firstly, the so-called *mini-computers* or *servers* were invented. These computers were not as powerful as the traditional mainframes, but they were able to serve several hundreds of users. Competitors of IBM joined forces and developed the new operating system Unix especially for these servers.

Secondly, IBM introduced the *personal computer* (or: PC) on the market. IBM spared neither money nor effort in their famous Charlie Chaplin campaign, and the PC quickly penetrated the office market and replaced the dumb terminals that were typical for the mainframe architecture.

Figure 4.3 IBM introduces the PC in 1981. *Source:* Digibarn [2006]

A client-server architecture is mainly based on the expectation that all elements of a physical architecture are becoming cheaper and more powerful, which enables the distribution of elements over centralised and decentralised locations. A client-server architecture is therefore also known as a *distributed architecture*. Because of the distribution of elements, performance bottlenecks can be resolved and network traffic, which was still relatively expensive in the last century, can be limited.

In a client-server architecture the strict separation between centralised and decentralised elements no longer exists. In this architecture, the client is the user's workstation. In general, this is a powerful PC with a large amount of internal memory, own disk space, a fast CPU, a graphical monitor, a printer and a keyboard. A PC with these powerful specifications is often called a *fat client*. The server is a powerful computer that offers large-scale data storage to the clients. The server also has internal memory and a CPU, but these are used only for the fast storage and retrieval of data, and not for computations for the users. The server can be located centrally, but architectures with a server on each location also exist. In these cases, the servers regularly exchange information with the central server. Between clients and servers, a network is installed. This can either be a cheap *local area network* (or: *LAN)* within a location, or a more expensive *wide area network* (or: *WAN*) between locations.

When an ERP system is installed on a client-server architecture, the ERP elements are distributed over the physical IT architecture. In Figure 4.4 an ERP system is mapped on a client-server architecture. The ERP database is installed on the disk space of a server. It is possible to store local data on a local server, while organisation-wide data are stored on a central server. In this case, a distributed ERP database is used, and a replication mechanism is required to synchronise the common data.

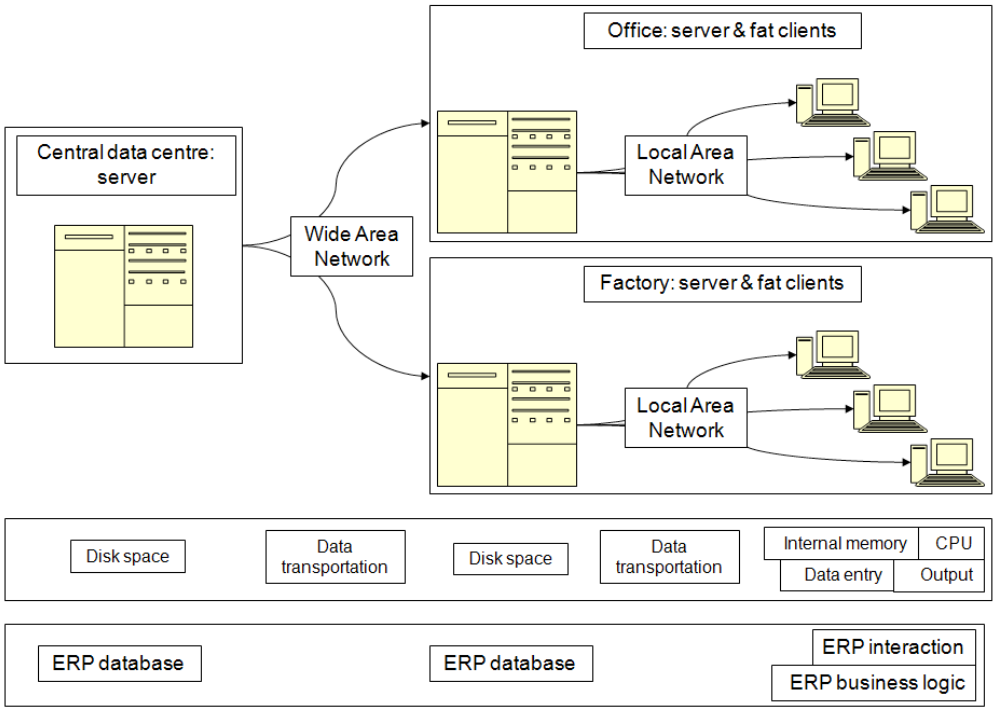

Figure 4.4 Logical ERP elements mapped on a physical client-server architecture

The two other ERP elements, the business logic and the interaction, are executed at the client-side. The calculations and data manipulations in the ERP business logic are handled by the internal memory and the CPU of the user's PC. The ERP interaction element is also available on the side of the individual user and consists of a monitor, a keyboard, a mouse and a printer.

The main advantage of a client-server architecture is the wide-spread use of relatively cheap elements. The servers offer large storage capacity at low costs. The fat clients offer powerful processing capabilities that individual users do not have to share with others.

The mapping of the ERP elements on a physical client-server architecture however is not obvious. Shared business logic is an essential element of ERP. In a client-server architecture, a copy the business model is required on every local PC, because the CPU and the internal memory of the client execute calculations and data manipulations. Whenever the business logic is changed, this change has to be replicated to every client and every server in the architecture. This can be labour-intensive and therefore costly, and it is almost impossible to guarantee that the ERP elements are synchronised at all times.

The client-server architecture has been used intensively during several decades. The underlying principles of cheap elements and minimalisation of expensive network traffic are no longer valid. Firstly, the lower hardware costs did not always outweigh the higher costs of synchronisation, Secondly, network traffic has become less expensive, and the importance of traffic minimalisation efforts has therefore decreased.

Some principles of the client-server architecture have remained valid. Sharing disk space, which is a principle that a client-server architecture has in common with a mainframe architecture, has become very common. Moreover, the fat client, the powerful PC for individual users, is now being used in almost every organisation. It is however mainly used for personal productivity applications, such as word processors, spreadsheets and presentation tools. For ERP the client-server architecture turned out not to be the best solution.

4.5 ERP on a browser architecture

In the 1990s a new IT architecture started to develop: the *browser architecture*. Continuous technological developments made computers and network connections affordable not only for companies, but also for individual consumers and households. Today, Internet, e-mail and social media have become an integral part of our daily lives.

For a browser architecture the network is the crucial element. The network no longer connects the various locations of s single company, but can technically connect all computers, clients and servers, that are connected to the Internet. Network capacity has increased enormously, and prices have decreased at the same time, which means that the network is no longer the bottleneck in an IT architecture. Through network management and network security an organisation can determine which of the millions of potential connections are necessary or useful for the organisation and offer these connections to the users.

Servers that can provide disk space, internal memory and processing power can be connected to the network, which is comparable to what mainframes provided in traditional architectures. The new element in a browser architecture is the *browser*, a software programme that is installed on the data entry and output device of the user. The browser programme executes the communication over the network via a standardised and efficient protocol that requires minimal internal memory and processing power on the client side. This means that a powerful PC is no longer required in a browser architecture, but that alternative options such as mobile phones, smart phones, tablets or blackberries can be used as data entry and output devices. The only requirement on the client side is the presence of a browser. Because of these minimal requirements in a browser architecture, the client is often named a *thin client.*

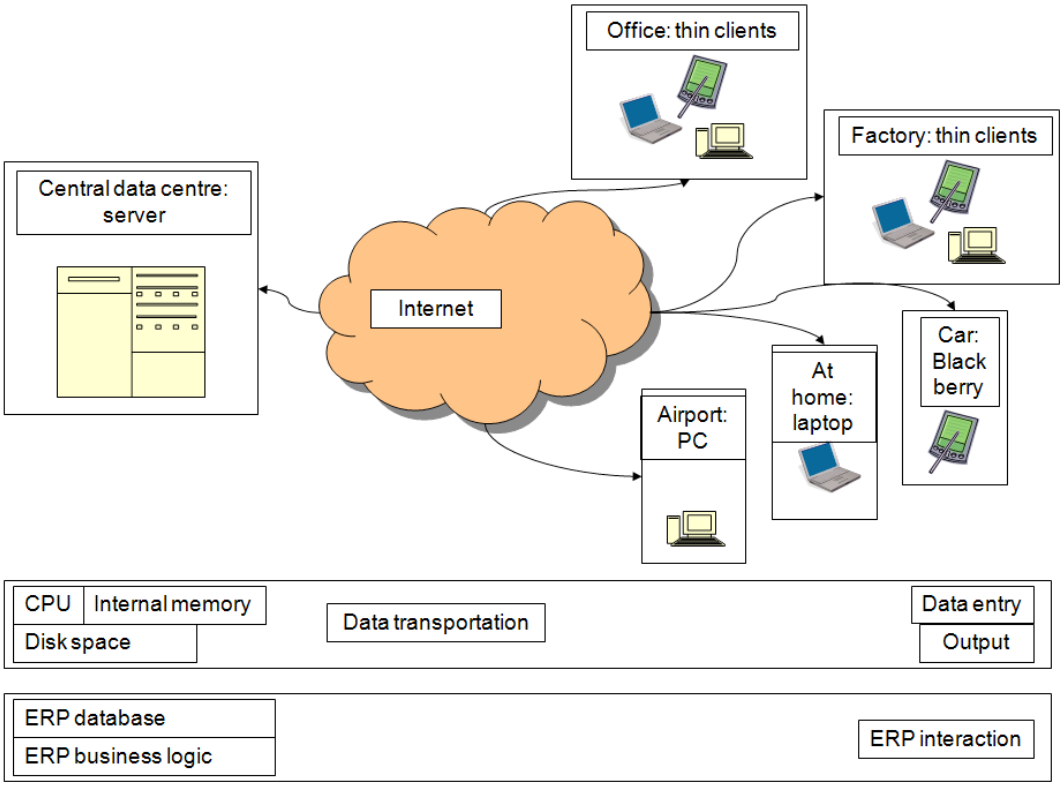

Figure 4.5 Logical ERP elements mapped on a physical browser architecture

In Figure 4.5 a schematic overview is presented of the mapping of the ERP elements on a browser architecture. The ERP database and ERP business logic are installed on a server, and this server is made accessible through a network. This network can be public Internet, a private company-owned network, or a combination of both. When public Internet is used, this is also called *cloud computing*.

Users can activate the interaction by starting their browser, connecting to the web-page from which the ERP server can be reached and logging in to the ERP system. The browser can be installed on a PC on the premises of the organisation, but also at the home of the user, on a smart phone or on a PC in an Internet cafe somewhere abroad.

The main advantage of a browser architecture is the ease with which users can gain access to the ERP database and the ERP business logic. The maintenance and version management of the database and the business logic only have to be carried out on one server. Via the browser, users always have access to the most recent version. Maintenance on the client side is rarely required; as long as it has a browser installed and it can set up a connection with the server from anywhere n the world, the user can work with the ERP system.

The browser architecture also has a few disadvantages. Firstly, working from various locations requires a high security awareness from the users. Leaving an open connection to an ERP webpage on an airport for instance is clearly undesirable. Transportation of data over public Internet without additional security measures is also not advisable; the route that the data will follow is not known in advance, and during transportation data can be intercepted. The second disadvantage is the complete dependence on the network: without a network connection the ERP system cannot be reached. On public Internet no availability guarantees are given, which means that if ERP is mission-critical, an alternative network connection has to be available.

The popularity of the browser architecture will probably increase in the coming years. The increasing capacity and decreasing prices of network connections, and the availability of browsers on more and more data entry and output devices ensure the further development and sophistication of the browser architecture in the coming decade.

4.6 Summary

The logical architecture of an ERP system has three elements. The *ERP interaction* element takes care of the exchange of information between the ERP system and its environment. The *ERP database* carries out the storage and retrieval of all data that are required for the correct functioning of the ERP system. The *ERP business logic* consists of a large number of best practices, that are either programmed in the system or can be configured.

The logical ERP system has to be installed on a physical IT architecture. In order to describe physical architectures for IT systems a simple classification that exists of six architectural elements has been presented in this chapter: *permanent storage* (mostly disk space), *temporary storage* (also known as internal memory), the *central processing unit* (or: *CPU*) that carries out calculations and data transformation, *data entry devices, data output devices,* and the *data transportation network*.

Many different options exist for the installation of an ERP system on the elements of a physical architecture. Three well-known architecture that have been used frequently for ERP in the past decades have been presented. The *mainframe architecture* is based on centralisation of as many elements as possible. The *client-server architecture* on the other hand uses the elements of the personal computer that the user has in the decentralised office or factory locations. In the *browser architecture* the network is the central element that gives the users access to the ERP system from every location where they have a browser and a network at their disposal.

A small remark is in order here. In order to keep the descriptions simple and brief, the three architectures have been described in their purest forms. In reality, these pure forms may not exist and mixed architectures are being used.

Part 2: ERP evaluation and implementation

This second part of the Guide to ERP presents the evaluation and implementation of ERP systems. The aim of this part is to inform the reader about the phases that can be distinguished during the usage life cycle of ERP within an organisation, and the most important decisions that need to be taken in these phases. It also aims to make the reader aware of the methods that can be used for evaluation and implementation of ERP systems. It consists of five chapters.

The part starts with a chapter on the phases in the ERP life cycle. In this chapter, implementation methods for the various phases are also discussed, as well as the four principles that set the boundaries of an ERP implementation. The next three chapters discuss the first phase in the ERP life cycle: the *ex ante evaluation.* In an ex ante evaluation three analyses are executed: *functional fit analysis, risk analysis* and *cost benefit analysis.* Each of these analyses is described in a separate chapter. Attention is paid to the importance of these analyses, their theoretical background, and the practices that can be applied when carrying out the analyses. In the chapter on cost-benefit analysis, a technique from corporate finance is used, but specialist terminology is avoided where possible. This chapter is therefore not exclusively written for readers with a strong financial background.

In the last chapter of this second part the execution of an ex ante evaluation is explained through an elaborate example.

5 Principles of an ERP implementation

This chapter starts with a description of the phases that can be distinguished in the life cycle of an ERP system in an organisation. It proceeds with four principles that set the boundaries of an ERP implementation.

5.1 Phases in the ERP life cycle

Once an organisation has selected an ERP system, it will use this system for several years. Surveys show that the first implementation project in an organisation takes twenty months on average [FEI, 2002]. It takes considerable time before the benefits of ERP are visible: the impact of ERP on the financial performance of the organisation is only realised after several years [Hunton et al, 2003; Poston & Grabski, 2001]. After a first implementation, organisation do not abolish their ERP lightly. As an example: SAP assumes that the relationship with a customer will last at least eight years after the initial acquisition [Luijten, 2000]. In this long life cycle of ERP in an organisation various phases can be distinguished.

Several authors have described the phases of an ERP life cycle [Sneller, 2004]. Although they all use their own definitions, their phasing methods are not fundamentally different. In this book the phases defined by Markus & Tanis [2000] will be used, because these have been used by various other authors. According to these authors, an organisation that uses ERP can distinguish four phases: *ex ante evaluation*, *configuration & roll out*, *go live*, and *onward & upward*. In many cases, the combination of the first three phases, that is ex ante evaluation, configuration & roll out, and go live, is indicated as *implementation*; the remaining onward & upward phase is also know as the *production* or *run phase*. In Figure 5.1, the four phases are depicted graphically. In the remainder of this section, each phase will be described briefly, and an overview is given of methods that are available to manage each of the phases.

Phase 1 is the ex ante evaluation. This phase is carried out prior to the other phases. In this phase, the direction is set for the further course of the implementation. A business case is created in which the objective and the approach for the implementation are described. On the basis of this business case, a go-no go decision can be made for the next phases of the implementation.

Although thousands of ERP implementations have been carried out world wide, relatively few complete methods are available for the execution of an ERP ex ante evaluation. Neither ERP suppliers nor ERP implementation partners have published methods that satisfy even the most basic requirements. This is remarkable, because ERP can have a positive impact on the organisation, but it is also a costly, complex and risky operation. A well-structured approach for an implementation is therefore essential, and this starts with a thorough ex ante evaluation.

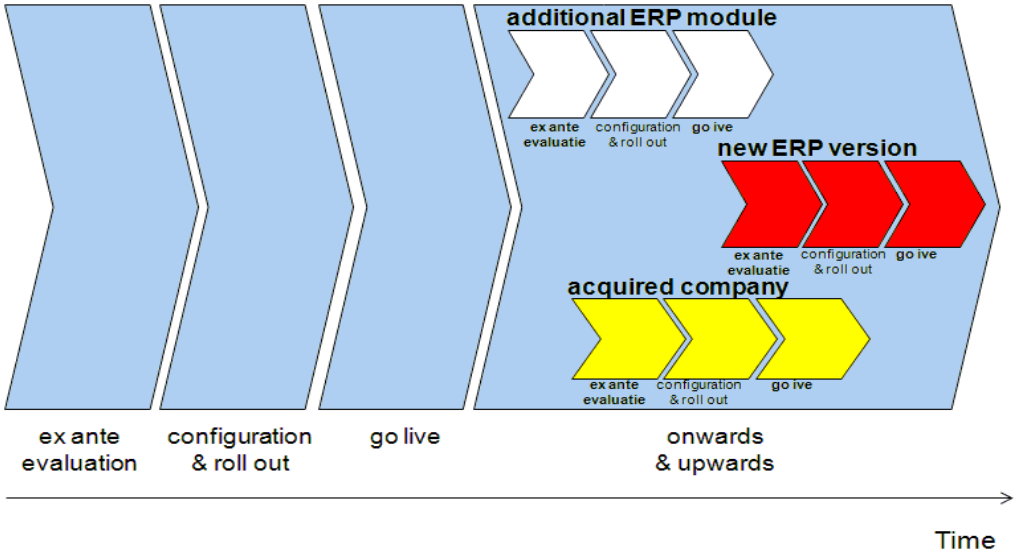

Figure 5.1 Phases in an ERP life cycle

Phase 2 is the configuration & roll out. In this phase, the business logic is built into the ERP system: the best practices that the organisation intends to use are configured, the system is localised where needed, and adaptations are programmed. Moreover, the conversion of data from existing systems into the new integrated database is prepared, and interfaces between the ERP system and other computer systems are developed. Finally, the future users of the ERP system are trained to prepare them for the execution of the tasks required once the ERP system has gone live.

Several methods are available for configuration & roll out of ERP. Both ERP suppliers and implementation partners often have detailed standards and guidelines that can be used to carry out the configuration & roll out. A well-known method developed by SAP is called *Accelerated SAP* (or: *ASAP*). In Figure 5.2 SAP describes a number of examples where the use of ASAP shortened the configuration & roll out phase considerably. An other method is *Stepwise*, that was developed by the company Intentia for the implementation of their ERP system Movex, and has by now been used for more than twenty years [Intentia, 2014]. Methods for configuration & roll out are often not suitable for all ERP systems, they have exclusively been developed for one specific ERP system.

AcceleratedSAP Achieves Success With Over 200 Worldwide Implementations;

BERN, Switzerland – (BUSINESS WIRE) – March 6, 1998 – Customers Choose SAP Because of Implementation Support and AcceleratedSAP(tm); Eight Thousand Consultants Trained to Support Implementations

At its TeamSAP(tm) European Summit today, SAP AG announced that more than 200 companies worldwide have realized reductions in time and cost in their SAP(tm) R/3(tm) enterprise business solution through the AcceleratedSAP(tm) implementation solution.

With AcceleratedSAP, the implementation time for most projects ranges from six to nine months. Customers that have benefited from the program include Crosfield, Sekisui S-Lec and Mid Ocean Holding B.V. from the Netherlands, a division of Akzo Nobel in Germany, and Ola Ice Creams and Ceramic Industries Ltd. from South Africa. Customers tell SAP they have experienced between 30 percent and 50 percent savings, proving that AcceleratedSAP is the most comprehensive approach for rapid, cost-effective R/3 implementations. As a result, customers are more rapidly able to take advantage of the business benefits resulting from their R/3 implementations, quickly gaining a return on investment.

"With the worldwide rollout last June, the AcceleratedSAP implementation solution has realized significant success," said Prof. Dr. Henning Kagermann, executive board member, SAP AG. "Customers and partners alike are embracing the worldwide program and the resulting business efficiencies."

As the demand for AcceleratedSAP implementations has grown, so has the number of certified AcceleratedSAP Partners. Since the global rollout of AcceleratedSAP in June 1997, SAP has trained more than 8,000 consultants worldwide to support rapid implementations of R/3. This support has enabled companies to execute superior results for their business and customer base as well.

In Germany, one of the projects is taking place in a business unit of Akzo Nobel. The chemicals company is implementing R/3 solutions for materials management (purchasing, warehousing and invoice verification) and financials (financial accounting, asset management and controlling). The materials management and financial components will be established after just seven months with 350 users. The total number of users will increase to 1,000 after plant maintenance is productive three months later.

Summing up the firm's experiences to date, Jorn Beneke, project manager, said, "Originally, we anticipated that the project would take well over a year, but SAP and Hewlett-Packard convinced us that we could do it more quickly. AcceleratedSAP has helped us organize the project work and the milestones for all the tasks. It also ensures that all the team members speak the same language and orient themselves using the AcceleratedSAP Roadmap." […]

Figure 5.2 The ASAP method for configuration & roll out of SAP. *Source:* Business Wire [1998]

Phase 3 is the go live, which is also known as *shakedown* or *production start*. In this phase the users start working with the ERP system for their daily work. The project team that has carried out the configuration & roll out phase is gradually dissolved, the implementation partner finalises its work and the application server provider assumes its responsibility for keeping the ERP system up and running.

In general, methods like ASAP and Stepwise also comprise the go live phase of the ERP life cycle.

Phase 4 in the ERP life cycle is called onward & upward. This is the longest phase of the ERP life cycle. The largest part of the benefits of the ERP implementation will only be realised in this phase. During the onward & upward phase the system is kept up and running and the users are being supported. Within this phase, new implementations are carried out regularly: new modules are being implemented, new versions of the ERP system are being rolled out, or newly acquired subsidiaries start using the ERP system. Every project in the onward & upward phase has its own life cycle, with an ex ante evaluation, a configuration & roll out, and a go live phase. Methods that have been used in the initial implementation for these three phases can also be applied in the onward & upward phase.

The four phases of an ERP life cycle are not necessarily executed by each organisation. They are also not always carried out in the above order. As an example, it is well possible that an organisations decides not to start configuration & roll out, because the ex ante evaluation shows that the required investment for the ERP system is prohibitive for an acceptable business case. It is also conceivable that a company carries out several go live phases, one for each manufacturing location, and thus executes several configuration and roll out phases in parallel.

With respect to implementation methods, this book focuses on the ex ante evaluation phase. This phase is crucial for the whole ERP life cycle. After all, an organisation sets the scene for the whole ERP life cycle in the ex ante evaluation. It is also important that the organisation makes up its own mind on the next phases of ERP independently, and that therefore ERP suppliers and implementation partners with their potentially conflicting commercial interests keep a certain distance. In later phases organisations can use methods specifically suitable for the selected ERP system, such as ASAP or Stepwise; as this book is not written for a specific ERP system, no methods for later phases are presented.

Before the next chapters, in which the focus will shift to ex ante evaluation, the remainder of this chapter is dedicated to four essential principles that have to be determined before the start of an ERP implementation. This is the *preselection* of potential suppliers, the *sourcing basis* between own employees and external implementation partners, the *roll out strategy* and the *go live strategy*.

5.2 The preselection of suppliers, implementation partners and application service providers

The first principle preceding an ex ante evaluation of ERP is the *preselection* of potential parties for the ERP implementation. An organisation that intends to implement ERP enters into a long-term relationship with a number of suppliers. In the first part of this book an explanation was given of the three parties in the ERP market that are involved in an ERP implementation: the ERP supplier, the implementation partner and the application service provider. Before the ex ante evaluation of an ERP implementation starts, a preselection of the three market players is required.

Many books have been written about supplier selection. The recommendation of most books is to use the following approach. At the start of the selection process, a *long list* can be made, a first selection of potential suppliers. A long list mostly consists of eight to ten suppliers. Each of the candidate suppliers on the long list is invited to give a presentation, that could consist of a demonstration or a reference visit. Subsequently, the presentations are evaluated by the organisation, and a *short list* is created, which consists of the suppliers that have given the three best presentations. Negotiations start with the suppliers on the short list, whereupon eventually the work is granted to the supplier with the best offer.

This generic approach is not suitable for an ERP ex ante evaluation, where three parties may have to be selected. The long list phase becomes very complex when not one, but three suppliers have to be chosen. Even in the short list phase the number of combinations becomes unmanageable: with a limited short list of three ERP suppliers, three implementation partners and three application service providers negotiations have to be carried out for 3×3×3 = 27 different combinations of offerings.

Although the generic approach for supplier selection is not suitable for ERP, an adapted form can be used as the basis for carrying out a preselection. As the choice for a specific ERP supplier to a large extent determines the options for the implementation partner and the application service provider, the preselection can be compiled in steps.

In the first step, a long list of ERP suppliers is compiled. Candidates for the long list are the international top suppliers, possibly supplemented with suppliers that offer industry- or country-specific ERP systems. The ERP suppliers on the long list receive information on the organisation and the objectives of the ERP implementation, and they are requested to give a presentation. This presentation however does not only consist of a demonstration or a reference visit. The ERP suppliers are also requested if they want to take on the role of implementation partner themselves, or if not, which implementation partner they recommend. Finally they are requested to recommend suitable application service providers. The presentations of the ERP suppliers are subsequently evaluated. On the basis of the evaluation not only a short list of ERP suppliers is created, but also two other short lists. One of these short lists consists of all implementation partners suggested by the ERP suppliers. The second short list consists of all application service providers suggested by the ERP suppliers, when applicable supplemented by the IT department of the organisation.

In the second step, the implementation partners on the short list are asked to give a presentation, in which they focus on the methods they intend to use and the quality of their implementation consultants. In parallel, the application service providers on the short list are requested to present themselves, and they are requested to pay attention to the availability and reliability of the ERP systems under their management. These presentations are also evaluated.

In the third step, the preselection of suppliers is created. This preselection consists of a short list of combinations of three parties: a candidate ERP supplier, a candidate implementation partner, and a candidate application service provider. This preselection ideally does not have more than three combinations, and is essential input for the first phase in the ERP life cycle: the ex ante evaluation.

5.3 The sourcing basis: turn-key or do-it-yourself

The second principle on which a decision has to be taken before the ex ante evaluation of an ERP system starts is the *sourcing basis*, the division of tasks between the organisation and the implementation partner. Most organisations that intend to implement ERP seek the support of an implementation partner. The costs of the implementation partner constitute a large proportion of the total costs of the ERP implementation, and the quality of the implementation partner to a large extent determines the success of the implementation. Clear agreement on the tasks and responsibilities of the implementation partner is therefore of the utmost importance for the ERP implementation project.

The sourcing basis can have two extreme shapes: the *turn-key* approach and the *do-it-yourself* approach.

With a turn-key approach, the implementation partner carries out all tasks it can reasonably do during the implementation. The full configuration is done by external consultants, the interfaces between the ERP system and other applications is built by them, they convert the data into the ERP system and they train the users. The employees of the organisation are only involved when this is unavoidable, for example when specialist organisation-specific knowledge is required.

The turn-key approach has advantages and disadvantages. An important advantage is the availability of resources: implementation consultants do not have operational tasks in the organisation and can therefore concentrate fully on the implementation project; this enables quick progress. Another advantage is the fact that the configuration of the business logic is executed by experts who know the ins and outs of the ERP system and will make optimal use of its functionality. An advantage that is not politically correct but still valid is the scapegoat role an implementation partner can take: when the implementation does not work out as planned it is less painless to replace the consultant than to replace an employee. Disadvantages of the turn-key approach are the extra time required by the end of the implementation for knowledge transfer from the consultants to the own employees, the risk that organisation-specific requirements are not fully configured, and a strong dependence on external consultants.

With a do-it-yourself approach the employees of the organisation carry out all implementation activities that they can reasonably be asked to do. They configure the business logic, design and develop the required interfaces with other applications and the data conversion programs, and train the users. The implementation consultant only supplies the expert knowledge of the ERP system.

This approach also has advantages and disadvantages. An important plus is commitment: employees that configure the ERP system build their own future working environment. Another advantage is the fact that the configuration is based on optimal knowledge of the own business processes. A last advantage is a potentially cheaper implementation: implementation partners have high rates. Potential downsides of the do-it-yourself approach are a longer implementation time span, because internal staff cannot always be fully relieved from their operational duties, and company myopia which may limit the creative use of options for process improvement offered by the ERP system. A disadvantage that should not be ignored is the risk that employees that are trained to become ERP experts are popular on the labour market and may be recruited by other organisations.

An example of a consciously mixed sourcing basis is presented in Figure 5.3. The company Recticel, supplier in the automotive industry, opted for an implementation team with both external implementation consultants and internal employees.

[…] Recticel, the Belgian manufacturer of products such as polyurethane foam is an example. The company has already worked with consultants from Cap Gemini Ernst & Young (CGEY) for two years to install the ERP package SAP R/3 in all its locations. The project team consists of around twenty people, 60 percent of which come from CGEY. Spokesman Kurt van Camp: "we have selected a large consultant, but at the same time we have strengthened the SAP knowledge of our own team. We have always tried to keep the organisation partly in our own hands. Consequently, we have both an internal and an external project manager. […]

Figure 5.3 Sourcing basis at Recticel. *Source:* De Tijd [2002]

The division of tasks and responsibilities between the consultants of the implementation partner and the employees of the organisation that intends to implement ERP is to a large extent determined by the choice for turn-key or do-it-yourself. Before a good ex ante evaluation can be started, it is therefore important to decide which of the two sourcing basis approaches is the principle direction for the implementation.

5.4 Model-building strategy

The third principle on which a decision has to be taken before the ex ante evaluation of an ERP system starts is the *model-building strategy*. ERP is often used by organisations that have multiple geographical locations, product-market combinations or business units. Such organisation can either build one organisation-wide ERP model, or develop a number of ERP models that are specifically tailored to the requirements of one location or market.

Three well-known model-building strategies exist. The largest degree of standardisation is achieved with the so-called *one instance* strategy. With this strategy, all ERP users work with one model in which the business logic is configured, independently of their geographical location, the market they serve or the business unit they work for. They also use the same physical IT architecture, and they work in the same ERP database. In the one instance strategy, standardisation is enforced by the ERP system itself. This strong form of standardisation is suitable for organisations that have limited variety in their businesses, or for organisations that are willing to impose the requirements of one location or business unit on all users of the system.

A second approach to standardisation is the *kernel strategy* (or: *template strategy*) for model-building. This strategy has two steps. In the first step, a basis ERP model is developed: the kernel model. This normally takes place on corporate level or by staff divisions. The kernel often contains the financial chart of accounts that is the basis for all financial processes in the organisation, and could also contain standardised customer, supplier or product codes. In the second step, each geographical location or business unit extends the kernel with its own business logic. Examples of such extensions are local legislation or local manufacturing processes. Standardisation of the kernel can be enforced by some ERP systems, but for other systems procedural agreements will have to be made to safeguard the standardisation of the kernel. This model-building strategy is suitable for organisations that want to have a well-controlled centralised financial consolidation process as well as flexibility at local level to foster entrepreneurship.

The third model-building strategy is the *multi-model* strategy. This strategy does not enforce standardisation. Each geographical location or business unit is free to model its own business logic. It is clear that the advantages of the characteristics of ERP, data integration and best practices, will not be realised on organisation-wide level when this strategy is selected. It can still be a sound strategy, especially for companies that regularly sell or spin off subsidiaries, or for conglomerate companies that have business units that have limited overlap and opportunities for synergy. The multi-model strategy is however not always a conscious choice, but can also be the result of a failed enforcement of a one instance or a kernel strategy.

The model-building strategy is an important boundary condition for an ERP implementation. The effort that is needed for model-building is dependent on the availability of a template and the degree to which this template is suitable for the business processes that the ERP system is expected to support.

5.5 Go live strategy

The last principle on which a decision has to be taken before the ex ante evaluation of an ERP system starts is the *go live strategy*. One of the critical phases in an ERP implementation is the go live or shakedown. In this phase, the new ERP system becomes operational, as well as the related new business processes. Old computer systems are shut down and old ways of working become obsolete.

The organisation of the go live is determined by the so-called *go live strategy.* This strategy determines in which sequence the new users start using the ERP system for their daily work. A go live strategy has to be selected for every unit of the organisation that starts to use ERP operationally.

A well-known go live strategy is the *big bang*: all users start using the new ERP system for their daily work at the same moment. It is obvious that this is a risky strategy, especially when users are spread over geographical locations and the ERP system covers a large part of the operational processes of the organisation.

The risk of a big bang can be limited to a certain extent by a good *fall back* scenario. When such a scenario is used, the old applications as well as the new ERP system are used in parallel during the beginning of the go live. Daily, the new ERP system is being evaluated. When the new system does not work sufficiently well the use of the new system is temporarily suspended, and the organisation falls back on the old applications. After the new system has been repaired, a new go live is attempted. As soon as the ERP system has proven to offer sufficient support for the business processes, the old applications and processes are abandoned.

The most popular go live strategy is the *go live per function*. As a first step in the go live the users in a certain function, often the financial department, apply the new ERP system. All other users continue to use their original applications. As soon as the new system's operation is considered stable and reliable for this one function, the other functions in the organisation, such as manufacturing and sales & marketing also start using it. With this strategy, the risk of the go live is mitigated. For this strategy it is however required to feed the financial modules of the ERP system with manufacturing or other data from the existing applications. This could be done manually, but only for a limited time. In a go live per function, the time between the go live of the first function and the subsequent go lives of other functions can span months; in this case it is recommended to build electronic interfaces between the ERP system and the old applications.

In addition to the big bang and the go live per function, many other go live strategies can be designed. Examples are a location-by-location small bang, a go live per process or per market. In each go live strategy, it is important to determine which data and processes are supported by which system or application at any time during the go live, and which temporary interfaces are required to make sure all applications are fed with the required data.

5.6 Summary

Once an organisation has implemented an ERP system it will use the system for several years. In this long ERP life cycle a number of phases can be distinguished: the ex ante evaluation, the configuration & roll out, the go live and the onward & upward phase.

The exact course of the life cycle is to a large extent dependent on the objectives the organisation wants to achieve with the ERP system. However, four principles set the boundaries of the life cycle. It is recommended to decide on these four principles before an ex ante evaluation is started. The first principle is the preselection of ERP suppliers, implementation partners and application service providers. The second principle is the sourcing basis between the implementation partner's consultants and the organisation's employees; the basis can vary from turn-key to do-it-yourself. The third principle is the model-building strategy; options for this principle are a one instance, a kernel or a multi-model strategy. The last principle is the go live strategy; the choices for this principle are big bang or some form of phasing.

6 Functional fit analysis

This chapter presents one of the steps in the ex ante evaluation of ERP: the functional fit analysis. The sections of this chapter are dedicated to the significance of functional fit analysis, its theoretical background, and the approach that can be used to execute a functional fit analysis. After the functional fit analysis it is clear which process improvements can be realised with ERP, and how business processes will be carried out after the implementation of the ERP system.

6.1 Significance of the functional fit analysis

ERP systems have two important characteristics: data integration and support for best practices. The objective of the functional fit analysis is to determine how these characteristics can be applied to improve the processes and management of organisations by implementing an ERP system.

The functional fit analysis has a strong link with organisational mission and strategy. The mission of every organisation is to add value. In companies the added value is mostly synonymous with profit. Profit is the difference between revenues and costs. Other organisations measure their added value on other bases, such as the number of students that graduate, the costs per permit issued, or the number of visitors for a special exhibition. In order to relate added value to business processes and ERP in a way that is not too complex, this chapter will focus on financial added value only.

Several strategies for value creation exist. Treacy & Wiersema [1993] have made an important contribution to value creation in the 1990s. In their study, they monitored forty companies during a longer period of time. On the basis of their study, they made a distinction between three strategies, which they call *value propositions*. Their study shows that companies that dominate their industry excel in one of these three value propositions, while they perform on an average level for the other two propositions.

The first value proposition that Treacy & Wiersema distinguish is *operational excellence*, offering reliable products or services that customers can acquire with limited effort or inconvenience against competing prices. Key words for operational excellence are efficiency and cost containment.

The second value proposition is *customer intimacy*, the diligent segmentation of markets and the specific targeting of products and services towards these market segments. Terms that belong to customer intimacy are customer satisfaction, repeat orders and customer profitability. Organisations that select this value proposition focus on the marketing and sales processes when determining functional fit for ERP [Tallon, 2007].

The last value proposition that Treacy & Wiersema distinguish is *product leadership*: the continuous development of the portfolio of products and services, to give customers a continuously improving experience and make competition lag behind. Creativity, innovation and time-to-market are important key words for product leadership, and organisations that select this value proposition are constantly looking for optimal product and service development processes.

Whatever strategy for value creation an organisation follows, the business management and processes will have to be developed in such a way that they strongly support the strategy. ERP can support the business processes and management with data integration and best practices. There are however two pitfalls that need to be avoided when connecting an ERP implementation to a value proposition.

The first pitfall is the implementation of an ERP best practice in such a way that value is destroyed rather than created. A best practice is a generally accepted way of working that has been adopted by many organisations and has proven its practical value. Best practices lead to standardisation of business processes, and through standardisation organisations will work in the same way. Best practices, however, are not necessarily optimal. It is well possible that a specific organisation has a competitive advantage just because it does *not* apply an generally accepted way of working.

A small example can clarify this. A company has customer intimacy as its value proposition. At the go live of the ERP system the following best practice for dunning customers who are falling behind on their payments becomes operational: customers who are behind thirty or more days get a letter that is clear rather than friendly, and announces the visit of a collection agency. It is well possible that this best practice is not the most suitable process for the company in this example, because it may lead to decreasing customer satisfaction or even the loss of customers. The best practice for dunning customers in this example may not match the strategy of the company, and it is potentially better to implement the dunning process in a different way.

The second pitfall is underutilising the best practices that the ERP system has on offer and hanging on to existing ways of working. Again a small example to explain this pitfall. The finance department in an organisation that strives for operational excellence creates a monthly reporting pack, a set of financial overviews. The pack is used by the company's management to monitor the financial performance and make adjustments where needed. At the go live of the ERP system, it turns out that the information of the reporting pack can be created automatically from the ERP system, though with a layout that is slightly different from the layout of the reporting pack that was used before the ERP introduction. The finance department finds the new layout unacceptable and hires a programmer who works a couple of weeks to make the layout of the reporting pack identical to what was used before. The employees of the finance department test the new layout, which also takes a couple of weeks. As the reporting pack now is an ERP adaptation, and no longer part of the ERP system itself, it will have to be rebuilt and tested for every new version of the ERP system. It is clear that this approach adds costs and decreases efficiency. The question is whether the programmed layout of the reporting pack contributes to the added value of the organisation to such an extent that it justifies the extra costs and loss of efficiency.

The objective of the functional fit analysis is to determine the optimal combination of best practices of the ERP system and tailor-made adaptations, given the value proposition the organisation has selected. A thorough functional fit analysis can also avoid the two pitfalls described above.

Time period	SAP application	Regulatory trends	Managerial trends
1990–1995	SAP R/2, module FI	Cashcommitment system	Financial and administrative automation
1995–2002	SAP R/3 3.1, modules FICO and PS Adaptations for multiple-year forecast, commitments, capital lending, reserves and provisions, financial evaluation	Public Accounts Act	Financial budgeting
2003–2006	SAP Enterprise 4.7, modules FICO, PS, CATS/HR, WF and MM/BW Adaptations for multiple-year forecast, capital lending, reserves and provisions, financial evaluation	Budget and Justification Decree	New public management with focus on resource control and justification
2006–2007	SAP ERP, modules FM, FICO, PS, CATS, MM and HCM/BW Adaptations for multiple-year forecast and financial evaluation	New Government	New public management with focus on process control and justification
Future	mySAP No adaptations	Electronic Government	Self-service for managers, employees, partners and citizens

Table 6.1 Chronological overview of ERP used by the province of North Brabant in The Netherlands. *Source:* Zwager et al. [2007]

An example of an organisation that applies both ERP best practices and adaptations for required support of the business is the Dutch province of North Brabant [Zwager et al., 2007]. The province has already used the ERP system SAP for many years. The value proposition of a province is operational excellence. In Table 6.1, an overview is presented of regulatory and managerial trends with which the province has to comply, and the combination of standard SAP and tailor-made adaptations that are used to optimally support the province's business processes and management.

The table clearly shows how ERP systems have developed after the 1990s. Regulatory requirements have increased, and the province uses ERP for more and more processes. However, the number of required tailor-made adaptations decreases, and the province expects that in the future they will no longer need adaptations.

6.2 A method for functional fit analysis

The functional fit analysis can be described using a theory designed by Talbert [2002]. She says that every ERP supplier has numerous assumptions about the way in which a business process should work. Suppliers use these assumptions when designing and consecutively programming best practices into their ERP systems.

These best practices do not always mirror the true business processes of the organisations that implement ERP. Many case studies and other descriptions indicate that *misfits*, differences between the programmed best practice and the actual business process, are a substantial risk for the successful implementation of ERP [Grabski et al., 2003; Koning, 2004].

A good functional fit analysis during the ex ante evaluation of ERP can mitigate the risk of misfits. According to Talbert, organisations have four options to create a good fit between their business processes and their ERP system.

The first option is *process replication*. When applying this option, organisations configure the ERP system in such a way that the existing business processes are duplicated or at best automated. When this option is followed in its extreme form, the ERP implementation will have limited impact on the business processes. It can be expected that the implementation will also have limited benefits, as process improvement is not achieved.

The second option is *process modification*. With this option, business processes are adapted in such a way that they fit with the best practices that the ERP system has on offer. Process modification leads to business processes that are based on best practices, with the related benefits of standardisation and process improvement. It also leads to changes in business processes that may impact the daily work of employees. When applying this option, organisations at least need to train the employees, and in a more extensive form process modification can lead to large-scale reorganisations. Outside of the ERP world, process modification is also known as *business process redesign* (or: *BPR*). Within the ERP world, process modification is also known as a *no adaptations* or *plain vanilla* approach.

The third option to create a good fit between business processes and ERP is *software modification*. This option consists of the configuration, localisation and adaptation of the ERP system in such a way that existing business processes are supported in the best possible way. The adaptations lead to company-specific extension of the ERP system, which in turn will lead to extra costs and extra time-to-market when a new version of the ERP system is implemented. Adaptation is justified when it sustains an existing competitive advantage or creates more added value than an ERP system without adaptations.

The last option distinguished by Talbert is called *exploration.* This options differs from the three options mentioned above: it does not prescribe one functional fit option for all business processes, but instead promotes a selection of the best option per business process. According to Talbert, exploration is the preferred option, because it offers the best balance between optimal business processes and the best practices an ERP system has on offer.

A side note to Talbert's theory is in order. Talbert, as well as other authors in ERP, warns against the high costs, the long time-to-market and the decreasing flexibility the come with software modification. This warning was certainly justified for the early generations of ERP systems. Today, however, a more nuanced view is required.

Firstly, ERP systems have developed in the past few years in such a way that they support more and more business processes. Additionally, the available best practices have become more sophisticated. This implies that the need for software adaptation has decreased over the past decade.

Secondly, the design of modern ERP systems takes potential adaptations into account. The ERP systems have become modular, and have built-in connection points for adaptations. The high-end ERP systems make sure that these connection points remain intact when new versions are introduced. This reduces the time and effort organisational need to invest when they decide to upgrade their adapted ERP system to a newer version.

Finally, software modifications do not always have to be built by the organisation itself. Functional extensions these days are also offered by partners of the ERP suppliers. The large ERP suppliers have worldwide networks of partners that offer solutions for specific organisational requirements [Oracle 2007b; SAP 2007]. Examples of these solutions are industry-specific production planning modules, reporting modules for catalogue printing, or financial consolidation tools. The partners take care of the seamless connection of their solution to the ERP system, not only for the current version, but also for future versions. These solutions mitigate the risks of adaptations to a large extent.

Summarising, in modern ERP systems adaptations are required less frequently, and their impact on costs and flexibility are less detrimental. The disadvantages of software modification nowadays are therefore smaller than in the past.

6.3 Approach

The approach of a functional fit analysis, as the first step in an ex ante evaluation, is based on Talbert's exploration option described in the previous section. It starts with the creation of a list of all business processes that will be supported by the ERP systems that were included in the preselection. This list of processes is industry- or even company-specific. A good starting point for such a list is available in text books on accounting information systems, e.g. Romney & Steinbart [2000], or Von Meyenfeldt [2002]. Most ERP suppliers also provide process lists; these will normally only contain the processes that can be supported by their own ERP system and will therefore need to be supplemented. If a company has an internal controls or quality handbook, this may also be a good starting point.

After the creation of a list of processes, the exploration is carried out for each process that is supported by each of the preselected ERP systems. In Figure 6.1 the steps in the exploration are depicted graphically.

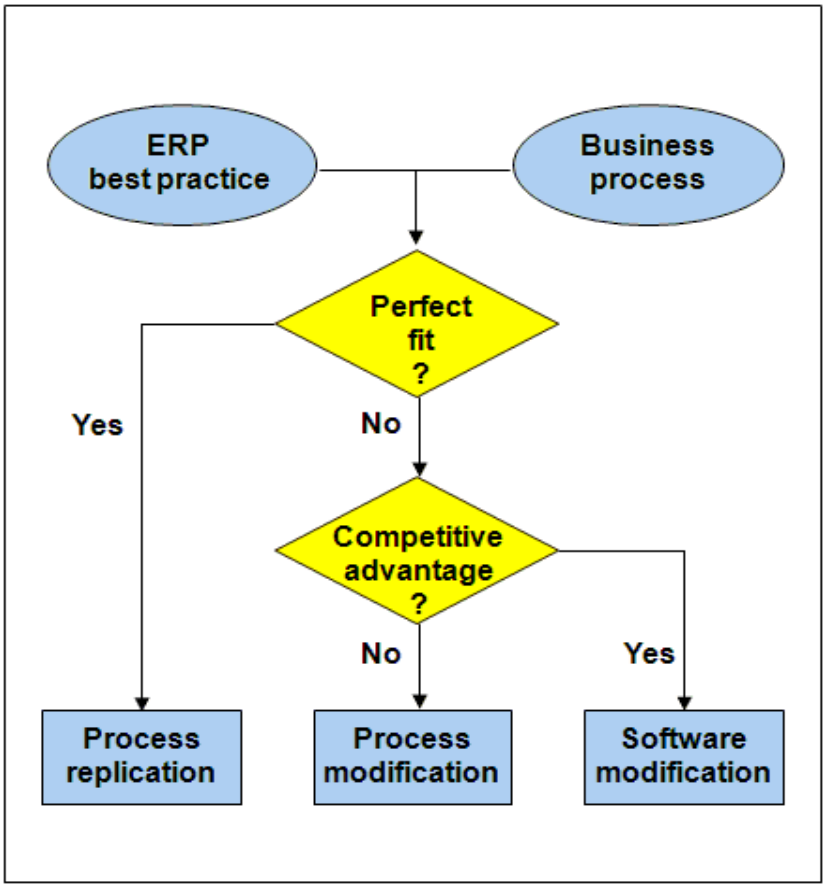

Figure 6.1 Functional fit analysis using Exploration

The first step is determining whether a perfect fit exists between a best practice supported by the ERP system and the current or desired business process. When a perfect fit exists, process replication can be used for this process, which in general is possible without additional costs or risks.

When no perfect fit exists, the contribution of the current business process to the organisational objectives has to be found out. If the current process does not offer a competitive advantage, is not crucial for the organisation's value proposition, and is not essential for other reasons, process modification is probably the best option. Process modification enables the organisation to implement one of the best practices of the ERP system, which may result in benefits like cost savings or shorter time-to-market. Costs that need to be taken into account for the implementation of process modification are process design costs and employee training costs. Risks associated with process modifications are related to resistance to change, or to errors made due to limited familiarity with the new process or the new ERP system.

If on the other hand the current process does constitute a competitive advantage, is crucial for the current value proposition, or is essential in any other way, software modification is probably the best option for this process. Costs of software modification have to be taken into account, not only during the initial ERP implementation, but also during the later onward & upward phase of the ERP life cycle. Risks associated with software modifications are budget overruns and late delivery of the modifications.

A functional fit analysis should be an integrated subproject of an ex ante evaluation. The participants of the project team are the decisive factor for the quality of the functional fit analysis. In the project team, thorough knowledge of business processes, specialist knowledge of each ERP system in the preselection, and IT system development capability are essential.

Team members with expert knowledge on the current business processes cannot be missed, because they know the current situation. However, knowledge of the current processes is not sufficient. Team members also need to be able to analyse the potential improvements offered by best practices in the ERP system. Experienced users of the current systems are good candidates for the project team, as well as process analysts, quality specialists or operational auditors.

ERP specialists are also indispensible, because they know the best practices that can be offered by their ERP system. These specialists may in some cases be available in the own organisation, but it is more likely that they will be hired from an implementation partner. This holds especially for small and medium-sized businesses, where the required knowledge most likely is not available [Nuffel & Debacker, 2007].

Finally, the contribution of IT system developers is essential. When for some processes the choice between process modification or software modification has to be made, system developers have to be able to estimate the effort required for the software modifications.

Proper use of tools and methodologies can simplify the functional fit analysis. The most important technique that is used for a functional fit analysis is *process modelling*, for which several methodologies are available. ISAC, NIAM or traditional flow charts have been used for decades [Von Meyenfeldt, 2002]; their common disadvantage is that they are labour-intensive.

Today, methodologies in combination with software are available that can model business processes in an intuitive and user-friendly way. An example of such a combination of methodology and software is DEMO [2014]. Less advanced office automation software for drawing flow charts is also widely available. A software package that is specifically made for flow charts is Visio, and other less complex software that is available for general presentations and drawings can also be used for drawing simple process models.

Some of the ERP systems can generate process models on the basis of the business logic that has been configured in them. This is very useful to document processes once they have been implemented. During the functional fit analysis, this software is not very helpful, because it is clearly not yet known how the business logic will be configured in the ERP system. Some tools for process modelling of which the output can be exported and directly be used as input for the ERP configuration are available.

6.4 Summary

Functional fit analysis is the first step in the ex ante evaluation of an ERP system. The objective of the functional fit analysis is to determine how the ERP characteristics, data integration and best practices, can be applied to improve the processes and management of organisations that intend to implement an ERP system.

In the functional fit analysis, for every business process it is determined whether it has a perfect fit with the ERP system, or whether process modification or software modification is required. The choice for modification always has to be made on the basis of the added value of the business process for the organisation's value proposition.

The project team for a functional fit analysis consists of people with knowledge of the business processes of the organisation, knowledge of the preselected ERP systems, and experience with software development. An important technique in the functional fit analysis is process modelling, and a useful tool is software for graphical representation of processes.

7 Risk analysis

This chapter presents one of the steps in the ex ante evaluation of ERP: the risk analysis. The first section of this chapter is dedicated to the significance of risk analysis. In the second section, the results of academic research on critical success factors and risks of ERP are presented. In the third section, a method for risk analysis is described, as well as the approach that can be used to execute a risk analysis. After a risk analysis it is clear which risks are related to an ERP implementation, how these risks can be mitigated, and how the associated costs can be estimated.

7.1 Significance of the risk analysis

The conclusions of academic research on ERP are positive: ERP improves business processes, and organisations that implement ERP have better financial performance than their peers that have not implemented ERP. However, *horror stories* also occur, examples of ERP implementations that overrun their budgets or even endanger the continuity of the organisation. In the first part of this book, several of these horror stories have been mentioned, such as Fox Myer Drugs, Dell, Hagemeyer, Wessanen, D'Ieteren and the Dutch Ministry of Defence.

Most ERP implementations do not become horror stories, but ERP implementations are undeniably risky. Grabski et al [2003] estimate that around ninety percent of all ERP implementations end later than planned or cost more than estimated. Other research shows that many implementations do not attain their initial objectives [Nucleus, 2003; Adam & O'Doherty, 2003; Koning, 2004], or may even be considered complete failures [Giannotten, 2003].

The above examples show that an ERP implementation should not be taken lightly. ERP is not straightforward and an implementation has associated financial and reputation risks. It is clear that no organisation aspires to become the next ERP horror story. A thorough risk analysis during the ex ante evaluation of an ERP implementation is therefore indispensible.

Though there is a general recognition that ERP is risky, only limited academic research is available on the specific risks of ERP and the ways in which organisations mitigate these risks. Below, a summary of existing research is presented. A distinction is made between *critical success factors* on the one hand and *risks* on the other hand.

A critical success factor is a condition for achieving objectives. When a critical success factor for an ERP implementation is not met, the objectives of the implementation most likely will also not be met. A risk is the potential occurrence of an event that will have a negative impact on achieving objectives [COSO, 2004]. Within the context of ERP the attainment of implementation objectives will be endangered when the event that is associated with the risk actually takes place; there is however also a chance that the event does not occur.

The following can be said about ERP critical success factors. Various authors have derived critical success factors for ERP on a theoretical basis, after which they have validated the factors in practice. Critical success factors that have been listed by at least two of these authors are top management support for the project, the presence of a so-called *champion*, a top management executive who owns the project, and continuous communication with all stakeholders [Markus et al., 2000; Grabski et al., 2003; Parr & Shanks, 2003; Sumner, 2003].

These critical success factors are probably not unique to ERP, but are inherent to all business process redesign and many IT projects. However, the research indicates that neglecting these critical success factors in an ERP implementation project is unwise, as the risk of failure then becomes very high. Therefore the management of these critical success factors should be part of the ERP ex ante evaluation.

The following is known about risks associated with ERP implementations. It is generally accepted that ERP implementation projects are risky. However, only limited research is available on which specific risks can be distinguished in practice during ERP implementations. Below, an overview is presented of four risks that have not only been deducted on theoretical grounds; they have actually been observed in practice when researchers carried out case studies, interviewed participants in ERP implementations, or studied financial reports. The four identified risks are:

- Cost overruns for implementation partner costs and software modifications [Stefanou, 2001; Koning, 2004]
- No or only partial realisation of projected benefits, due to functional mismatch between the organisation's processes and the functionality of the ERP system [Sumner, 2003; Koning, 2004]
- No improvement in financial performance [Hunton et al., 2003]
  - For small companies that were financially unhealthy when they started the ERP implementation (they may not have enough resources to complete the implementation successfully)
  - For large companies that were financially healthy when they started the ERP implementation (they may not have enough improvement potential)
- Operational problems in the go live phase [Markus et al., 2000; Have, 2003]

These four risks are specific to ERP implementations. If one or more of the events associated with a risk actually occur during an ERP implementation, the objectives of the implementation are at risk. It is therefore essential to already pay attention to active risk mitigation during the ex ante evaluation of an ERP implementation.

Money Machines

[…]

Replacing its legacy system with a new SAP order-management application at the Unilever group could easily have taken as long as two years. But the company set a one-year timetable that was part of a broader effort to simplify its IT architecture and achieve what it considered world-class supply-chain operations.

Project planning and other preliminary work such as assembling the implementation team were already complete when the project officially kicked off on April 2, 2002, with an April 2, 2003, target for putting the application into production. The dates were chosen with a nod to superstition. "I didn't want to go live on April 1," Marshall says.

The order-management system is really a set of 15 applications, including planning, reporting, and order-to-cash processing, all running on Unix and an Oracle database. People on the project had weekly goals to meet and team meetings to decide how to solve problems that arose. Preparing training documents for customer-service representatives who use the order-management system, for example, took far more time and resources than expected. Project workers had to scramble in late 2002 to stay on schedule and avoid working the Christmas week, Marshall says.

Just how big a risk was this project? Big enough that Unilever, in addition to testing applications as they were installed, subjected the entire system to three months of simulation testing using real customer orders at a rate of 500 to 600 orders per day. Usually such systems are tested for only two to four weeks. The reason they did so much testing was that a primary objective was to complete the project without disrupting the retailers to which Unilever sells through its order-management system. "We wanted this transition to be transparent to our customers," Marshall says. Post-project surveys showed most Unilever customers were unaware of the shift.

Marshall won't disclose the project's cost but says the company assigned 35 to 40 IT people to the effort, many of whom had helped install other SAP apps at the company, plus a number of people from Unilever's business operations who were assigned full time to the task. About a dozen employees from Clarkston Consulting were brought in to add SAP experience to the effort. Marshall says it came in 8% under budget.

[…]

Figure 7.1: Risk management and ERP implementation at Unilever. *Source:* CMP Media [2003]

An example of a company that has carefully evaluated risks during an ERP implementation, and has also taken the relevant mitigating measures is Unilever. The company implemented SAP and went live in 2003. In Figure 7.1 the project is described.

In 2002, Unilever consciously decided for a high-risk approach for their ERP implementation. The planned implementation horizon was twelve months, while an average ERP implementation takes eighteen months. The business processes that were going to be supported with ERP were critical for Unilever's operation, as they comprised the whole demand & supply chain. Finally, the project should run smoothly in order to retain good relationships with the retailers, the most important customers for Unilever.

The company has consciously taken risks, but has also consciously implemented risk-mitigating measures. Testing was carried out on a large scale with operational data. No costs were spared on the implementation team, that consisted of at least fifty people, and in the team knowledge of business processes, SAP, and IT was amply available. The project suffered from some misfortune, but it ended on time and under budget.

7.2 A method for risk analysis

Risks are present and cannot always be prevented. It is however important to be aware of risks in order to control the potentially adverse effects of events in case they do occur. A good risk analysis can safeguard the attainment of the objectives of an ERP implementation, even if events have occurred that endangered realisation of these objectives.

Various authors have described how a risk analysis can be executed [Kupras, 1993; COSO, 2004]. According to these authors, three steps can be distinguished in a risk analysis: *risk identification*, *risk assessment* and *design of controls*.

The objective of the first step in the risk analysis, the so-called risk identification, is the creation of a list of potential events that could negatively influence the attainment of the objectives of the ERP implementation. This list should at least contain the four above-mentioned risks of ERP implementations: implementation cost overruns, limited benefits realisation, no financial improvement and operational problems during go live. The list should be supplemented with other project- or company-specific potential events.

The second step in a risk analysis, the risk assessment, aims to determine to which extent each of the identified risks is a threat for the attainment of the objectives of the ERP implementation. The extent to which the risk is a threat is called the *severity* of the risk. For each identified risk, the *impact* it would have on the costs and benefits during the ERP life cycle has to be estimated, as well as the *probability* that the event will actually occur. The impact is preferably measured in financial terms, while the probability is a number between zero and one. In a formula this becomes:

$$(7.1) \quad \text{Severity}_{\text{uncontrolled}} = \text{Probability}_{\text{uncontrolled}} \times \text{Impact}_{\text{uncontrolled}}$$

The third and last step in the risk analysis consists of the design of *control measures*, or briefly *controls*. The objective of a control is the reduction of the severity of a risk. A control for a risk reduces the probability that an event occurs, the impact that the event has when it occurs, or both. It is easy to see in the formula that with lower probability or impact the severity also becomes lower.

Controls generally come at a cost, which means that their side effect is decreased benefits of the ERP implementation or increased costs. For a controlled risk the following formula can be used:

$$(7.2) \quad \text{Severity}_{\text{controlled}} = \text{Probability}_{\text{controlled}} \times \text{Impact}_{\text{controlled}} + \text{Cost}_{\text{control}}$$

A control is economically worthwhile when:

$$(7.3) \quad \text{Severity}_{\text{controlled}} < \text{Severity}_{\text{uncontrolled}}$$

Four classes of controls can be distinguished: *evasion*, *reduction*, *transfer*, and *acceptance* [Gevers & Hendrikxs, 2001; COSO, 2004]. The evasion of a risk means not carrying out the activities that enable the risk to occur. An example could be a company that plans to implement the Available to Promise (ATP) method for production planning in ten factories. One of the identified risks of the implementation is the required skill level of the planners: a successful implementation of ATP in a factory requires a planner with skills at university graduate level. In the smallest three of the factories, no such planners are available. As the expected benefits of ATP in these factories are small, they do not outweigh the costs of hiring extra planners. The company decides not to implement ATP in the three smallest factories. This control measure avoids the risk: it reduces the probability of the risk to zero.

The second class of controls is risk reduction. A well-known risk in ERP implementations is operational problems during the go live. In a manufacturing company, this could lead to production interruptions, which in turn could interrupt order delivery to customers. A control measure that reduces the probability of this risk to occur is an additional investment in user training before the go live; a control measure that reduces the impact is building extra safety stock just before the go live. Both controls have associated costs: more training means more time of the planners and costs for the trainers, and safety stocks means more working capital.

When a risk is transferred, a third party partially or fully takes the risk. The best-known example of risk transfer is insurance. In an ERP implementation the contracting of an ERP implementation partner on a fixed price basis is a control measure for the risk of cost overrun. The cost of this control measure is the risk margin that the implementation partner will add on top of the hourly rates that would be applicable for a time material contract.

The last class of controls is risk acceptance, simply taking the risk. In this case both the probability and the impact of the risk remain unchanged. It is clear that this is a suitable control only if the severity of the risk is low or the control measures are extremely expensive.

7.3 Approach

During the execution of a risk analysis, it is recommended to make a distinction between analysis of the critical success factors on the one hand and the analysis of risks on the other hand. The analysis of critical success factors is relatively simple. The first critical success factor, top management support, can be arranged by measures like periodical explicit approval for next steps in the implementation, and the corresponding approval for budgets. The second critical success factor, the availability of an ERP champion who sponsors the ERP implementation, takes ownership for it and promotes it, can be realised by the appointment of a member of the top management team for this role. The third critical success factor, the continuous communication with all stakeholders, can be realised by the design and rigorous execution of a communication strategy for the ERP implementation. The strength of these individual measures can be increased by overarching measures that tie the sponsor, the other members of the top management team and other stakeholders to the success of the ERP objectives. Examples of such measures are integration of the ERP objectives into the organisational strategy and annual plans, and the creation of a link between ERP achievements and bonuses or other types of variable compensation.

The analysis of risks starts with the risk identification, the creation of a list of potential events that could negatively influence the attainment of the objectives of the ERP implementation. The list starts with the four aforementioned risks, and can then be extended with industry- and organisation-specific risks. Good starting points of lists with risks associated with large project can be found in books on risk management, such as Kupras [1993] or Gevers & Hendrikxs [2001].

After the creation of a list with risks, the severity of each risk has to be determined for each of the preselected ERP systems that are taken into account in the ex ante evaluation, and corresponding control measures have to be designed. In Figure 7.2, the risk management process is depicted graphically.

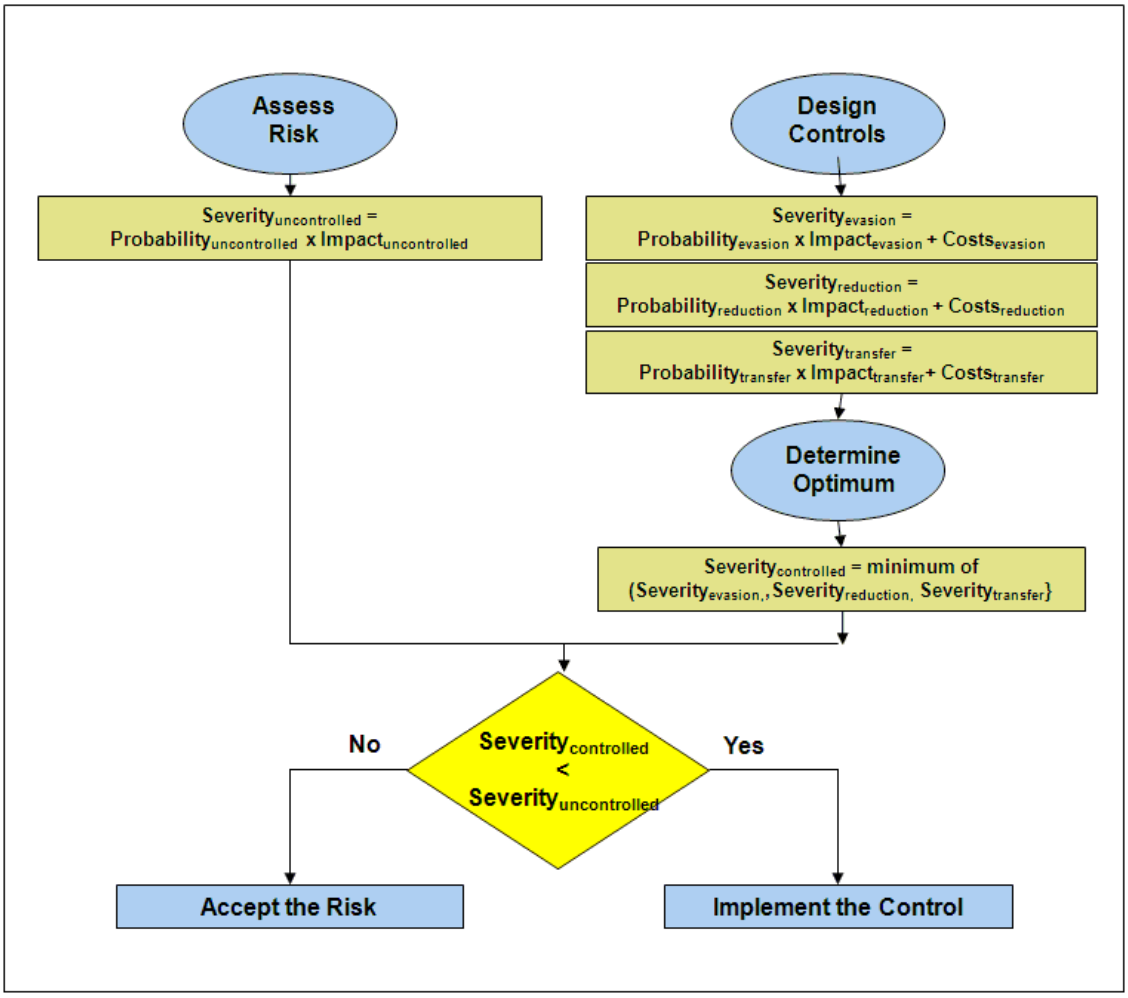

Figure 7.2: Risk analysis

Firstly, probability and impact of the risk are determined in case no controls are implemented. Secondly, controls are designed that avoid, reduce or transfer the risk. Per measure, the costs are determined, as well as the reduced probability and impact of the risk when the control would be implemented. Finally, the control that minimises the risk is selected for implementation. It is also possible to implement more than one control to mitigate a single risk; for readability reasons, this possibility has not been depicted in Figure 7.2.

Like a functional fit analysis, a risk analysis is best executed as a subproject of the ex ante evaluation of ERP. And like for the functional fit analysis, the quality of the results is highly dependent on the composition of the project team. In the project team, knowledgeable risk managers, experienced project managers, and experts in the organisational processes are essential.

The specialists in risk management are required in the project team because they know the methods and techniques that are applied in risk analysis projects. If the company employs a risk manager then this person is an obvious candidate for participation in the risk analysis team. Other suitable candidates are internal, operational and IT auditors.

The experienced project managers bring the practical experience of risk identification and assessment to the team. When the organisation has already completed ERP implementations, the project managers of previous projects can be very valuable for the risk analysis. When the company does not have employees with sufficient knowledge and experience, hiring an external consultant who has experience with managing ERP implementations for participation in the project team is worth considering.

The experts in organisational processes have an essential role in the assessment of risks and the design of appropriate controls. They have intimate knowledge of the organisation and can make well-founded estimates of the impact of adverse circumstances.

Various tools and techniques are available for the support of risk analysis. Well-known techniques for risk identification are workshops and open-ended interviews. Project evaluation documents and audit reports can also be useful sources for risk identification. For risk assessment, numerous methods can be applied, such as scenario analysis, benchmarking, sensitivity analysis, or advanced statistical techniques such as value-at-risk or cash flow-at-risk [COSO, 2004].

Tools that automate a risk analysis are hardly available. The functionality of software that is advertised as suitable for risk analysis is mostly meant for compliance projects and internal controls. For an ex ante evaluation of ERP this software is too cumbersome. Traditional software for office automation, like a word processor or a spreadsheet are the best tools for risk analysis.

One final remark with respect to the outcomes of a risk analysis is in order. Above, a description is given for the execution of a well-structured risk analysis. It is certainly recommended to apply this structure and carry out a diligent risk analysis.

However, the outcomes of a risk analysis are never complete, because it is not possible to predict all circumstances that might endanger the realisation of the objectives of the ERP implementation. Moreover, the outcomes of a risk analysis can never be exact and unambiguous, because both the probability that an adverse event will occur and its impact are estimates that are subjective. It is therefore recommended to avoid a false sense of accuracy by presenting very detailed and precise outcomes of a risk analysis without an indication that the outcomes are to a large extent based on assumptions and estimates.

7.4 Summary

Risk analysis is the second step in the ex ante evaluation of an ERP system. The objective of the risk analysis is increasing the chance of a successful ERP implementation by analysing key success factors and by identifying, assessing and mitigating risks.

In this step in the ex ante evaluation, general as well as organisation-specific critical success factors are identified and measures are designed to implement these success factors. Moreover, general as well as industry- or organisation-specific risks are identified and an estimate is made of the severity of the risk with respect to the realisation of the objectives of the ERP implementation. For each identified risk, control measures are designed. Four classes of controls exist: risk evasion, risk reduction, transfer of risk and risk acceptance.

The risk analysis is executed by a project team in which thorough knowledge of risk management, project management and organisational processes is available. Techniques that can be used for risk identification are workshops and interviews, while for risk assessment methods like scenario analysis, sensitivity analysis, benchmarking and several statistical techniques can be applied.

The outcomes of a risk analysis are never complete or exact, and the real ERP implementation will always meet with unexpected adverse circumstances. Despite this, a structured risk analysis is an important subproject in a good ex ante evaluation, given the risks associated with ERP implementations.

8 Cost benefit analysis

This chapter presents the third and last step in the ex ante evaluation of ERP: the cost benefit analysis.

The first section of this chapter is dedicated to the significance of cost benefit analysis, and to the relationship of this analysis with the functional fit analysis and the risk analysis presented in the previous two chapters. In the second section the theoretical background of cost benefit analysis is presented. The third section describes how a cost benefit analysis can be executed. After its completion, a cost benefit analysis shows the investment required for the ERP implementation, and the benefits that an organisation can realise by ERP.

8.1 Significance of the cost benefit analysis

It is difficult to give a general estimate for the costs of an ERP implementation. A very rough rule of thumb for the estimated implementation costs of ERP is one per mille of annual revenue [CFOIT, 2003]. Surveys give a diverging image of ERP implementation costs. One survey under 500 companies showed average ERP implementation costs of US$ 5.3 million [FERF, 2003], while an other survey under almost 100 companies reported an average of US$ 15 million for an initial ERP implementation [Nucleus Research, 2003]. Although the estimates are wide apart, they do show that ERP implementations come with considerable costs.

The absence of a generally applicable estimate also holds for the benefits of ERP. Theoretically, the main characteristics of ERP, data integration and support for best practices should be beneficial for organisations. Survey-based research confirms this. In a survey under over 400 mostly American companies, eighty percent of the respondents indicate that ERP increases the efficiency in the supply chain and reduces working capital requirements [FEI, 2002]. However, exact numbers on the extent to which the financial position of organisations improve are not available.

It was already noted that ERP can be beneficial for organisations, but also that ERP implementations have inherent costs and risks. In the third step of the ex ante evaluation of ERP a cost benefit analysis of the implementation is executed, in order to create a better understanding of the costs and benefits that can be expected for companies that consider an ERP implementation.

A thorough cost benefit analysis satisfies at least three criteria in order to realise this better understanding. Firstly, the analysis has to have a *financial outcome*. Every investment in an organisation leads to financial, other quantitative and qualitative benefits. An example of a potential financial benefit after an ERP implementation is lower working capital requirements. A potential non-financial quantitative benefit could be lower emission of toxic gas by better production planning. An example of a qualitative benefit is lower workload in the finance department during financial month ends because of a higher degree of automation. In the past fifteen years, especially during the Internet dream, IT investments have more than strictly necessary been justified on the basis of non-financial benefits alone. When everyone woke up from the Internet dream, billions of investments had gone up in smoke. In order to prevent a too shallow justification of an ERP investment it is important to express the benefits of an ERP implementation in financial terms. This will allow a fair comparison of ERP with other investment opportunities, and it also allows a better evaluation of benefits realisation after the implementation has been completed.

Secondly, a thorough cost benefit analysis has to be *complete*. In most companies, many investment opportunities exist, while the total investment budget is limited. The budget that is made available for an ERP implementation could also be used for alternative investment proposals, that could potentially have higher benefits. For this reason, the ERP cost benefit analysis has to be complete: all relevant costs and benefits have to be included, and not just a few obvious categories. Only when cost benefit analyses are complete, organisations can make well-founded investment decisions.

Thirdly, a cost benefit analysis has to be *integrated*. The outcomes of the other two steps in the ex ante evaluation, the functional fit analysis and the risk analysis, are in financial terms already, and now have to be incorporated in the cost benefit analysis. In the functional fit analysis, the costs and benefits of process modifications have been estimated, as well as the costs of software modifications. These estimates have to be incorporated in the cost benefit analysis. The risk analysis also has a strong connection with the cost benefit analysis. The severities of the various risks in the cost benefit analysis need to be taken into account as ERP implementation costs. After this, the costs and severity reduction has to be included for each of the control measures that have been selected for implementation in the risk analysis. Finally, the costs associated with the critical success factors have to be added to the cost benefit analysis.

Shell spends RM50m for R/3 ERP system

SHELL Malaysia has embarked on a RM50 million computerisation project to integrate the entire business operations and financial processes in major parts of its Oil Products (OP) sector.

An integral part of the project, dubbed Wave 2, is the implementation of the SAP R/3 enterprise resource planning (ERP) software package.

The project is spread over three phases and the subsidiaries involved are Shell Malaysia Trading (SMT), Shell Timur Sdn Bhd (STSB), Shell Refining Company (SRC), Shell Malaysia Ltd (SML) and Shell Middle Distillate Synthesis (SMDS).

According to Shell Malaysia's OP sector managing director Saw Choo Boon, implementation of phase one began in April last year and covers finance and cost management, materials and services procurement, project management and fixed assets. Over 800 users are expected to use the system in this phase.

The user base should increase to 1,200 in phase two, which started in January this year. This phase covers sales and distribution, production planning and plant maintenance and is expected to go live on Jan 1 next year.

Saw said out of the RM50 million investment, 40 per cent is allocated for consultancy services, 30 per cent for staff manpower costs, 20 per cent for training and development and 10 per cent for software and hardware.

He added that the SAP R/3 system replaces Shell Malaysia's 13 existing separate major systems and a range of smaller applications and makes the company the first in the Asean region to implement the latest SAP R/3 version – version 3.1h – with the IS Oil module.

In terms of benefits, the implementation of SAP R/3 is expected to reduce transaction processing, which allows more time for value-added work to be undertaken by Shell Malaysia, Saw said.

"Realigned processes and increased automation will also reduce paperwork and low-value activities such as reconciliation, error-correction and data re-entry," he said, adding that by using SAP R/3, the company's operations will also be Year 2000 (Y2K)-compliant.

[…]

Figure 8.1 Cost benefit analysis for an ERP implementation. *Source:* Lim [1998]

It would be interesting to study the trends in costs and benefits of ERP for companies that are implementing ERP, or have finalised their implementation. Unfortunately, most companies do not disclose the costs and benefits of their ERP implementations. One of the rare exceptions is the Malaysian subsidiary of Shell. In 1998, the company started an SAP implementation [Lim, 1998].

In Figure 8.1 the costs and benefits of the project are described. The currency in Malaysia is the Malay Ringitt, which in 1998 was worth around €0.24. It is remarkable, though not uncommon, that in the description the costs are presented in financial terms, while the benefits are largely expressed in qualitative terms. It is indeed difficult to express Millennium or other compliance in financial terms. However, reduction of paperwork and other work with low added value can be estimated in financial terms, and the same holds for phasing out a number of IT systems. Shell may have carried out the analysis in financial terms, but the company obviously chose not to mention these estimates. It is also remarkable that the description of costs is concentrated on costs during the implementation, while the impact of ERP in the later phases of the ERP life cycle is not mentioned. Software and hardware in the Shell project account for only a small proportion (ten percent) of the project costs, while the largest part of the budget (forty percent) is spent on implementation consultants. This is consistent with information from other projects.

8.2 A method for cost benefit analysis

Many methods are available for the evaluation of information technology related projects. After a thorough review of literature, Andresen [2001] found 82 of such methods. These methods are suitable for an ERP cost benefit analysis only if they have a financial outcome, and are complete and integrated. None of the methods described by Andresen satisfies all three criteria. Therefore, a method for cost benefit analysis is presented below that combines the strengths of a number of methods.

In general, organisations have several investment opportunities, and a limited investment budget that is insufficient for carrying out all investment opportunities. The management of the organisation has to create an optimal portfolio of investments, by selecting those investment opportunities that collectively do not exceed the investment budget and maximise the value of the investments.

A well-known method that is used to choose between investment opportunities is the Net Present Value (or: NPV) method. Methods specifically developed for IT investments also exist, such as Information Economics [Parker & Benson, 1988] or one of the various grid methods [Berghout & Meertens, 1992]. These methods are multi-criteria methods: they use several measures to allow comparison of investment opportunities, and NPV is often one of them. General methods, that can not only be used for evaluation of IT investments, are the Internal Rate of Return (or: IRR), or the Payback Period method. It can be shown on theoretical grounds that these measures are not as strong as the NPV.

An NPV calculation is based on the costs and benefits of an investment during the whole life cycle of that investment. Various authors describe the use of NPV specifically for ERP [Murphy & Simon, 2001; Zalm & Noordam, 2003], or for general IT investments [Verhoef, 2004]. The NPV for an investment is calculated by filling in the costs and benefits in the following formula:

$$(8.1) \qquad NPV = \Sigma_{t=0,T} [R_t / (1+d)^t]$$

A brief description of the various symbols in the formula is in order here; a more detailed explanation of the Net Present Value method can be found in standard text books for corporate finance, such as Brealy & Myers [2000] or Hawawini & Viallet [2011].

Firstly the symbol T, the time horizon over which the NPV is calculated. For an ERP implementation, T is normally measured in years, but for short-term investments quarters or months can also be applied. According to the theory of the NPV, T should be the length of the life cycle of the investment. For ERP this implies that costs and benefits for a period of at least eight years should be estimated. A time horizon of this length is practically not feasible given the large inaccuracy in the estimates. A time horizon that is too short also does not paint a good picture for ERP, because the benefits of an ERP implementation only become visible three years after the initial investment. A commonly-used length for the time horizon in ERP ex ante evaluation is therefore five years. T in the formula therefore often is set to 5.

The second symbol in the formula is R_t, which indicates the return of the investment in period t. The return for time period t is calculated as the total benefits in the period t minus the total costs in the same period t.

The last and most complicated symbol in the formula is d. This symbol stands for the *discount rate*. It is the compensation that the organisation has to pay to its shareholders and banks in order to get the investment financed, and for these reason, it is also know as the *cost of capital*. Theoretically, the cost of capital can be determined on various levels: for the organisation as a whole, for a division or subsidiary, or for a specific project. In practice, the cost of capital for the whole organisation is normally used. For companies with a listing on a stock market, the cost of capital can be calculated; for other organisations, estimates have to be made. In general, the cost of capital for organisations lies between five and fifteen percent.

The NPV method can only be applied if all costs and benefits of the ERP investment are expressed in financial terms. Gathering all required information is not an easy task for the costs, and for the benefits it is often even more complicated. A method to determine the benefits of an ERP investment in financial terms has been designed by Murphy & Simon [2001]. In Table 8.1 their method is explained on the basis of an ERP example.

Step in Murphy and Simon's method	Example
Identification	We miss orders because we are out of stock
Definition of measures	By using ERP we could reduce out of stock with 90%
Prediction of the benefits in physical terms	In the past month we missed 3 orders of product p, sales price €100 18 orders of product q, sales price €120 12 orders of product r, sales price €130 With ERP we could have realised 90% of these missed orders
Evaluation in cash flow terms	The missed revenue over the past month was 3 x €100 + 18 x €120 + 12 x €130 = €4020 Our profit margin is 50% on the products p, q and r. We therefore missed a profit of €4020 * 50% = €2010. With ERP we could have realised 90% of this profit, €1809. The past month is representative for all months. With ERP we could therefore realise an annual additional revenue of 12 x €1809 = €21708, which is the amount we add to the cost benefit analysis as additional annual return.

Table 8.1 Quantifying ERP benefits. *Source:* Murphy & Simon [2001]

A valid comparison between an ERP implementation and other investment opportunities is possible only if the list of costs and benefits for each of the investments is as complete as possible. In an ERP implementation, five categories of costs and benefits can be distinguished, each with a number of subcategories [Sneller, 2004]. In Table 8.2, these categories are listed.

Category	Subcategory
Project costs	Licenses
	Implementation partner costs
	Software development costs
	IT infrastructure costs
	Employees' time spent
	Employees' training costs
Costs and benefits in core and support business processes	Working capital reduction
	Additional revenue
	Cost reduction
Costs and benefits in IT	Hardware
	Software
	Communication costs
	Internal staff costs
	External staff costs
	External services
Costs and benefits from functional fit analysis	Process modification
	Software modification
Costs and benefits from risk analysis	Key success factors
	Severity of risks
	Risk avoidance costs
	Risk reduction costs
	Risk transfer costs

Table 8.2 Costs and benefits of an ERP implementation. *Source:* Sneller [2004]

The first category consists of project costs spent during the configuration & roll out and go live phases of the ERP life cycle. These are normally one-off costs. This category has five subcategories. The first two are licences of the ERP system, and the costs that implementation partners claim for configuration and localisation. Additional software development costs need to be made for conversion of data from the current IT systems to the ERP system, and for interfaces with IT systems that will continue to be used even after the introduction of the ERP system. The IT architecture has to be adapted to meet the requirements of the ERP system. Finally, the hours of internal staff need to be taken into account, as well as the costs of the training.

The next two categories are costs and benefits in the onward & upward phases of the ERP life cycle. These costs are mostly recurring in every period of the life cycle.

Firstly, the ERP system will have operational benefits. The characteristics of ERP, data integration and support for best practices, can lead to three subcategories of financial benefits. The first two, reduction of working capital and reduction of costs are confirmed in surveys and other forms of empirical academic research. The last subcategory, additional revenue as a result of an ERP implementation, is mainly a theoretical effect of ERP, in practice this is not often confirmed as an ERP benefit.

The second category consists of costs for keeping the ERP system up and running after the go live. The subcategories mentioned here are often used in benchmark research [Gartner, 2001]. It is possible that the costs of system maintenance decrease after the implementation of ERP, but it is also possible that it is more expensive to keep the ERP system up and running than to keep previous systems in the air.

The last two categories in the table ensure the integration between the cost benefit analysis on the one hand, and the functional fit and risk analyses on the other hand. For integration with the functional fit analysis, the costs and benefits of process modification and software modification need to be included in the cost benefit analysis, while for the integration with the risk analysis, the costs associated with the risk mitigating measures and the safeguarding of the key success factors need to be added.

By the combined usage of the NPV method, the method of Murphy & Simon for translation of benefits in financial terms, and the incorporation of the outcomes of the functional fit analysis and the risk analysis, a cost benefit analysis will be executed that satisfies the criteria of a good cost benefit analysis: it has a financial outcome, and it is complete and integrated.

8.3 Approach

The execution of a cost benefit analysis has four steps. Firstly, the parameters of the NPV method have to be determined. For the planning horizon T and the cost of capital d suitable values have to be determined. For the length of the planning horizon, five years is recommended, unless the organisation uses a standardised value of different length. The value of d is organisation-specific. For listed companies the cost of capital can be calculated using stock prices, interest rates and tax rates, for other organisations the finance director is the best source for the value of d.

Secondly, costs and benefits of ERP have to be estimated, for each of the combinations of ERP supplier, implementation partner and application service provider in the preselection. The first step is the identification of the benefits of the ERP implementation, and the conversion of these benefits into financial terms. The list of benefits is based upon the characteristics of ERP systems: data integration and support for best practices. In financial terms, these benefits can lead to reduction of working capital, reduction of other costs, or increase of revenue.

The third step is the estimation of costs of the ERP implementation, for each of the time periods in the planning period. The list of costs and benefits is company-specific. A good starting point for a list is presented in Table 8.2 above, other sources are checklists for project management or information management.

Finally, the results of the functional fit analysis and the risk analysis are integrated into the cost benefit analysis, again for each of the combinations of ERP system, implementation partner and application service provider in the preselection.

The cost benefit analysis is the third and final subproject of the ex ante evaluation. In order to successfully conclude the subproject it is essential to have project team members with the right knowledge and experience in the following areas: finance, IT management and procurement. Moreover, close cooperation is required with the project teams that execute the functional fit analysis and the risk analysis, as well as with the suppliers in the preselection.

The availability of financial skills are essential for the proper calculation of the NPV. If the organisation has an IT controller, this person is a very good candidate for participation in the cost benefit analysis team. Other suitable candidates are general controllers, management accountants or business analysts.

IT management expertise is also required in the project team. During the cost benefit analysis, it is not only necessary to look at the existing IT organisation, but it is also required to design a new organisation. This means that IT management that participates in the cost benefit analysis has to be able to have an unbiased look at potential changes in their organisation. This may be too much to ask. When political or personal interests start to dominate the analysis, it may be useful for the project team to hire an external consultant who is experienced with the design of IT organisations.

An important part of the costs of an ERP implementation consists of externally acquired products and services. For this reason, it is important to have an experienced purchaser in the project team. If the organisation has purchasers on the payroll, they are good candidates. Alternative candidates are the company legal council or a strong negotiator from an other functional area.

Several tools and techniques are available to support a cost benefit analysis. For cost and benefit identification, workshops and interviews can be a good source. Benchmarks are often used to analyse and compare costs, and several high-quality commercial benchmarks are available on the market. The disadvantage of commercial benchmarks is that they are expensive; an alternative can be to formally or informally exchange information with organisations in the same industry. A good source for historical costs are the organisation's financial accounts.

Tools that automate the cost benefit analysis do not have to be very complex. A modern spreadsheet, which supports NPV calculations, will often be sufficient.

Two pitfalls should be avoided during the cost benefits analysis. The first pitfall is the confusion of accounting costs with cash flows. For the correct NPV calculation all amounts should reflect cash flows. As an example: when in the first year hardware is purchased, the whole cash out has to be taken in the first year of the NPV calculation, although in the organisation's financial accounts an annual depreciation will be recorded during several years.

The second pitfall is ignoring intercompany charges. In many organisations, IT costs are recharged to the departments that use the IT services. For correct NPV calculations all costs including recharges have to be taken into account.

8.4 Summary

Cost benefit analysis is the last step in the ex ante evaluation of an ERP system. The objective of the cost benefit analysis is to create insight in the investment required for the ERP implementation, and the benefits that an organisation can realise by an ERP implementation.

In this step, costs and benefits of the ERP implementation are identified and expressed in financial terms. The value of the ERP investment is calculated using the Net Present Value (or: NPV) method. The outcomes of the other two steps in the ex ante evaluation, the functional fit analysis and the risk analysis, are incorporated in the cost benefit analysis. Because of this, the cost benefit analysis has a financial outcome; moreover, it is complete and integrated.

It is recommended to let a team in which financial knowledge, IT management expertise and procurement skills are well represented execute the cost benefit analysis. Besides identifying costs and benefits, the team will have to assess offerings of external parties: the ERP suppliers, the implementation partners and the application service providers in the preselection.

For identification of costs and benefits workshops, interviews and benchmarking are suitable techniques. The most important electronic tool for carrying out a cost benefit analysis is a spreadsheet.

9 ERP ex ante evaluation – an example

In this chapter, the ex ante evaluation of an ERP implementation is illustrated on the basis of an extensive example The objective of the chapter is to give the reader a proper impression of the ex ante evaluation process, consisting of the three phases functional fit analysis, risk analysis and cost benefit analysis. The company that is used in the example does not really exist, but the ex ante evaluation is a stylised version of an ex ante evaluation that actually took place and for which the true data have been disguised before publication in this book.

9.1 Introduction of the example company

P&V Inc is an American listed multinational company that manufactures and sells door mats. The company has three divisions: Americas, Asia-Pacific and Europe. Each of the divisions accounts for one third of the world-wide revenue. The manufacturing of the door mats is standardised to a large extent: P&V use identical manufacturing and planning processes throughout the world. The customer-facing and supplier-related processes are different for each location, because in every country where it is based, P&V adapts to the local business culture. The financial processes are also different for each location, as P&V has to comply with local legislation. The localised financial reports are rolled up every quarter in a standardised way for financial consolidation on P&V Inc level and stock market reporting.

The head offices of P&V Europe are based in The Netherlands. In Europe, the two manufacturing locations are located in Ireland and The Netherlands, which each produce fifty percent of European demand. P&V has sales offices in twenty-five European countries; the most important markets are The United Kingdom (half of the European revenue) and France (a quarter of the European revenue). The IT department in The Netherlands is responsible for all IT services for P&V Europe. Three important applications are in use. Manufacturing processes are supported by a tailor-made application for goods flow. This application is developed and maintained by the American corporate office, and P&V Europe pays an annual fixed fee for its two hundred users. Financial processes in Europe are supported by an outdated off-the-shelf financial application. The human resource departments of the manufacturing locations use their own local payroll application, while payroll processing for the twenty-five sales locations is outsourced to local payroll providers.

The American division of P&V has recently implemented a new ERP. With the integrated ERP system this division can now comply with the increasingly strict American stock market rules, that require companies to disclose their quarterly and annual reports within a limited number of days after the close of the financial period. ERP has now been operational for a year in P&V Americas, and the division has successfully shortened the time between financial quarter end and finalising the financial reports.

However, the speed of reporting of the divisions Europe and Asia-Pacific is still a bottle neck. P&V Inc wants to look into the option to implement ERP world-wide, in order to remove the reporting bottle necks. The European Board of Directors have been asked to investigate whether a European ERP implementation would be feasible, and what the costs and benefits would be.

The European Board of Directors decides to start a project for the ex ante evaluation of the ERP system. The European financial director will act as the sponsor for the project. She appoints the European planner as the project leader. His assignment is to carry out an ex ante evaluation, consisting of a functional fit analysis, a risk analysis and a cost benefit analysis. After three months, he has to make a recommendation as input for a go-no go decision by the European Board concerning the introduction of ERP in P&V Europe.

The project leader requests a dedicated team for the ex ante evaluation, in which the manager IT development, the European controller and the European procurement manager participate. This team is granted, and the proposed team members are released from all other duties for a period of the months.

9.2 The principles of the ERP implementation at P&V Europe

Before starting the ex ante evaluation, the project leader looks into the principles that will guide his ex ante evaluation project. He investigates which strategy P&V Europe uses for the preselection of suppliers, the sourcing basis for the division of work between implementation partners and P&V Europe's employees, the model-building strategy and the go live strategy. The project sponsor gives the following guiding principles for the ex ante evaluation as well as the later implementation[2].

Principle 1: the preselection of suppliers, implementation partners and application service providers

As explained in Chapter 5, it is important to have a preselected short list of triplets of ERP suppliers, implementation partners and application service providers. In the case of P&V Europe, the ERP supplier is predetermined, as the US corporate head office prescribes the use of the large ERP supplier ERPack that is also used by P&V Inc in the US. The choice for an application service provider has also been made already: the corporate IT department will act as an ASP, and the IT infrastructure will be placed in the data centre that P&V use in the US. The ERP supplier and the application service provider are prescribed by corporate head office, but P&V Europe can select their own implementation partner. The project sponsor asks the project leader to recommend an ERP implementation partner after the ex ante evaluation.

The project leader wants to create a preselection of implementation partners before the actual ex ante evaluation starts. With his project team he chooses the following approach. A long list is created consisting of six potential implementation partners that have experience with the implementation of ERPack. These implementation partners are invited to present their company to the project team. They are also requested to provide a number of reference implementations, and the project team interviews the references about their experience with the implementation partners. On the basis of the presentations and the references of the six long-listed implementation partners, the project team decides that two parties will constitute the preselection: the large international consultancy firm Acons that has several thousands of consultants in Europe, and the small specialised company Bcons that employs around fifty consultants that only implement ERPack. Both parties are invited to participate with one consultant in the ex ante evaluation, and to present their quotation for the full ERP implementation at the end of the ex ante evaluation project.

Principle 2: sourcing basis

In Chapter 5 a description was given of the two extreme approaches for the sourcing basis. A company can expect the implementation partner to deliver a turn-key ERP solution, or opt for a do-it-yourself approach with a minimal effort of the implementation partner.

The board of P&V Europe intends to give their own employees an opportunity for personal development and growth during the ERP implementation, and to let employees design their own future work. The project sponsor therefore gives the project leader directions to use a do-it-yourself approach as the sourcing basis for the ERP implementation.

Principle 3: model-building strategy

In Chapter 5 of this book three model-building strategies were distinguished: the one instance, the kernel and the multi-model strategy. The board of P&V Europe studies the various model building strategies, and they base their decision on the following considerations. P&V is a company with standardised production processes: identical processes are used world-wide; the standardised processes offer opportunities for economies of scale. Moreover, P&V has a listing in the US. The company is only able to comply with all rules and regulations of the US stock exchange if the general ledger is standardised and the financial consolidation is a fast and smooth process.

In the three divisions of P&V the marketing and sales strategies are strongly diversified. Order taking processes, contractual terms and conditions for customers and suppliers, and shipping modes from factory to customer all strongly depend on local habits and cultures. The same holds for financial processes: they vary by country because of the local value added tax rules, import tax legislation, sales statistics reporting requirements and payment methods. The company can only operate successfully in the local markets if the P&V ERP system can support the variety of local processes.

The above means that for some processes P&V requires extensive global standardisation, while for other processes the divisions must be able to design their own processes. The one instance strategy of full standardisation is therefore not suitable for P&V, while the complete freedom of the multi-model strategy would lead to missed opportunities for economies of scale and speed. The P&V Europe board of directors therefore prefers a kernel approach. In order to optimally align the P&V kernel to the business requirements, the kernel should include manufacturing processes, the general ledger and the financial consolidation, while the customer and supplier processes as well as the country-specific financial processes should be modelled locally in the divisions.

As the ERP system has already gone live in the American division of P&V, an obvious candidate for the kernel is the ERP model that has been developed for P&V Americas. The project sponsor contacts her American colleague and requests if the American model can be used in Europe. She also agrees coordination processes for the continuous development and improvement of the world-wide manufacturing processes. After the coordination has been agreed, the European project leader is requested to base the ex ante evaluation on a kernel model-building strategy.

Principle 4: go live strategy

As discussed in Chapter 5, several strategies exist for getting a fully configured ERP system up and running. The most important go live strategies are the big bang and the go live per function.

In P&V Europe, the project sponsor highly appreciates a gradual and controlled go live. She is well aware of the risks of ERP implementations and she especially wants to avoid disruptions in the day-to-day operations during or shortly after the go live. She also sees a pioneering role for the finance department in the ERP implementation project. In order to contain the size of the first implementation project she wants to restrict this to the financial and goods flow modules of the ERP system. Other modules, such as the payroll module, may be interesting during the onward & upward phase, but their implementation will not be part of the scope of the first implementation project.

The project leader translates these directions into a go live per function strategy. In Figure 9.1 the strategy is depicted. The left hand side of the picture shows the current situation with two operational applications, the financial application and the goods flow application. The applications are linked via interfaces.

In the first phase of the ERP implementation, the current financial application is replaced by the financial modules of the ERP system. The existing goods flow application remains operational, and is linked to the ERP system via temporary interfaces. During this first phase, employees of the finance department have the opportunity to familiarise themselves with the ERP system, which will enable them to play a pioneering role during the second phase.

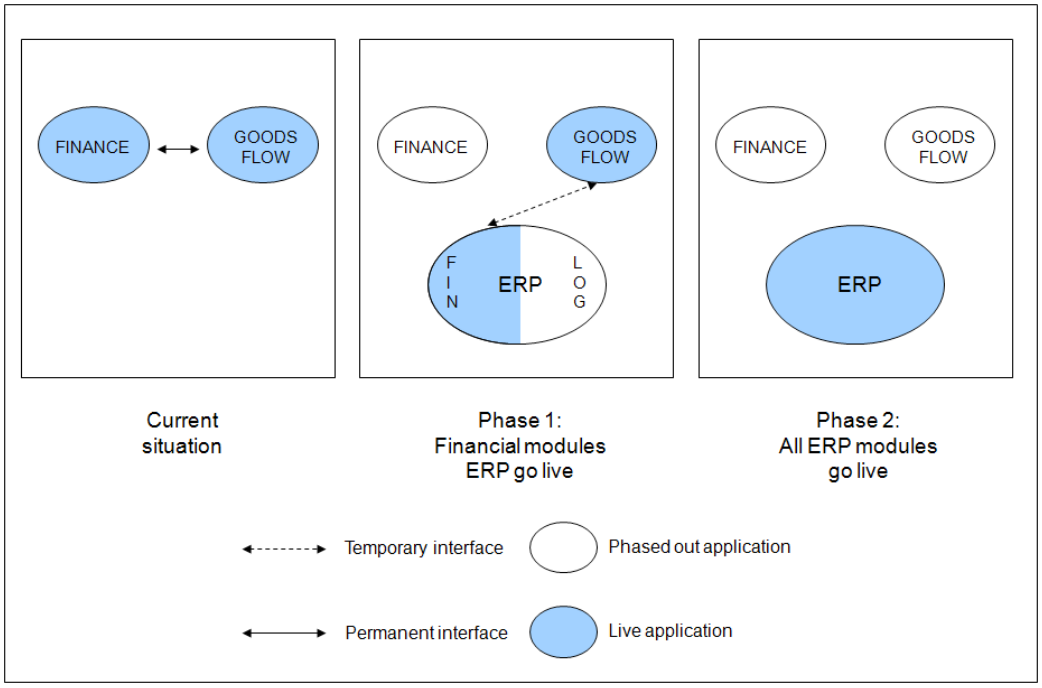

Figure 9.1 Go live strategy of P&V Europe

In the second phase the current goods flow application is replaced by the logistic modules of the ERP system. During the go live of this phase the risk of disruption of operational processes is high, for example when orders cannot be entered or shipped, stock levels registered in the ERP system do not match stock levels in the warehouse, or invoices cannot be created. When the financial department plays its pioneering role well and uses the experience acquired during Phase 1, they can give early warning signals and help remediate problems during the second phase of the go live.

Summary of the principles

Summarising, P&V Europe will base the ex ante evaluation of its ERP implementation on the following principles:

- *Preselection:* The supplier of ERP Europe will be ERPack, the implementation partner will be either Acons or Bcons, and the application service provider will be P&V corporate IT. Two triplets of partners will therefore be investigated during the ex ante evaluation: {ERPack, Acons, P&V IT} and {ERPack, Bcons, P&V IT}.
- *Sourcing basis:* In the relationship with its implementation partner, P&V Europe opts for a do-it-yourself strategy.
- *Model-building strategy:* P&V Europe has selected a kernel strategy for the ERP model-building, and the division will use the model developed by P&V Americas as the kernel.
- *Go live strategy:* P&V Europe will go live per function, starting with the financial function and continuing with the logistics function thereafter.

The project leader is now aware of the principles that he can take into account. He starts the ex ante evaluation project, and decides to split the project in three steps: functional fit analysis, risk analysis and cost benefit analysis.

9.3 Functional fit analysis

The objective of the functional fit analysis is to determine how the ERP characteristics, data integration and support for best practices, can be applied to improve the processes and management of organisations that intend to implement an ERP system. In the functional fit analysis, each business process is analysed to determine whether it has a perfect fit with the ERP system, or that process modification or software modification is required[3].

P&V Europe intends to achieve the objective of the functional fit analysis as a subproject of the ex ante evaluation, and the project leader is tasked to find out how the data integration and best practices offered by ERPack can be used by P&V Europe in such a way that the required shortening of the month end close process is achieved.

For the functional fit analysis, the project leader requires a team in which knowledge of the processes, of the ERPack system, and of software development is available. He sets up a team with six members that will work together for a month on a full time basis. The first two members of the team are the accounting managers of the UK and France, the largest sales countries in P&V Europe. Two other members of the team come from the candidate implementation partners Acons and Bcons. This arrangement is beneficial for all parties. On the one hand Acons and Bcons bring in knowledge of ERPack to the team, which is beneficial for P&V Europe. On the other hand, during their participation the consultants can gather information they need to make a good quote for the full implementation, which is beneficial for the implementation partners. The last two members of the functional fit team are the application servers provider of the current financial system, and a software developer of the IT department of P&V Europe. The project leader of the functional fit analysis is one of the members of the ex ante evaluation team, the European procurement manager.

Business Process	Subprocess	Perfect fit?	Process Modification?	Software Modification?
Fixed Assets	Management of Master Data and Transaction Data	Yes	-	-
	Calculation of Depreciation and Amortisation	Yes	-	-
	Reconciliation of Fixed Assets	Yes	-	-
	Revaluation and Impairment of Fixed Assets	Yes	-	-
General Ledger and Close	Management of Master Data	Yes	-	-
	Journal Entry Processing	Yes	-	-
	Reconciliation of the General Ledger	Yes	-	-
	Revaluation and Impairment of Balance Sheet Items	Yes	-	-
	Month End	Improvement	Yes	-
	Year End	Improvement	Yes	-
	Financial Consolidation	Improvement	Yes	-
Accounts Receivable	Transfer of Credit Limits	Temporary	-	Temporary Interface
	Management of Other Master Data	Yes	-	-
	Sales Invoice Processing	Yes	-	-
	Transfer of Sales Invoices	Temporary	-	Temporary Interface
	Draft, Check and Bill of Exchange Processing	Yes	-	-
	Factoring	Change for Worse	-	Yes
	Cash Receipts Processing	Yes	-	-
	Bank Receipts Processing	Improvement	Yes	-
	Receivables Monitoring	Yes	-	-
	Reminders and Collection	Yes	-	-
	Bad Debt Processing	Yes	-	-
	Sales Bonuses and Pace List Processing	Yes	-	-
	Reporting	Yes	-	-
Accounts Payable	Management of Master Data	Yes	-	-
	Purchase Invoice Processing (non-stock keeping units)	Yes	-	-
	Transfer of Purchase Invoices (stock keeping units)	Temporary	-	Temporary Interface
	Payment Selection	Yes	-	-
	Draft, Check and Bill of Exchange Processing	Yes	-	-
	Bank Payables Processing	Yes	-	-
	Reminder Processing	Yes	-	-
	Procurement Bonuses and Pace List Processing	Yes	-	-
	Reporting	Yes	-	-
Tax and External Reporting	VAT Reporting	Yes	-	-
	Export Statistics	Yes	-	-
	Income and Company Tax	Yes	-	-
	Local Annual Reporting	Yes	-	-
	Intercompany Reconciliation	Yes	-	-
	Cash Flow Forecasting	Yes	-	-
Budgeting	Management of Budget Data	Yes	-	-
	Reporting	Yes	-	-

Table 9.1 The financial processes and subprocesses of P&V Europe

All logistic processes in Europe are identical to those in the US, which was one of the reasons to decide for the kernel model-building approach. Because of this assumption, the project leader assumes that the logistic processes have been modelled in the ERP kernel in such a way that they have a perfect fit with existing processes, as this turned out to be the case in the US.

Unlike the logistic processes, the financial processes in Europe are significantly different from those in the US. A detailed functional fit analysis for Europe therefore has to be carried out for financial processes. The first week of the functional fit analysis is used to create a list of the relevant financial processes. The project team distinguishes forty-one subprocesses, which are listed in Table 9.1.

After the list has been created, the project team makes detailed descriptions of each of the forty-one processes. An example of such a detailed description for the subprocess Reminders & Statements in the business process Accounts Receivable is presented in Figure 9.2.

Using the detailed subprocess descriptions, the project team investigates how each subprocess can be modelled in ERPack. According to this analysis, thirty-three processes can be modelled in the ERP system in such a way that there is a perfect fit between the current business process and the future process supported by ERPack. For the other eight subprocesses, no perfect fit is available and additional analysis is required. The last week of the functional fit analysis is used by the project team to estimate the consequences of these misfits.

Three types of misfits exist. Firstly, the ERP system may offer better support for a business process than the current financial application. In the P&V Europe situation, this is the case for the subprocesses Month End, Year End, Financial Consolidation and Bank Statement Processing for Accounts Receivable. The improved support for Month End, Year End and Financial Consolidation implies that P&V Europe can shorten the processes and fulfil the requirements of the P&V corporate financial department. This is however a qualitative improvement, which does not have associated financial costs or benefits. The improved Bank Statement Processing for Accounts Receivable however does have a financial impact. In the current process, several hundreds of payments are processed manually every day, while after the go live of ERPack eighty percent thereof can be processed automatically. This will lead to a saving of one full time person as soon as ERPack has gone live in Phase 1.

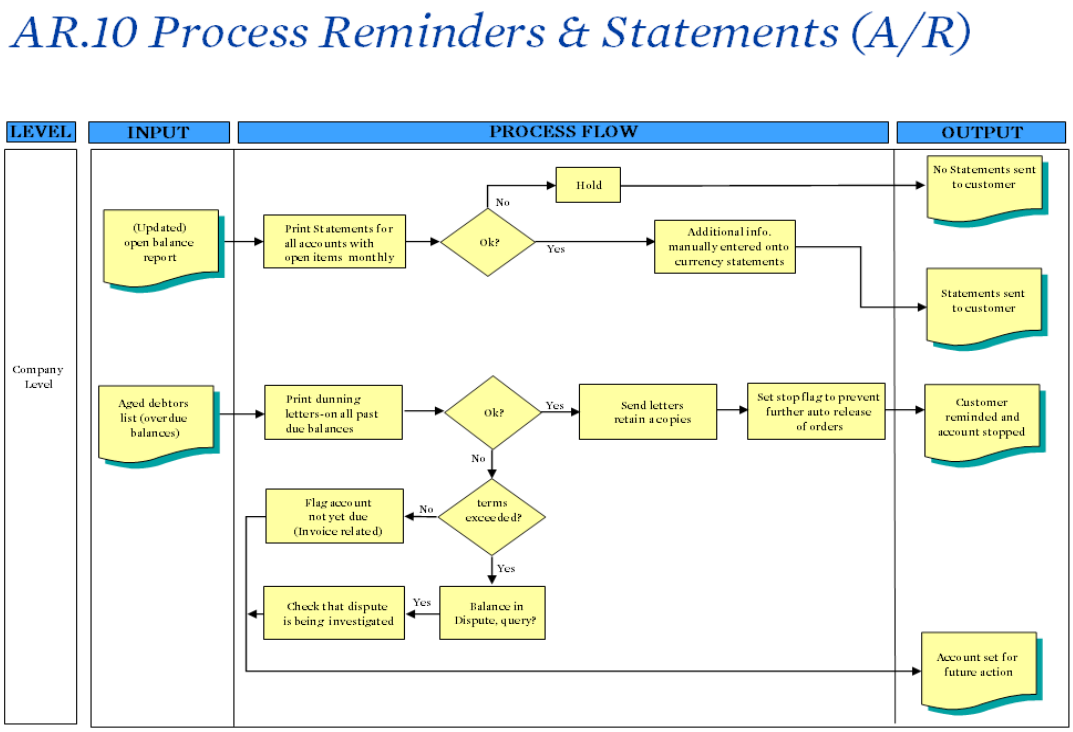

Figure 9.2 Detailed Subprocess Flow for Accounts Receivable – Reminders & Statements

The second type of misfits arises as a result of the selected go live strategy. The go live per function leads to a number of temporary interfaces between the new ERP system and the existing goods flow system, as depicted in Figure 9.1 in the previous section. Three temporary software modifications are required: credit limits for customers, sales invoices and procurement invoices for the goods for which the stock registration is kept in the goods flow system. As an example: an important subprocess at P&V Europe is the monitoring of credit risks on the basis of credit limits. P&V Europe wants to limit the exposure to the default or bankruptcy of individual customers. Customer orders therefore can only be fulfilled provided that they don't extend the exposure to that customer beyond a customer-specific credit limit. In the temporary situation between phase 1 and phase 2 of the implementation, customer credit limits will be maintained in the new ERP system while order taking is still done with the existing goods flow application. This means that a temporary interface is required in which the customer credit limits are transferred from ERPack to the goods flow application. For other temporary interfaces similar requirements hold. As soon as phase 2 of the implementation is completed and the full ERP system has gone live, the temporary interfaces become obsolete. The IT specialist in the functional fit team estimate that building the three temporary interfaces will take thirty days of development work, and that testing the interfaces will take another ten days.

The last type of misfits is a change for worse. One current process will be less well supported by ERPack than by the current financial application: the draft and factoring process. At P&V Europe, this process only occurs in France. In France a payment term of sixty or ninety days applies: French customers only have to pay sixty or ninety days after an invoice is sent. P&V Europe has made the following factoring arrangement with its bank in order to reduce the adverse impact of the payment term on cash flows. The company sells the receivable to the bank directly after the invoice is sent to the customer. The bank pays the amount due minus a small fee to P&V Europe, and takes care of the collection process. For P&V this arrangement means a cash flow advantage of sixty to nine days, as well as a minimal collection effort. This complex draft and factoring process is supported by the current financial application; however, ERPack does not support the draft process in the way that is legally required in France. P&V Europe finds a process modification not acceptable for this subprocess, because of the large financial impact it would have on the French business. The project team therefore decides on a software modification for this process. The effort to build the software for the required extension is estimated on thirty development days and fifteen testing days.

Functional Fit	***Process / Subprocess***	***Start***	***Phase 1***	***Phase 2***			***Remarks***
		Year 1	***Year 2***	***Year 3***	***Year 4***	***Year 5***	
Process	General Ledger and Close						
Modification	Accounts Receivable / Bank Receipts Processing		60	60	60	60	1 full time equivalent is €60K
	Sum Process Modifications		*60*	*60*	*60*	*60*	
	Interface Credit Limits	-12					10 development + 2 test days, €1000 / day
Software	Interface Sales Invoices	-14					10 development + 4 test days, €1000 / day
Modification	Interface Procurement Invoices (stock keeping units)	-14					10 development + 4 test days, €1000 / day
	French Drafts and Factoring	-45					30 development + 15 test days, €1000 / day
	Sum Software Modifications	*-85*	*0*	*0*	*0*	*0*	
	Sum	***-85***	***60***	***60***	***60***	***60***	

Table 9.2 Outcomes of the Functional Fit Analysis

Summary of the functional fit analysis: after four weeks, the functional fit analysis is completed. The outcomes of the functional fit analysis are presented to the ex ante evaluation project team, and the functional fit team is dismantled. In Table 9.2 the financial consequences of the functional fit analysis are summarised.

9.4 Risk analysis

The objective of the risk analysis is increasing the chance of a successful ERP implementation by analysing key success factors and by identifying and assessing risks. For key success factors and significant risks, risk-reducing measures need to be designed and their costs and benefits need to be estimated[4].

P&V Europe executes a risk analysis for every large project. It is therefore no surprise that the project leader of the ERP ex ante evaluation is tasked to investigate which risks are associated with the ERP implementation, and which mitigating measures can be taken at acceptable costs.

For the risk analysis, the project leader requires a team in which risk management knowledge, project management experience and knowledge of the business processes is represented. He creates a team of five members that will work together on the same location during three weeks. Risk management knowledge is contributed by the internal auditor of P&V Europe. Project management experience is brought in by a team member who has successfully run the P&V Europe Millennium, Euro and SEPA projects. The other three members all have long experience in their area of expertise: the manager of the factory in Ireland knows the ins and outs of all manufacturing processes, the manager customer service in France is very familiar with order taking and sales processes, and the Dutch accounting manager is a specialist in financial processes. The risk analysis team is managed by one of the members of the ex ante evaluation team, the European IT development manager.

In the first week of the risk analysis, the team identifies which key success factors and risks will be included in the analysis. In Table 9.3 a list is presented of the risks for which, according to the project team, a deeper analysis is required.

	Key success factor or risk
Key Success Factor	Top management support
	Project sponsor
	Continuous communication
Risk	Cost overruns for implementation partner costs
	No or only partial benefits realisation
	Operational problems during the go live

Table 9.3 Overview of Key Success Factors and Risks

The team first discusses the success factors that are critical for the success of the implementation project. In order to guarantee the fulfilment of the critical success factors the team proposes a number of measures. For the first factor, top management support, the team expects that a high level of involvement and support from the US top management already exists, and that nu additional measures are required. This is because it is important for the US top management that the ERP implementation in Europe succeeds and that the shorter financial closing times are realised. Involvement and support from the European board is less obvious. The European ERP implementation project will have to compete for the attention and support of the European board with many other projects. In order to guarantee commitment, the European board will be invited for a quarterly ERP progress meeting during the whole ERP implementation. In every progress meeting, an external ERP expert will also be invited. The project team estimates that a budget of €15 000 is required for the progress meetings.

With respect to sponsorship, the project team is positive about the relationship with the European CFO. She is interested in the project and prioritises it above other projects and activities. She also takes the required decisions and acts as a linking pin between the ERP ex ante evaluation project team and the European board. The project team is confident that the responsibility for reaching the implementation objectives is in good hands when the CFO continues to act as a sponsor during the ERP implementation.

Finally, the project team understands the importance of continuous communication with all stakeholders during the ERP implementation. In order to guarantee that this critical success factor is fulfilled, the project team budgets €100 per ERP user specifically for communication; for 200 users this implies a communication budget of €20 000. Moreover, the team proposes to have one of the employees of the internal communications department spend ten percent of his time on the project. Using the standard annual costs per full time equivalent of €60 000 and an implementation time span of three years, a project budget of €18 000 will be required for this.

In the second and third week of the risk analysis, the project team investigates three risks for which they estimate that the likelihood of occurrence is more than fifty percent. Per risk, the severity is determined, risk-mitigating measures are designed and the associated costs are estimated. Finally, the optimal risk reduction strategy is determined for each of the three risks.

The first risk that is investigated is the risk of cost overruns for implementation consultants and software modifications. In order to analyse this risk the project team uses the quotations of the implementation partners Acons and Bcons, and applies the lessons learned of the ERP implementation of P&V Americas. Acons and Bcons were asked to make two quotations for the ERP implementation at P&V Europe: one on time-material basis, and one fixed-price-fixed-date quotation. They have handed in their quotations, and the estimated costs are presented in Table 9.4.

	Acons				**Bcons**			
	Time-material	**Fixed-price-fixed-date**	**Risk premium**	**%**	**Time-material**	**Fixed-price-fixed-date**	**Risk premium**	**%**
Implementation consultants	2100	2750	650	24	1500	2000	500	25
Data conversion	150	250	100	40	180	250	70	28
Total	**2250**	**3000**	**750**	25	**1680**	**2250**	**570**	25
Highest minus lowest		**highest**			**lowest**			

Table 9.4 Quotations of the implementation partners

Table 9.4 shows that the implementation partners incorporated a twenty-five percent mark-up for the risk of cost overruns. Moreover, there is a considerable difference between the lowest and the highest quotation. The project team knows that in the US the time-material based quotation was used, and the overrun amounted to one hundred percent of the initial quotation. The project team estimates that the likelihood of a fifty percent cost overrun for the European implementation very high, and the team intends to mitigate this risk they by agreeing a fixed-price-fixed-date contract with the implementation partner. In order to create a pessimistic rather than an optimistic view on the financial estimates, they also decide to use the most expensive quotation as the basis for the cost estimates. The costs of the risk mitigating measure is calculated as the difference between the most expensive fixed-price-fixed-date quote and the cheapest time-material quote, that is €3 million – €1.680 million = €1.320 million. When this amount is spread evenly over the implementation horizon, this means an annual amount of €440 000.

The second risk that is being investigated is the likelihood that the benefits of the ERP implementation are not realised. In order to estimate the severity of this risk, the project team again uses the P&V Americas project experience. In the US, an annual cost saving of one percent of the annual revenues was realised by the better support that ERPack offers for the standardised logistic processes. The project team assumes that P&V Europe is comparable to P&V Americas with respect to cost saving opportunities in the logistic processes, and that therefore P&V Europe should be able to also realise a one percent cost saving. At a revenue level of €200 million this implies an annual benefit of €2 million. The assumption is not based on an actual analysis of the European logistic processes. For this reason, there is a chance that misfits in the logistic processes are overlooked. The project team wants to mitigate the risk of exaggerated expectations by including only 75 percent of the expected cost savings. They do this by labelling 25 percent of the cost saving in the risk analysis as at risk.

The last risk that is investigated are the effects of operational problems during or shortly after the go live of the ERP system. If planning mistakes are made as a result of an imperfect go live of the ERP system and this results in insufficient stock, orders cannot be shipped. In that case, customers are free to cancel their orders and place them at a competitor of P&V. P&V Europe assumes that once customers have purchased from competitors, they will not come back and that their revenues will be missed for several years. In Table 9.5 the financial consequences of missing revenue is depicted.

Severity of the Go live risk	*Start*	*Phase 1*	*Phase 2*		
	Year 1	*Year 2*	*Year 3*	*Year 4*	*Year 5*
Margin loss as a result of operational problems			-200	-200	-200
Risk mitigation measure: safety stock			-110		

Table 9.5 Risk of the loss of customers as a result of operational problems

As mentioned above, the annual revenue of P&V Europe is €200 million, and a profit margin of twenty-five percent is realised on every order. If after the go live of the ERP system two percent of the revenues is lost because of out-of-stock situations, this means a loss of 2 percent times 25 percent times €200 million, or an impact of the risk of €1 million. The project team estimates that the probability of this risk is twenty percent, which leads to an estimated annual severity of €200 000.

As this is a considerable risk, the project team investigates risk avoidance measures. The risk avoidance measure that is selected is keeping additional stock to avoid out-of-stock situations. This means that before the go live of the system a safety stock is produced with a value of €1 million. This measure will incur the following costs: P&V Europe will have to close a bank loan for a year, which will lead to interest costs, and P&V Europe will have to pay additional warehousing costs. The interest rate is estimated on ten percent per year, the additional warehousing costs are €10 000 per year, and the estimated time period during which safety stock has to be kept is one year. The total costs of the mitigating measure are therefore €100 000 + €10 000 = €110 000. The total severity of the risk mitigating measure is considerably lower than the severity of the risk, and for this reason the project team decides to incorporate the mitigating measure into the ERP implementation plan.

Summary of the risk analysis: after three weeks, the risk analysis is finalised. The outcomes of the risk analysis are presented to the ex ante evaluation project team, and the risk analysis team is dismantled. In Table 9.6 the financial consequences of the risk analysis are summarised.

	Description	***Start***	***Phase 1***	***Phase 2***			***Remarks***
		Year 1	***Year 2***	***Year 3***	***Year 1***	***Year 2***	
Key success factors	Top management support	-5	-5	-5			Meetings
	Project sponsor						
	Continuous communication	-12	-13	-13			€200 per ERP user, 0.1 fte
	Total	*-17*	*-18*	*-18*			
Risks	Cost overruns for implementation partner costs	-440	-440	-440			Risk premium for the fixed price quotations; full amount to be included in the cost benefit analysis
	No or only partial benefits realisation because of misfits			-500	-500	-500	Risk that only a cost saving of 0.75 percent of revenue is realised; full benefit to be included in cost benefit analysis
	Operational problems during go live		-110				Costs of temporary safety stock
	Sum	*-440*	*-550*	*-940*	*-500*	*-500*	
Sum		***-457***	***-568***	***-958***	***-500***	***-500***	***To be included in cost benefit analysis***

Table 9.6 Outcomes of the Risk Analysis

9.5 Cost benefit analysis

Cost benefit analysis is the last step in the ex ante evaluation of an ERP system. The objective of the cost benefit analysis is to create insight in the investment required for the ERP implementation, and the benefits that an organisation can realise by it[5].

P&V Europe has a limited investment budget and wants to make a thorough evaluation of all investment proposals. For this reason, the European board takes an upfront analysis of costs and benefits very seriously. P&V Europe compares all investments on the basis of the Net Present Value (NPV) rule. The investment horizon in all proposals is five years, and the cost of capital is always set to ten percent. The sponsor of the European ex ante evaluation of ERP requests the project leader to carry out a thorough cost benefit analysis for the ERP implementation project.

In order to do this, the project leader requires a team in which financial knowledge, IT management experience and procurement knowledge are represented. He creates a team with three members that will work on the same location for a period of three weeks. The financial knowledge is brought in by the UK accounting manager. The second member is the IT operations manager, who has a long term management experience. The European procurement manager participates in the team to guarantee the level of purchasing knowledge. The project leader of the cost benefit analysis team is the European controller, who also participates in the ex ante evaluation team.

The project team gets together for a period of three weeks. The first week is used to create a list of all relevant costs and benefits. In Table 9.7 all costs and benefits are presented. They can be categorised in three classes: one off costs, benefits of the operational system, costs and benefits of the ERP application service provider, outcomes of the functional fit analysis and outcomes of the risk analysis. After the list has been created, the team members discuss the way in which the outcomes should be presented. They want to make two scenarios, one with a high risk and one with a low risk. In the high risk scenario, no risk-mitigating controls are included, while in the low-risk scenario the outcomes of the risk analysis as described in the previous section are included.

The first category of costs and benefits that is investigated consists of one off costs. As the ERP system has already been purchased in the US, no negotiations with ERPack need to take place. It is clear which costs will be recharged to P&V Europe for licences and maintenance of the ERP system. The licence costs are one off and amount to €1 million; they have to be paid at the European go live of the ERP system. The maintenance costs are annual, and they are sixteen percent of the one off costs. They are recharged to P&V Europe every year in January, and the first recharge takes place after the European go live.

The costs of the implementation partners that are included in the cost benefit analysis can be based on the quotations that Acons and Bcons have prepared. They can be found in Table 9.4. These quotations include configuration, localisation and user training. The project team decides to include the lowest implementation costs in the high risk scenario; this is the time-material offer of Bcons that amounts to €1.680 million. In the low risk scenario the highest implementation costs offered are included, an amount of €3 million. The implementation costs are spread evenly over the first three years of the investment horizon.

The IT infrastructure at P&V Europe is sufficient for an ERP implementation. All input and output devices, such as desktop computers, laptop computers and printers have enough capacity, and all other components are provided by the P&V corporate data centre. No additional investments are therefore required for the IT infrastructure.

P&V Europe have selected the do-it-yourself strategy as their sourcing basis. This means that the number of implementation consultants on the project will be limited, while a significant number of hours will be spent on the ERP implementation by internal staff. In order to estimate the number of hours and the associated costs, the project team treats the do-it-yourself basis in the following way. When internal staff start working on ERP, their current work will at least partially have to be carried out by others. This will be realised by *backfill*, the hiring of labour on a temporary basis. The cost benefit analysis team assumes that during the implementation four full time equivalents will always be working on the project, and that they need to be backfilled for fifty percent of their time. The backfill costs are €60 000 per full time person per year. As the estimated implementation horizon is three years, and during these three years four persons need to be backfilled for fifty percent of their time, the total backfill costs will be €60 000 × 2 persons × 3 years = €360 000.

Lastly, all future users of the ERP system need to be trained. The costs of the training are included in the implementation partner quotations, but the time spent by internal staff is also considerable. On average, the 200 users will get four days training. This means around 800 training days, or around four persons for one year. When replacement costs are also taken into account here, the costs of training are €240 000.

The second cost benefit category investigated during the analysis consists of the benefits of the operational ERP system. As explained above, the benefits if the operational ERP system for P&V Europe are a cost saving. In the high risk scenario, the project team includes the full cost saving that P&V Americas have realised with their ERP implementation, that is one percent of annual revenue, or €2 million per year. In the low risk scenario, the assumption is that only 75 percent of the cost savings is realised, which means a correction of the benefits of €500 000.

Cost benefit analysis	***Category***	***Start***	***Phase 1: finance***	***Phase 2: logistics***			***Sum***	***NPV (at 10% cost of capital)***
		Year 1	***Year 2***	***Year 2***	***Year 4***	***Year 5***		
One off costs	ERP licences	0	-1000	0	0	0	-1000	-909
	Implementation partner	-620	-620	-620	0	0	-1860	-1696
	IT architecture	0	0	0	0	0	0	0
	Hours of internal staff	-120	-120	-120	0	0	-360	-328
	Hours of training of internal staff	-80	-80	-80	0	0	-240	-219
	Sum of one off costs	*-820*	*-1820*	*-820*	*0*	*0*	*-3460*	*-3152*
Benefits of the operational ERP system	Cost saving	0	0	2000	2000	2000	6000	4522
	Sum of benefits	*0*	*0*	*2000*	*2000*	*2000*	*6000*	*4522*
Costs and benefits in ERP application services	ERP licence maintenance	0	0	-160	-160	-160	-480	-362
	Change in application service provider costs	0	0	0	0	0	0	0
	Sum of application services	*0*	*0*	*-160*	*-160*	*-160*	*-480*	*-362*
Outcome of the functional fit analysis	For details see Table 9.2	-85	60	60	60	60	155	105
	Sum functional fit analysis	*-85*	*60*	*60*	*60*	*60*	*155*	*105*
NPV	High risk scenario	***-905***	***-1760***	***1080***	***1900***	***1900***	***2215***	***1113***
Outcome of the risk analysis	For details see Table 9.6	-457	-568	-958	-500	-500	-2983	-2482
	Sum of risk analysis	*-457*	*-568*	*-958*	*-500*	*-500*	*-2983*	*-2482*
NPV	Low risk scenario	***-1362***	***-2328***	***122***	***1400***	***1400***	***-768***	***-1369***

Table 9.7 Net Present Value Calculation

The third category analysed by the project team consists of costs and benefits in ERP application services provisioning. In the pre-ERP situation, P&V Europe uses a number of applications that are managed in the US. ERP Europe pays a fixed amount per year for application services for these applications. When P&V Europe start using ERPack, the application services continue to be provided by the US, and though the services for the new ERP system are different, the costs don't change. The only additional costs that P&V Europe will have to pay are the maintenance costs of the licences of ERPack; these costs are sixteen percent of the purchase price.

The last two categories of costs and benefits are direct outcomes of the previous two analysis phases in the ex ante evaluation: the functional fit analysis and the risk analysis. These costs and benefits have been discussed in the previous two sections of this chapter.

Summary of the cost benefit analysis: after three weeks, the cost benefit analysis is finalised. The outcomes of the cost benefit analysis are presented to the ex ante evaluation project team, and the cost benefit analysis team is dismantled. In Table 9.7, the NPV calculations of the cost benefit analysis are summarised.

9.6 Go-no go presented to the European board

The project leader and the ex ante evaluation project team use the last weeks of the ex ante evaluation to finalise the project file, check the outcomes and complete them if required, and prepare a presentation for the European board.

The complete ex ante evaluation shows that the ERP investment has a Payback Period of less than five years, provided that the European board is willing to take considerable risks. The NPV of the investment in the high risk scenario is €1.1 million. If the European board wants to mitigate various risks, the five year project horizon is too short for a positive payback. The NPV of the investment in the corresponding low risk scenario is €-1.3 million. As the annual cost savings are €1.4 million, the investment is paid back after a little more than six years.

The project leader presents a summary of the results of the ex ante evaluation project to the board of P&V Europe. The board decides on a go for the ERP implementation project, and as they want to reduce the risks they intend to execute the low risk scenario.

Part 3: Managerial trends and ERP

In the third part of this book, ERP is viewed from the organisational and managerial perspective. The aim of this part of the book is to give the reader an overview of recent managerial trends, and how they relate to ERP. Trends that will be discussed are open source software, corporate governance and shared service centres. This third part consists of four chapters.

The first chapter describes a trend that has attracted much attention in the past few years: open source software. The chapter starts with a brief overview of the origin of open source software, the recent developments, and a number of examples of open source applications. After this the relationship between open source and ERP is explained. The chapter ends with a description of the consequences for the organisation when it decides to implement an open source ERP system.

The second chapter treats corporate governance. As a result of the accounting scandals in the beginning of the century and the banking crisis later in the decade, corporate governance issues have been in the focal point of the news. The chapter starts with a short introduction into corporate governance, internal control and a number of related concepts. Thereafter, the link with ERP is established. Finally, the impact of ERP on the efficiency and effectiveness of corporate governance audits is explained.

In the third chapter, the relationship is described between ERP and an emerging organisational form: the shared service centre. The chapter starts with a brief introduction into the concept of shared service centres. After this, the link between shared service centres and ERP is discussed. The chapter concludes with implementation strategies for organisations that intend to implement both ERP and shared service centres.

Undoubtedly, ERP is one of the most important and influential trends in information technology of the past decades. This, however, does not imply that everyone automatically subscribes to the advantages of ERP. The main characteristics of ERP, and their impact on organisations have been criticised. In a guide to ERP this criticism should not be ignored. The last chapter of this book is therefore dedicated to this criticism.

10 ERP and open source software

This chapter describes a trend that has attracted much attention in the past few years: open source software. The chapter starts with a brief overview of the origin of open source software, the recent developments, and a number of examples of open source applications. After this the relationship between open source and ERP is explained. The chapter ends with a description of the consequences for the organisation when it decides to implement an open source ERP system.

10.1 Open source software: a brief introduction

Software for which the source code is distributed with the software is called *open source software*. Because of the availability of the source code, open source software can be studied, improved, adapted and further distributed without restrictions. Everyone is free to make the best use of the software without being restricted in any way [Working Group on Libre Software, 2000]. Open source software is different from what is known as *closed software* or *proprietary software*, that is distributed in binary format that is readable for computers only and cannot be modified by people.

A wide-spread misunderstanding with respect to open source software is that open software is free of charge. This misunderstanding has arisen because in English the term *free software* has often been used as a synonym for open source software. The word *free* in English has several meanings, while *free* in relation to open source software should be read as *source code at everyone's disposal,* and not as *free of charge.* Some open source software is free of charge, but this is not necessarily the case. However, the source code of open source software is always accessible and available with the software.

Although open source software has gained much publicity in the past few years, the concept of open source software is certainly not new. In the 1960s, when IBM and other suppliers sold their first large mainframe computers, it was common practice to distribute the source code of the software with the hardware. The software could be shared with other companies, and could also be enhanced. The suppliers' primary commercial interest lay with the hardware, and software was considered a secondary product. In the 1970s and 1980s this changed as a result of the emergence of the mini and personal computers. Software and hardware were distributed more and more separately, and software became a product on its own for which licences were sold. The distribution of source code with software became rare.

As a reaction to the restrictions of proprietary software, two groups arose in the 1970s that can be seen as the founders of the open source movement: the GNU Free Software Foundation at the Massachusetts Institute of Technology, and the BSD Unix group at the Berkeley University. Initially both groups focused on operating systems. As an example: the well-known open source operating system Linux has its origins in the GNU Free Software Foundation.

In the 1980s and 1990s, many of the isolated open source software development initiatives were integrated. Since then, open source has been recognised as a valid direction for software development. Additionally, the quality of the developed software has increased enormously. In some markets, open source products are even market leader. A good example is Apache: it is estimated that sixty percent of all worldwide websites run on this open source web server [Fermont, 2003]. Other examples of successful open source products are MySQL, database software with four million users, OpenOffice, the open source suite for office automation, or Android, the mobile phone and tablet operating system.

Universities and governments have already sponsored open source initiatives since their inception. Today commercial organisations also spend time and resources on open source software development. The announcement of the publication of the source code of the Netscape browser in 1998 made large companies interested in open source. Nowadays, companies like Oracle, IBM, and Google investigate new market models to develop open source software in a profitable way.

Various market models have now proven to be successful. The most obvious reason for making software development resources available is building new functionality for open source software that is already in use but does not fully match the requirements of a company. Other companies invest in specialist knowledge of open source applications, in order to be able to offer implementation consultancy services to companies that want to use the software . Hardware suppliers often sponsor the development of operating systems or drivers for their products: the availability of an open source driver for a printer or a scanner can increase demand for that hardware. Many other products and services can be linked with open source software, such as books, magazines or training modules on open source. Finally, there are still open source software developers, who participate in open source projects, because they enjoy the cooperation with others, or like the idea that their software will be used by a large user community.

The software development methodology used for open source deviates strongly from the methodology used for proprietary software. The latter is often developed under centralised supervision, access to the source code is restricted to a designated group of software developers, and software quality is attained by a strict segregation of duties: designers make the specifications for the software, developers write the software source code, and testers test whether the software matches the specifications. These tasks are carried out sequentially: developers start when the specifications are ready, and testers start when the software is ready.

Open source software is usually developed by so-called *communities*, groups of developers that work together on a project. The developers do not meet in person, but they meet virtually on open source hosting sites. One of the largest hosting sites is Sourceforge. This site hosts more than 100 000 projects, and the collective community consists of more than one million registered developers [Sourceforge, 2007]. In principle, specification, software development, testing and error correction can executed by any member, and these activities can also be carried out in parallel. A healthy competition exists between participants. Community members who see the benefits of cooperation can reach synergies, while members who do not agree a selected direction can go their own way and create a so-called *branch* of the software. In recent years it has turned out that this development methodology leads to high quality software that can be developed very fast.

Inherent to open source software is the fact that no marketing and sales organisations exist for developed software. Formal patch planning for error correction, and formal release planning for new functionality, are incompatible with the way open source communities work, and it is also not always clear on which computer architecture the software will run. This can be a barrier for the use of open source products by companies and other organisations, because they are used to the professional, sometimes even obtrusive sales and marketing organisations of proprietary software applications.

In times of software monopolies the transparency of open source is attractive for our society. Many opinion leaders have studied the opportunities of open source software and have determined their position. As an example: most political parties in The Netherlands advocate the use of open source as an alternative for proprietary software. The political parties expect lower costs when open source software is used; for some parties, a sentiment against large multinational companies also plays a role. According to some parties, open source software could be a valid alternative for companies like Microsoft, that are experienced as monopolists in the market, and that can enforce prices and version management by keeping their source code confidential [VOSN, 2007a].

Various Dutch ministries carry out experiments to experience the pros and cons of open source software in The Netherlands. The Ministry of Economic Affairs researched the use of open source software not only as a cost saving opportunity, but also as a means to stimulate the innovation the Ministry deems desirable. Several Dutch ministries cooperated in a project that aimed to enhance the quality as well as the costs of common governmental processes by using open source software [VOSN, 2007b].

The application of open source in practice progresses very slowly. In 2005 the Municipality of Amsterdam carried out a pilot project with open source solutions, where migration and maintenance services were also considered. The evaluation of the pilot showed that open source was not yet a valid alternative for proprietary software [Politiek-digitaal.nl, 2005]. In 2007, the municipality again budgeted €300 000 for a pilot project [Lechkar, 2006]. Two municipal organisations experimented with office automation using open source software. One of the organisations, the Zeeburg district, is known for its innovative spirit. In this district, open source software was installed on twenty-five computers, and after a few teething problems the experience was largely positive [Plekker, 2008]. In cooperation with nine other large municipalities, Amsterdam signed a manifesto to stimulate the application of open source software by governmental organisations.

Commercial organisations are also using open source software more and more. The Dutch Rabobank reported on three pilot projects that were suggested in 2001 during an internal seminar of IT employees. The three projects were: the test of a new desk top based on OpenOffice, the use of open source software for a website, and the use of an open source tool for directory services, an essential element of the Rabobank IT infrastructure. The open source software had to meet the same maturity requirements as its proprietary alternatives. In Table 10.1 an overview is presented of these requirements.

	Maturity Question
1	How many users does the product have?
2	To what extent is the user base growing?
3	How many members does the product's community have?
4	What is the release plan of the product?
5	What is the speed of releases of the product?
6	How do software distribution and version management take place?
7	How are functional requirements coordinated?
8	What is the architecture on which the product is built?
9	Which user fora, news groups and mailing lists are available?
10	Is commercial support available for the product, and by whom is it supplied?
11	Which licence is applicable to the software?
12	What is the quality of the documentation, and is a style guide available for coding?
13	Do we have in-house knowledge of the product?
14	Do we have in-house knowledge of the programming language in which the product is written?

Table 10.1 Checklist to assess the maturity of open source software products. *Source:* Kuipers [2004]

After their completion, the three pilot projects were evaluated. The most important positive aspect of the open source software was the reduced dependence on the supplier, especially with respect to version management. The most important negative aspect was the absence of an external commercial sales and maintenance organisation; this had to be organised internally [Kuipers, 2004].

The Rabobank is not the only company that carries out experiments with open source software. Philips, the electronics manufacturer, has already applied open source drivers for all sorts of consumer electronics equipment. For this company, the ownership of the source code is the largest obstacle. Many different open source licence schemas exist, and Philips has a specialised group of legal advisers who determine whether or not a specific piece of source code may be incorporated in Philips's products [Genuchten, 2004].

10.2 ERP and open source software

Many ERP systems are developed under open source software licence agreements. The ERP category on the aforementioned open source hosting site Sourceforge holds almost 200 open source ERP systems [Sourceforge, 2014]. It is hard to judge on the basis of this listing alone to what extent these systems are full ERP systems with which data integration and support for best practices can be realised. It is even more difficult to predict which systems will survive and which will only have a temporary existence. An ERP system that is generally expected to survive is Compiere [Fermont, 2003; Kuipers, 2004]. Another system that has already been there for years is Fisterra. TinyERP was considered a good choice for continuity in 2005 [Kuipers, 2004]; the name of the system has been changed to OpenERP, and it is indeed still available on Sourceforge. In 2007 OpenBravo had the most active community of all open source ERP systems, in 2010 vTiger was downloaded most, and in 2014 the top five most popular systems were downloaded more than 16 000 times weekly. However, nobody can predict whether this will still be the case in five years' time.

According to Janssen Lok et al. [2006], two important criteria determine the suitability of an open source ERP solution for businesses: the professionalism of the community and the critical mass of the user base.

The professionalism of the community can be measured on the basis of the information on open source hosting sites. On these sites, a large number of key performance indicators is registered per open source project. The numbers of open and resolved software errors, requests for support, and change requests are reported, as well as the number of registered developers and other members of the community. Technical information is also available: the architecture platforms on which the software will run, the programming language in which it was written, and the underlying database management system all can be found on the hosting site. The information is readily available and gives a good overview of the professionalism of the community.

The critical mass of the user base is considerably more difficult to measure than the professionalism of the community. Exact data do not exist, because most open source ERP systems do not have an extensive sales and marketing organisation, and no licence registration is available. Moreover, sources of information that exist for proprietary software, such as seminars, trade fairs, and reference visits are hardly available. One potential source of information could be the websites of the various open source ERP systems, but these sites also do not announce information about organisations that actually use their ERP system.

In general, it is assumed that open source software only has a limited share of all organisations that use ERP. The organisations that select open source software are often those organisations that have always developed their own software and want to continue doing so after an ERP implementation [Gruman, 2007]

Centre Hospitalier Universitaire Tivoli

The Centre Hospitalier Universitaire Tivoli is the hospital of the City of Louviere and its vicinity. The hospital was built in 1976 and when we were there a thorough refurbishment was on its way. The hospital has around 500 beds and employs around 2000 people. There are 750 IT users and our host Etienne Stanus manages an IT operations department of 12 persons. The hospital also has a small development department.

Fifty percent of our software can be adapted by us

"In this hospital, 25% of the software is open source, 25% is not open source but can be adapted by us, and the other 50% is closed and cannot be adapted", says Etienne when he welcomes us. "Especially the software that was specifically made to comply with Belgian legislation is mostly proprietary. The market here is just very small and therefore no open source communities emerge. We do like it that half of our software can be changed by us. My two colleagues Farid Henry and Benjamin Desbuqoit have good relations in the 'open source' world, especially with respect to the development of our ERP system Compiere (www.compiere.org)."

ERP implementation

"A few years ago we had to replace a number of applications", Etienne explains. "We had new hospital management, and also because of compliance we were forced to review our IT environment. For some processes, such as the administering of medicines, there are only two suppliers in Belgium. However, we also wanted a new environment for our accounting processes, invoicing etc, so we scanned the market to review our options. We found two suppliers of closed source software, and one supplier of open source software. The latter offered us a very attractive price, and we invited them for a presentation of their offer", Etienne smiles.

"The supplier, called Audaxis (www.audaxis.be) told us about Compiere. The told us that Compiere already met many of the requirements that we had for our core processes. Specific requirement for our business processes could be adapted relatively easily. And as Compiere has no licence costs, we could spend that money on tailor-made extensions and close a maintenance contract with Audaxis and still spend less than on a closed source ERP solution. We therefore decided to continue with it. We took three months to adapt the software and to test it. This is actually quite fast for an ERP implementation. Compiere has now been used for one and a half year to our full satisfaction."

Open source is our standard

"In fact, open source is our standard", Etienne explains. "Almost all 750 users use OpenOffice for word processing and spreadsheet. A limited number of them have to use Microsoft Office because their specific applications do not yet support OpenOffice. Employees did not struggle at all with the migration, and management sees that employees work more efficiently and at lower costs with open source software. […]"

Figure 10.1 Open source ERP in a hospital. *Source:* Koelstra [2006]

In Figure 10.1 an example is presented of an organisation that consciously selected an open source ERP system. A medium-sized Belgian hospital had to replace its existing applications a couple of years ago. In addition to mandatory applications for hospitals, the organisation also wanted to implement an ERP system. A choice had to be made between a number of proprietary ERP systems, and the open source ERP system Compiere. For various reasons, such as cost savings and flexibility, the open source solution was selected. The implementation was finalised within a short time period, and meanwhile the software has been used to the organisation's full satisfaction. Currently the hospital uses a mixture of open source and proprietary software. Fifty percent of its software can be adapted by the hospital staff at any time, the other half can only be changed by the supplier.

10.3 Implementation strategy

Two important differences exist between proprietary and open source ERP systems: the relationship with the ERP supplier and the use of the source code.

In case of a proprietary ERP system the organisation that wants to use ERP starts a long-term relationship with an ERP supplier. The organisation agrees a licence contract with this supplier, which grants the right to use a clearly demarcated use of the software. The demarcation can be described in terms of users or modules. Moreover, the organisation normally agrees a maintenance contract with the supplier: in return of an annual maintenance fee, the supplier makes sure the ERP system is adapted to match requirements of new legislation, is extended with new functionality and is upgraded for new technological developments. In case of an open source system, there is no obvious party with which a licence contract and a maintenance contract can be agreed. The advantage is that no party can limit the use of the system; the disadvantage is that support and maintenance of the ERP system are not taken care of by itself.

In case of a proprietary ERP system the organisation that implements ERP does not normally have access to the source code of the ERP system, while unlimited access to the source code is the main characteristic of an open source ERP system. Open source software is not necessarily free of charge, but the use of the software and the associated source code may never be restricted. The advantage of this is that the functioning of the system is fully transparent: the source code can be studied line by line if necessary, and it can be adapted to meet the requirements of the business and management processes of the organisation that uses the system. Adapting the software also has its downsides of course: the use of best practices can be neglected, and software maintenance is a labour-intensive activity.

Often, cost savings are indicated as an advantage of open source software: the licences may not always be free of charge, but they are often considerably cheaper than licences for proprietary software. However, in the case of ERP it is not realistic to expect a substantial cost saving through the use of open source software. The licence costs may be lower, but in an ERP implementation, these costs constitute only a small portion of around ten percent of the total costs of the ERP implementation. It is also possible that the licence costs are lower, but that the maintenance costs are higher. In a proprietary situation, annual maintenance costs of ten two twenty percent of the initial licence fee should be taken into account. In an open source setting these costs are replaced by software development and maintenance, that can easily be more expensive. When measured over the total ERP life cycle, the costs of an open source ERP system will not necessarily be lower than those of a proprietary ERP system.

		Strategy	
Phase	**Step**	**Open source software as if it were proprietary software**	**Open source software with in-house software maintenance**
Principle	Preselection of suppliers	Selection of a commercial party that offers to deliver the software as a package and maintains the source code	Selection of an open source ERP system in stead of selection of a proprietary ERP system Selection of an internal or external party that will maintain the software
	Sourcing basis	Not different from proprietary ERP	Turn-key or do-it-yourself agreements need to be made with both the implementation partner and the party that will maintain the software
	Model-building strategy	Not different from proprietary ERP	Not different from proprietary ERP
	Go live strategy	Not different from proprietary ERP	Not different from proprietary ERP
Ex ante evaluation	Functional fit analysis	Not different from proprietary ERP	The approach for the functional fit analysis is not different from the approach for proprietary software; however, more software modifications can be expected, because they are easier to make in open source software than in proprietary software
	Risk analysis	Analysis of an additional risk: the community of the ERP system is no longer active	Analysis of an additional risk: the community of the ERP system is no longer active
	Cost benefit analysis	Not different from proprietary ERP	The approach for the cost benefit analysis is not different from the approach for proprietary software; however, a shift from licence costs to software maintenance costs is not unlikely.

Table 10.2 Comparison of open source implementation strategies

Organisations can choose one of two strategies when using open source ERP as an alternative for proprietary ERP. The first strategy is to implement the open source system as if it were a proprietary system, by selecting a commercial party that offers to deliver the software as a package and maintains the source code. The second strategy is to actively use the differences between open source software and proprietary software by maintaining the software in the organisation itself. Both strategies have consequences for the implementation of the system. The most important consequences are presented in Table 10.2, which is based on the phases distinguished in the ERP life cycle that were described in Part 2 of this book.

10.4 Summary

Open source software is software for which the source code is distributed with the software. As a result, the functioning of the system is fully transparent: the source code can be studied line by line, it can be adapted, improved and distributed further. Universities and governments have sponsored open source software since its inception, and nowadays commercial organisations also allocate time and resources to open source software development. The development methodology of open source software and proprietary software are significantly different. Open source software is developed by so-called communities, groups of software developers that jointly work on a project. The developers meet virtually on open source hosting sites.

A large number of ERP systems are being developed under open source. The most popular systems are Compiere and Fisterra, while OpenBravo and OpenERP are emerging. Two important differences exist between an open source and a proprietary ERP system: the relationship with the ERP supplier and the use of the source code.

Organisations can choose one of two strategies when using open source ERP as an alternative for proprietary ERP. The first strategy is to implement the open source system as if it were a proprietary system, by selecting a commercial party that offers to deliver the software as a package and maintains the source code. The second strategy is to actively use the differences between open source software and proprietary software by maintaining the software in the organisation itself. Both strategies have consequences for the implementation of the system.

11 ERP and corporate governance

This chapter describes corporate governance, internal control and the way in which ERP can be used to improve internal control. The chapter starts with a brief overview of the developments in corporate governance legislation in the past decades. After this, various types of controls are discussed, as well as which of these types can be implemented in ERP systems, and how corporate governance audits can be carried out more efficiently and effectively when ERP is used.

11.1 Corporate governance legislation: a brief introduction

In September 2001, the US stock exchanges were startled by what has become known as the Enron scandal. Enron was a large distributor and service provider on the American energy market, that brought together demand for and supply of energy. The company was listed on the US stock market. Until 2000 the company realised profits and rapid growth [Enron, 2001]. In 2001 things went thoroughly wrong: the company had to issue profit warnings almost daily and restate its published accounts downwards. Shareholders of Enron were hit by plummeting stock prices: the stock price went down from $ 47 in July to several pennies in December.

The scandal shocked everyone who was directly involved in Enron. The Enron employees not only lost their jobs, but often also their pensions, as they had invested their pension reserves in Enron stock. Many of the Enron managers and directors were brought to trial on suspicion of fraud, market abuse and insider dealing. The external auditor, Arthur Andersen, was criticised for its lack of independence; it used to be one of the largest accountancy firms in the world, but it did not survive the Enron scandal.

Enron was the first accounting scandal that came into the light, but the Enron scandal turned out not to be unique. Since 2001 severe shortcomings in the financial statements of companies like MCI Worldcom, Quest, Vivendi, Paramalat and Ahold have been discovered. This came hand in hand with other developments, such as the terrorist attacks on September 11th 2001, the global economic downturn, and the end of the Internet bubble. This resulted in a world-wide loss of confidence in the stock markets.

In order to counteract the accounting scandals and regain the trust of investors, all over the world measures have been taken to improve corporate governance. These measures aim for a strong and more transparent corporate management, and a more stringent supervision on this management. Below a brief introduction is given into the developments in corporate governance legislation since 2002.

In the US, Congress designed and accepted new legislation in July 2002. The new law was named the Sarbanes Oxley law after the two senators that initiated it: Paul Sarbanes and Michael Oxley [Sarbanes &Oxley, 2002]. The name of the law is often abbreviated to Sox.

The law has almost seventy sections. As an example, the Sox section that must guarantee the external auditor's independence is presented in Figure 11.1.

The most drastic Sox section is Section 404. It states that every US-listed company has to extend its annual report. Until 2003, the annual report consisted of the financial statements, such as a balance sheet and an income statement, notes to the financial statements, and a director's report. Since 2004, or for some companies since 2006, presenting the financial statements is no longer sufficient. The corporate management also has to assess the quality of the so-called *system of internal controls*, the whole of internal processes and procedures that have resulted in the presented financial statements. This assessment has to be audited by the external auditor, who also has to attest to the findings in a new part of the auditor's report.

All companies world-wide that have a US listing, and all world-wide subsidiaries of US-listed companies have to meet the requirements of Sox. Especially meeting the requirements of Section 404 can implicate a lot of work: companies have to describe their internal control system, assess it, and adapt it if its quality is insufficient. After having done this, they have to present it to the external auditor, who also has to assess it and attest to it.

"(g) PROHIBITED ACTIVITIES.—Except as provided in subsection (h), it shall be unlawful for a registered public accounting firm (and any associated person of that firm, to the extent determined appropriate by the Commission) that performs for any issuer any audit required by this title or the rules of the Commission under this title or, beginning 180 days after the date of commencement of the operations of the Public Company Accounting Oversight Board established under section 101 of the Sarbanes-Oxley Act of 2002 (in this section referred to as the 'Board'), the rules of the Board, to provide to that issuer, contemporaneously with the audit, any non-audit service, including—

"(1) bookkeeping or other services related to the accounting records or financial statements of the audit client;

"(2) financial information systems design and implementation;

"(3) appraisal or valuation services, fairness opinions, or contribution-in-kind reports;

"(4) actuarial services;

"(5) internal audit outsourcing services;

"(6) management functions or human resources;

"(7) broker or dealer, investment adviser, or investment banking services;

"(8) legal services and expert services unrelated to the audit; and

"(9) any other service that the Board determines, by regulation, is impermissible.

Figure 11.1 Section 201 of the Sarbanes Oxley legislation. *Source:* Sarbanes Oxley [2002]

In reaction to local accounting scandals and the US Sox legislation, many other countries also updated or extended their corporate governance rules and legislations. In The Netherlands for example, the Ministry of Economic Affairs invited a committee to revise the existing, outdated corporate governance code. The committee, that was chaired by former Unilever CEO Morris Tabaksblat, published its recommendations in 2003 [Commissie Tabaksblat, 2003]. In 2008, a slightly revised version of the code became an integral part of the Dutch company law [Monitoring Committee, 2008].

The Dutch corporate governance code gives recommendations for good corporate governance with respect to corporate management, the supervisory board, the shareholders and the financial reporting. Every recommendation consists of a principle, in which the objectives of the recommendation are presented, as well as a number of potential measures. An example of a measure that should guarantee the external auditor's independence is presented in Figure 11.2.

V.2.2	The management board and the audit committee shall report their dealings with the external auditor to the supervisory board on an annual basis, including his independence in particular (for example, the desirability of rotating the responsible partners of an external audit firm that provides audit services, and the desirability of the same audit firm providing non-audit services to the company). The supervisory board shall take this into account when deciding its nomination for the appointment of an external auditor, which nomination shall be submitted to the general meeting.

Figure 11.2 Measure V.2.2 of the Dutch Corporate Governance Code. *Source:* Monitoring Committee [2008]

Companies that have to adhere to the code have two options for each of the recommendations: they can either *comply* with the recommendation or they can *explain* why they chose not to comply. The *comply-or-explain* principle, which is also used in corporate governance codes in various other countries such as The United Kingdom and Germany, makes the Dutch corporate governance code fundamentally different from Sox, which requires full compliance.

This does not mean that the Dutch corporate governance code is easier to comply with than Sox. Like Sox, the Dutch corporate governance codes has requirements with respect to internal controls. According to Section II.1.4 of the code, corporate management has to report on the functioning of the internal risk management and control system during the fiscal year in the annual report over this year. This section is more stringent than Sox, because the whole system has to be described, while for Sox the description is limited to internal controls over financial statements.

Originally, corporate governance rules and regulations were designed for listed companies only. It is expected however, that their scope will be extended in the coming years, first to all companies, and then to the public sector of the economy. Several related codes have already been developed, for example for building societies, housing corporations, health care organisations and education.

The recent corporate governance legislation has not always been received enthusiastically by the organisations that have to comply with it. The need for more transparency and accountability is generally accepted, but the way this has been prescribed in legislation has been criticised severely. Especially the mandatory description, assessment and auditor attestation of the system of internal controls is considered time-consuming and expensive [Sneller & Langendijk, 2007]. Describing and testing internal controls can take thousands of hours, even in medium-sized companies [FEI, 2005]. The auditor fees in companies that have to comply with Sox have increased with fifty percent on average since the effectuation of Sox [Eldridge & Kealy, 2005].

11.2 Core concepts in internal control

Central to the various corporate governance rules and regulations is the quality of internal control. According to the corporate governance codes, corporate management has to assess whether it controls the company in such a way that the annual or quarterly financial reports are reliable to such an extent that external stakeholders can base their decisions upon these reports. External stakeholders can be divers: shareholders for example study financial reports to see if they want to reduce or enlarge their interest, banks calculate metrics to approve or reject loan requests, and suppliers use the financial statements to investigate whether their counterparty in a business transaction is creditworthy.

Corporate management gives an assessment of the quality of the company's internal control in a specific statement that is part of the annual report, the so-called *in-control-statement*. In Figure 11.3, the in-control-statement of the company TNT from the annual report of 2006 is presented.

> Under the supervision, and with the participation of our management, including our chief executive officer and chief financial officer, we have conducted an evaluation as of 31 December 2006 of the effectiveness of our internal control over financial reporting based on the framework in Internal Control – Integrated Framework issued by COSO. Based on this evaluation, management has concluded that the company's internal control over financial reporting was effective as of 31 December 2006.

Figure 11.3 Example in-control-statement. *Source:* TNT [2007]

Before the relationship between ERP and internal control is discussed, essential concepts from the domain of internal control are explained. The first important concept is *process cycle*, a recurring set of business activities including the associated information processing. Within a process cycle, one or more processes exist. A *process* is a set of actions, manual or automated, again including the associated information processing. An example of a process cycle is the revenue cycle of an organisation, which typically includes the processes order intake, order picking, packaging and shipping, invoicing and collection. An extensive description of process cycles can be found in standard text books, such as Romney & Steinbart [2000].

A company is in control when all separate process cycles are in control [Starreveld et al., 2002]. A process cycle itself is in control when all of its processes are in control.

A second important concept in internal control is *risk*, which in the domain of corporate governance is defined as the potential occurrence of an event that negatively impacts the reliability of the financial statements[6]. An example may clarify this. A risk in the revenue cycle are open invoices. If a large customer goes bankrupt and does not pay its invoice, the accounts receivable position on the company's balance sheet may no longer be reliable, and as a result the company may no longer considered be in control.

A risk can be mitigated or even fully prevented by one or more risk mitigating measures or *controls*. In order to clarify this concept, the above revenue cycle example is continued. In order to reduce the risk of bad debt, an organisation can implement several controls. One control could be to ask a creditworthiness report for every customer and reject orders if the report gives a negative outlook; this control reduces the risk. An other control could be to force the customer to pay in advance; this control completely prevents the risk.

Three classes of controls can be distinguished: *organisational controls*, *physical controls* and *specific control activities*. An example of an organisational control is the creation of an opposing interest. The risk that the products in the warehouse of an organisation do not meet the quality requirements can be mitigated by using the opposing interest between the production manager who delivers goods to the warehouse, and the warehouse manager accepts goods for storage in the warehouse. The production manager wants to be able to prove that goods that have been produced meet the quality requirements, while the warehouse manager wants to be able to be sure that only goods that meet the quality requirements are stored in the warehouse. At the receipt of newly produced goods in the warehouse the managers have an opposing interest. The measure that mitigates the risk of products shipped from the warehouse that do not meet the quality requirements can be mitigated by a quality inspection at acceptance in the warehouse, which is signed off by both the production manager and the warehouse manager.

The second class of controls consists of physical controls. An example of a physical control is access control. The risk of damage or theft of goods or documents by unauthorised access can be mitigated by porters, vaults, locks and keys, fences or other physical controls.

The last class of controls comprises *specific control activities.* An example is the four eyes principle. Changing bank account numbers of suppliers or employees has a high error or fraud risk: if the wrong account number is entered, the organisation will make payments to unintended bank accounts. The four eyes principle means that changes to bank account numbers are entered by one person while the an other person checks the accuracy of the input.

Controls can also be classified by strength, that is the extent to which they mitigate the risk. The strongest controls are *preventive*: they prevent the adverse event from happening. Weaker controls only discover the event after it has happened. These weaker controls are called *detective*, as they can only detect and mitigate the impact of the adverse event once it has taken place.

Finally, controls can be classified by the way they are carried out. This can be *manual* or *automated*. An example will clarify this distinction. In order to reduce the risk that an invoice is paid while no goods or services have been received, most companies let budget owners sign off invoices before payment. A manual control for this risk is that after the receipt of a paper invoice, the accounts payable department sends it to the budget owner by internal mail who checks the invoice, signs it off with a pen, and sends it back to the accountants payable department, who prepare a payment transaction.. The same risk can also be mitigated in an automated way: invoices are received electronically, an automated workflow application determines the budget owner and forwards the invoice to the budget owner, who signs off the invoice electronically, after which a payment transaction is prepared automatically. Automated controls are executed mainly by hardware or software, and to a lesser extent by human beings [Weber, 1999]. Frequently-used automated controls are *boundary controls*, such as authorisation and encryption, *input controls*, such as input validation and context-specific menu options, *processing controls*, such as audit trails that register who has created, updated or deleted a transaction, and *output controls*, such as printer selection.

After process cycle, process, risk and control, a final important concept from the internal control domain is *evidence*. Evidence is the auditable confirmation that a control actually has been carried out. As an example: evidence for creditworthiness checking to mitigate the risk of bad debt are stored copies of the creditworthiness reports.

Risks do not always materialise, and it is therefore not always easy to prove that controls are effective. In order to be able to prove that controls are in place and that therefore an organisation can be considered in control, the execution of controls is often audited through testing. Testing controls consists of checking the evidence that proves that a control has actually been carried out.

For every risk, numerous controls can be designed. Overviews of risks and matching controls for many business processes have been described by the Committee of Sponsoring Organisations [COSO, 1994, 2004]. For automated controls, the sizeable textbook written by Weber [1999] can be consulted.

Which control an organisation decides to implement depends on the impact that the risk has when it materialises, the costs involved in implementing the controls, and the strength of the controls. In recent years, automated controls have become more and more popular. They are often preventive and therefore stronger than manual controls, they are generally cheaper to implement, and they are easier to audit [Sneller & Langendijk, 2007]. For this reason it is advised to use automated controls where possible to increase the efficiency and effectiveness of internal control.

11.3 ERP and internal control

ERP systems are not the only way to comply with corporate governance rules and legislation and enhance the quality of internal control. However, Morris [2011] studied the relationship between the use of ERP and reported material weaknesses in internal control for US listed companies, and he found that firms with implemented ERP systems are less likely to have to report such material weaknesses. The characteristics of ERP are beneficial for internal control.

Firstly, corporate governance rules and legislation on the one hand, and ERP systems on the other hand share a process-oriented approach. Corporate governance rules and legislation require companies to assess their internal control and publish their assessment in the in-control-statement of their annual report. In order to be able to do this, they have to evaluate their processes, risks and controls. One of the characteristics of ERP is exactly the support for best practice processes: when an organisation uses one of the best practices of the ERP system, the whole process including related information processing is taken care of. ERP encourages a high level of internal control.

Secondly, the data integration characteristic of ERP mitigates a wide variety of risks, and thereby makes a large number of manual controls redundant. In companies that do not have ERP, several applications may be used in parallel. A well-known risk of parallel applications is inconsistencies between the data in the parallel applications. In a manufacturing company, the stock level of finished goods in the financial application is not necessarily the same as the stock level of finished goods in the production application, which is a risk for the reliability of the financial reports. In such cases, the accounting department of the organisation will reconcile the stock every month during the financial close, and correct any differences that they may find. The data integration characteristic of ERP prevents such differences. When organisations have implemented ERP the time-consuming data reconciliation controls become obsolete.

The advanced ERP systems do not only provide data integration, but they provide a plethora of other automated controls. The risk of incorrect data entry by unauthorised or unskilled employees is reduced in ERP by restricting the access to certain menu options or functions of the system. The risk of order entry for non-existing products, with wrong order quantities, or with wrong prices is reduced in ERP by extensive automated data validation. In addition to these preventive controls, modern ERP systems have detailed audit trails, that enable auditors to track which employee has changed, added or deleted data in the ERP system.

Collaboration Speeds Phase I Implementation

Loral worked closely with Oracle Consulting to implement Oracle Internal Controls Manager, with consultants helping to configure the solution to Loral's business processes and organizations, and populate Loral's risk library with each organization's risks, controls and process owners. That entire process took less than six weeks, thanks to the fact that Goldfeder's team had already identified most of the company's many internal control activities as part of its SOX Section 404 certification process.

"We've already turned on most of the internal controls already embedded in Oracle Financials, like three-way matching and combination edits. Now with Oracle Internal Controls Manager in place and the auditing features that the solution provides, we'll be able to strengthen those controls even more," explains Goldfeder. "If you had a person that wasn't allowed to procure and for some reason there was an exception granted, Oracle ICM has the ability to send that notification to an internal audit group.

Figure 11.4 ERP to support compliance. *Source:* Oracle [2007c]

Lastly, the partners of ERP suppliers closely follow trends in the market and adapt their services to those trends. One of the important consequences of stricter corporate governance is the increasing number of audits. In a Sarbanes Oxley project it is not unusual that every control is audited three times per year: one self assessment by the employee responsible for executing the control, one assessment by the internal audit department, and one assessment by the external auditor. Various external suppliers now offer tools for so-called *audit automation*, the automation of audits of internal controls. When audit automation software is used, an auditor no longer has to check all authorisations in an ERP system to see if employees have access to menus that go beyond the requirements of their job or create violations of segregation of duties. The audit automation software simply generates a report that indicates which authorisations create potential conflicts with internal controls.

In Figure 11.4 an example is presented of a company that applied ERP to simplify compliance with corporate governance legislation. Loral Space & Communications is a medium-sized American company in the telecommunications industry that has to comply with Sox. The company use their ERP system in several ways to attain Sox compliance. They use best practices, such as the four eyes principle through combination edits, to firmly root internal control in business processes. Additionally, they use audit automation in the procurement module: if a purchaser exceeds his or her purchase limit the internal audit department gets an automated notification. Lastly, they use the internal control module in the ERP system to document and test controls in a uniform way. Because of their use of ERP, Loral has not only complied with Sox on time, but the company has also laid the foundation for compliance with future corporate governance rules for the telecommunications industry.

11.4 Summary

After the accounting scandals that occurred at the beginning of this century, measures have been taken all over the world to improve corporate governance and regain investors' trust. These measures aim for a strong and more transparent corporate management, and a more stringent supervision on this management.

Central to the various corporate governance rules and regulations is the quality of internal control. According to the corporate governance rules and legislation, corporate management has to assess whether it controls the company in such a way that the annual or quarterly financial reports are reliable to such an extent that external stakeholders can base their decisions upon these reports. Corporate management gives an assessment of the quality of the company's internal control in the in-control-statement.

A company is in control when all separate process cycles are in control. A process cycle itself is in control when all of its processes are in control. A process is in control when its risk-mitigating controls are effective.

For every risk, numerous controls can be designed. Which control an organisation decides to implement depends on the impact that the risk has when it materialises, the costs involved in implementing the controls, and the strength of the controls. Automated controls are often preventive and therefore stronger than manual controls, they are generally cheaper to implement, and they are easier to audit. For this reason it is advised to use automated controls where possible to increase the efficiency and effectiveness of internal control.

ERP systems are not the only way to comply with corporate governance rules and legislation and enhance the quality of internal control. However, the characteristics of ERP make them especially suitable for improvements of internal control. Firstly, corporate governance rules and legislation on the one hand, and ERP systems on the other hand share a process-oriented approach. Secondly, the data integration characteristic of ERP mitigates a wide variety of risks, and thereby makes a large number of manual controls redundant. Lastly, various external suppliers offer tools for audit automation in ERP. Summarising, ERP systems can efficiently and effectively support compliance with corporate governance rules and legislation.

12 ERP and shared services

In this chapter, the relationship is described between ERP and an emerging organisational form: the shared service centre. The chapter starts with a brief introduction into the concept of shared service centres. After this, the link between shared service centres and ERP is discussed. The chapter concludes with implementation strategies for organisations that intend to implement both ERP and shared service centres.

12.1 Shared service centres: a brief introduction

A *shared service centre* is a profit and loss responsible unit within a parental company, governmental organisation or not-for-profit institution, whose mission is to deliver specific specialised services to the operational units of its parental organisation at a transfer price and on the basis of an agreement [Strikwerda, 2004].

The definition shows that a shared service centre differs from other organisational units. Firstly, the shared service centre is profit and loss responsible. It is therefore different from a staff department in a traditional centralised or decentralised organisation, which does not have a profit and loss responsibility and whose costs or revenues are directly let through to business units, organisational units that do have profit and loss responsibility. Despite its profit and loss responsibility, a shared service centre is also not a business unit. A business unit operates on the external market, while a shared service centre offers its services to the internal operational units only.

Furthermore, according to the definition used in this chapter, the shared service centre is a unit within the parental organisation. Other definitions of shared services also encompass services fully delivered by external parties. In this chapter however, the shared service centre is assumed to be part of the internal organisation. This does not mean though that the shared service centre has to produce all services itself, but it does mean that the profit and loss responsibility lies with the management of an internal organisational unit.

Lastly, the specific specialised service offer characterises a shared service centre. There are no limitations for the services in which a shared service centre specialises, but mostly shared service centres provide services in the secondary processes of the value chain: accounting, human resources or information technology services. However, shared service centres that provide services for primary processes like customer service or telesales also exist.

Several authors describe the reasons for organisations to establish a shared service centres [Schulman et al., 1999; Strikwerda, 2004; Janssen & Joha, 2006]. Some of these reasons are mentioned more than once:

- *Cost savings and cost transparency*: shared service centres give the opportunity to concentrate services. In stead of fragmentation of work over many people in various operational units, the work in a shared service centre can be concentrated and the processes can be streamlined. Reduction of fragmentation in this way leads to cost savings. It also improves transparency, as employees in operational units no longer have a high number of small tasks, and the services of the shared service centre are well-defined and mapped out. Cost savings can be significant, and can vary from twenty-five to fifty-five percent [Wilson, 2004].
- *Higher service quality and continuity*: in a shared service centre, the supply of services is concentrated, which allows employees to specialise in certain services. Competence centres can be created, and the back up in case of illness or other absence can be improved because of the larger critical mass. As a result, a shared service centre can offer services of higher quality and higher continuity.
- *Clear management focus*: in the operational units as well as in the shared service centre, management can focus on its core business. The management of the shared service centre has to concentrate on the quality of the services supplied, and on controlling the costs of these services. As a profit and loss responsibility has been agreed, this requires more entrepreneurship than in a traditional centralised or decentralised staff department. If the shared service centre performs better than agreed, it can make a profit, which could be used in bonus schemes of the management and employees, for additional investments in the shared service centre's facilities, or for training and education of its employees.
- *Flexibility in setting up new business units*: when an organisation that has implemented a shared service centre wants to set up a new business unit to serve a segment of its external market, not all processes and activities for that new business unit need to be designed. The management of the new business unit can fully focus on the new market, while the other services can be provided by the shared service centre. For the shared service centre, serving one additional business unit generally will not take too much time and effort.
- *Preparation of outsourcing*: at the start of a shared service centre, mutual exclusivity often applies. The business units are forced to buy from the shared service centre and cannot select a supplier on the external market, while the shared service is forced to sell within the parental organisation only and cannot win external customers. A shared service centre can be a first step on the road to full outsourcing of an organisational unit, the so-called *business process outsourcing* (or: *BPO*). On the road to outsourcing the shared service centre can slowly detach from the organisation, both in the legal and in the commercial sense.

Shared service centres have been on the rise in the past decade. An important explanation for this rise is the trend that organisations want to focus on core activities when possible. Every organisational unit has a specific core activity that has to be executed in an excellent way, and all other activities should cost as little time, effort and money as possible. Shared service centres align well with this trend.

Shared service centres have only been able to grow as fast as they did because of the rapid technological developments. A prerequisite for a shared service centre is the supple communication with its customers. Information and communication technology developments in recent years have enabled this. Important technologies that are used are traditional and internet telephony for individual and conference calls, video conferencing when visual contact is also important, and scanning and imaging for fast distribution and archiving of documents and forms. These technologies are all based on the world-wide data communication networks with high capacity that are available at reasonable costs today.

In many cases, shared services have been able to realise their ambition of combined cost savings and improved quality of services. By moving the service centre to countries with lower wages, such as Eastern Europe or Asia, or to countries with attractive tax rates, such as Ireland, the costs per employee decrease. However, shared service centres only work when the quality of its services meet the required service levels. The high level of education in these countries coupled with the language skills of their inhabitants have enabled many successful shared service centres abroad.

Shared service centres are certainly promising. However, the creation of a shared service centre is a substantial operation. Firstly, the selection of the right location is a complex project in which many factors play a role. Furthermore, the start of the shared service centre goes hand in hand with the termination of the existing organisation, which means that currently employed staff may lose their jobs. This will have a financial impact, as redundancy payments will have to be made; redundancy payments often are a substantial part of the business case of a shared service centre. But more importantly, the prospect of losing their jobs will probably impact the motivation of the affected employees, while at the same time it is essential that those employees who will eventually leave the organisation are dedicated to their work until the newly-founded shared service centre can take it over. Managing this process requires high-level leadership skills. Finally, the shared service centre may have to deal with sceptical or even distrusting internal customers, who were used to being served from colleagues who were based in the same building if not on the same floor. The shared service centre will have to prove from its inception that is can provide the services at the right quality from a distance [Janssen & Joha, 2006].

Even after the initial hurdle in the services has been taken, it is not easy for a shared service centre to provide the services at agreed prices and at the right quality level [Shulman, 1999]. Especially when the shared services are based in a different country, cultural barriers also have to be over won. Moreover, the shared service centre's employees have to get used to specific rules and legislation for which they provide the services. In many cases, time zones have to be bridged and the number of overlapping office hours is limited. Shared service centres are heavily dependent on data communication, which has to be available for purchase at high capacity and availability. Finally, the recruitment of employees for shared services is not easy, but the retention is an even larger issue, especially in popular locations where the skilled labour force is not inexhaustible.

In Figure 12.1 an example is presented of a shared service centre with various specialisations based in several European locations.

Avis Europe PLC – Final Results

[…] Rigorous cost reduction

The Group has largely completed a significant organisational re-structuring and re-design of key processes to address fixed costs. This comprised a reduction in staff and running costs at the European headquarters; an acceleration of the transfer of back-office activities into the shared service centre in Budapest; consolidation of all call centre activities into the existing Barcelona facility; and a number of staff and overhead cost reductions in country head offices. These changes have created a more effective and efficient business. Savings in 2006 were ahead of expectations at €11 million and are expected to increase to €25 million in 2007. Exceptional restructuring costs of €26 million in 2006 were lower than anticipated. Final costs of the programme in 2007 are expected at some €10 million. […]

Figure 12. 1 The shared service centre of Avis Europe. *Source:* RNS [2007]

Avis Europe, the well-known rental car company, has accelerated the creation of its shared service centre. The various locations each have their specialisation: back office processes are carried out in Budapest while call centre activities are based in Barcelona. The company makes considerable investments. In 2005 and 2006 the total investment amounts to €36 million. The savings are substantial too: in 2007 the shared service centre is expected to lead to a €25 million saving.

12.2 ERP and shared service centres

ERP systems and shared service centres can exist independently. The majority of ERP implementations takes place in organisations that do not have shared service centres. However, many shared service centres use ERP to support their business processes. This is not surprising, as the reasons mentioned for setting up shared services and the characteristics of ERP are well aligned. Schulman et al. [1999] argue that process improvement may be the driving force behind shared services, but that only technology can enable these process improvements, and that the primary technology for innovation in shared services is ERP.

The prevalent motive for setting up shared service centres is cost savings in combination with higher quality of the services. The characteristics of ERP, data integration and support for best practice processes, align well with this motive. The data integration of ERP guarantees that the information entered either in the shared service centre or by employees of its customers can be used throughout the organisation, which bridges a potential geographical distance between the shared service centre and its customers. The best practices offered by the ERP system can be used to optimise the processes in the shared service centre, and the optimised processes can contribute to the intended cost savings and quality improvements.

Today, ERP is also increasingly fit for the support of international business [Leladze, 2007]. The modern systems are multi-lingual, support foreign currencies and country-specific payment methods, have standardised reports for mandatory filings for tax and other government bodies, offer specific modules for country-specific wages and salaries calculations, and a variety of other functions that can support shared service centres that have international customers.

Even though the characteristics of ERP align well with the motives for setting up shared services, and ERP is increasingly fit for support of international shared service centres, situations do exist where the use of ERP in a shared service centre is not the obvious choice. The suitability of ERP is related to the specialisation of the shared service centre.

Shared service centres are set up mainly for concentration of secondary processes. As explained in Part 1 of this book, ERP is traditionally strong in manufacturing processes and secondary processes in the value chain. ERP therefore excels in shared services that specialise in accounting, payroll and order taking. At this moment, ERP support for shared services that are specialised in industry-specific processes like mortgage administration or insurance policy issuance is still in its infancy.

A different combination of ERP and shared service centres exists. This combination is created when the application support for the ERP system is executed by a shared service centre. In this case the ERP system does not support the processes of the shared service centre itself. The ERP users are based in the business units and other operational units, and the shared service centre provides the application services for these organisational units.

In Figure 12.2 a fragment is presented of the decision of the Dutch government to set up an organisation called SSC HRM P&S, which is a shared service centre for the human resource management processes personnel administration and salary administration.

[…]

One of the advantages of the set up of a SSC HRM P&S is that ministries partly are already concentrating the facilities in the areas of support or otherwise have plans for such concentration during the current governmental period. Moreover, cooperation by central governmental organisations in the area of payroll processing has already existed for years.

In addition, for the bundling of the required automation, proven technology and solutions already in use by central governmental organisations will be used where possible. A few examples are:

- Four ministries (Finance, Economic Affairs, Education Culture and Science, and Infrastructure) are preparing the roll out of payroll processing in the ERP system that they currently use.
- Two ministries (Economic Affairs and Internal Affairs) currently already use a self-service application (Emplaza). Other ministries (Public Housing, General Affairs and Social Affairs) are planning to start using this application shortly, with the intention to enable employees to get used to the new way of working.

These current initiatives and 'working solutions' within the central government can contribute positively during the next steps in realising the ultimate objective. The government is therefore of the opinion that these experience should be used as optimally as possible.

[…]

Figure 12.2 ERP in the governmental shared service centre for HR processes. *Source:* Kabinet [2003]

With this decision, the government announced how it intends to change the HR function of the central government and the ministries. The motive is to increase both the efficiency and the quality of the HR function. According to the decision, a cost benefit analysis that has been validated by the Ministry of Finance shows that setting up shared services has a saving potential of €250 million to €300 million in the years between 2004 and 2015, which is a saving of around twenty-five to thirty percent [Kabinet, 2003].

With respect to information technology usage, the shared service centre intends to build upon experience already available within the participating governmental organisations. As an example: for payroll processing the intention is to use an ERP system, as ERP technology has already been used by several ministries before the introduction of the shared service centre.

12.3 Implementation strategy

The recommended way to set up a shared service centre is by a project. According to Wilson [2004], five phases can be distinguished in this project, which in total will take between twelve and twenty-one months. In the first phase, which is called the *opportunity assessment*, internal performance and productivity information is gathered and compared with external benchmarks of similar services. On the basis of this information, an investment proposal is prepared and presented to decision makers.

Once the investment proposal has been approved, the second phase starts, which is called *operating strategy planning*. The processes that will be transferred to the shared service centre are selected, a high-level implementation plan is prepared, and a thorough cost benefit analysis is drawn up.

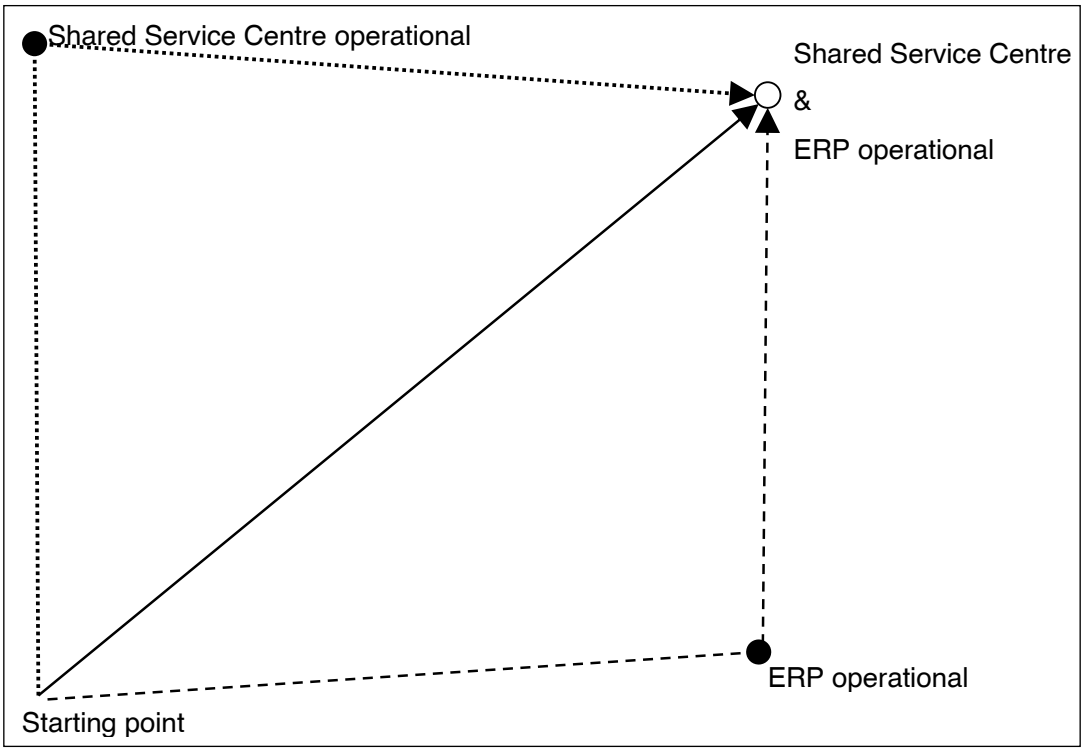

Figure 12.3 Implementation strategies for shared services combined with ERP

In the third phase, the operating plan is used as the basis for the *detailed design*. The location is selected, processes and procedures are analysed and redesigned, as well as technological infrastructures. The staffing for the shared service centre is mapped out, and recruitment and education plans are drawn up. Costs and benefits are again estimated and compared to the previous plans. If they deviate significantly, the decision makers are asked to reconfirm the decision to go ahead.

The fourth phase consists of the creation of a *roll out plan*, which determines in which steps the transfer of the services to the shared service centre and the termination of the current services will take place. The fifth and last phase is the actual *execution* of the roll out plan.

Already during the opportunity assessment of the shared service centre, the information technology required to support the services has to be on the agenda. The most important decision issue is the ERP implementation strategy. Three options exist for implementation of ERP for shared services, which are depicted in Figure 12.3.

The implementation strategies are characterised by the order in which they implement ERP and shared services [Shulman et al., 1999]. In Figure 12.3, the first option is depicted with a dotted line. From the start of the project, first the shared service centre is set up, and after the ERP system is introduced in the organisation. The advantage of this implementation strategy is the fact that the requirements that the ERP system has to meet for the shared service centre are known before the ERP implementation is started, which will make the ERP implementation more efficient.

The second option, which is indicated with a dashed line in Figure 12.3, consists of an ERP implementation followed by an implementation of shared services. This strategy has the advantage that ERP knowledge is available and can be used for an optimal redesign of the processes in the shared service centre. Figure 12.2 shows that this strategy was chosen by the Dutch government for its SSC HR P&S implementation plan.

Parallel implementation of an ERP system and a shared service centre, which in Figure 12.3 is depicted with a straight line, is the fastest but also the riskiest way to realise the expected benefits. With this strategy, double work is prevented, but as the organisation undertakes two large changes at the same time, the risk of failure is high.

In Figure 12.4 an example is given of an organisation that has selected the parallel strategy for its implementation of a shared service centre and an ERP system. The city council of Glasgow set up a shared service centre in 2004 in which 130 people were employed. The following processes have become the responsibility of the shared service centre: finance, human resource management, sales, procurement, knowledge management and business development.

Before the shared service centre could become operational, two hundred business processes had to be redesigned, and at the same time two hundred existing applications had to be replaced by one ERP system. The motive for the whole operation was an annual cost saving of £5 million.

CASE STUDY : Glasgow City Council

[…]

But the council took its first steps down the shared services route in November 2004, when it opened a 130-seat centre to handle backroom services such as finance, human resources, sales, procurement, knowledge management and business development across all of its departments.

The aim of the move, which took place under the auspices of the 1Business back office efficiency programme, was to save Glasgow £5m per annum by automating processes and removing duplication of effort, and another £8m by improving purchasing procedures.

The council had to redesign and standardise more than 200 business processes, as well as replace 200 legacy applications with a single SAP-based system. It also introduced self-service applications for functions, such as recruitment, learning and absence management, and created a single customer database for the first time.

[…]

Figure 12.4 Parallel implementation of ERP and shared services. *Source:* Everett [2007]

12.4 Summary

A shared service centre is a profit and loss responsible unit within a parental company, governmental organisation or not-for-profit institution, whose mission is to deliver specific specialised services to the operational units of its parental organisation at a transfer price and on the basis of an agreement.

The prevalent motive for setting up shared service centres is cost savings in combination with higher quality of the services. The characteristics of ERP, data integration and support for best practice processes, align well with this motive.

The data integration of ERP guarantees that the information entered either in the shared service centre or by employees of its customers can be used throughout the organisation, which bridges a potential geographical distance between the shared service centre and its customers. The best practices offered by the ERP system can be used to optimise the processes in the shared service centre, and the optimised processes can contribute to the intended cost savings and quality improvements. It is therefore not surprising that shared service centres often implement ERP.

Already during the opportunity assessment of the shared service centre, a potential ERP implementation has to be on the agenda. The most important decision issue is the combined implementation strategy. Three implementation strategies exist, characterised by the order in which they implement ERP and shared services. The first option is to first set up the shared service centre, after which the ERP system is introduced in the organisation. The second option consists of an ERP implementation followed by an implementation of shared services. The third option is parallel implementation of an ERP system and a shared service centre, which is the fastest but also the riskiest way to realise the expected benefits.

13 Criticism of ERP

Undoubtedly, ERP has been one of the most important and influential trends in information technology in the past forty years. This, however, does not imply that everyone automatically subscribes to the advantages of ERP. In the forty years of its existence, ERP has been praised, but the main characteristics of ERP, and their impact on organisations have also been criticised. In a guide to ERP this criticism should not be ignored. The last chapter of this book is therefore dedicated to the criticism of ERP, which finds its origin in the two main characteristics of ERP: data integration and support for best practice processes.

13.1 ERP data integration and organisational culture

An important stream of criticism of ERP stems from organisational developments and the role that ERP plays in those developments. Peters & Pouw [2006] describe modern organisations as human stock farming. They see that the degrees of freedom of employees on the shop floor are systematically reduced, while top management usurp more and more of those degrees of freedom. Attention and esteem for professional expertise is replaced by emphasis on economic growth and rational principles such as profit maximisation, quantitative growth and measurement systems.

Information technology in general and ERP in particular are viewed as means to maintain the intensive human stock farming. Especially the data integration characteristic of ERP systems supports the use of instruments like productivity norms, key performance indicators and other measures. This aspect of ERP is considered comparable to Big Brother: the ERP system knows exactly what you are doing.

The criticism of ERP of various authors is very outspoken. Van der Reep & van den Heuvel [2005] are very clear in their judgement of ERP: the disadvantage of ERP systems is that they create exanimate organisations in which people operate in silos. Van der Reep [2007] has not found a single example of a successful implementation of the ERP concept. ERP only gives management a sense of control, and creates dependency on the IT department for the whole organisation. He does see a role for ERP, but states that the ERP concept is only suitable for goods flow and routine large-volume processes, and not for information technology that is people-centric.

Dillard et al. [2006] also do not see a single positive role for ERP. They design the concept of *administrative evil*, which they define as administrative behaviour that deprives innocent people of their humanity, that is dignity, justice, rights, safety, health etcetera. Administrative evil is created when people can deny all responsibilities because of the absence of individual accountability for the eventual outcome of organisational action. ERP systems are central components of administrative hierarchies, and because of that they are the incarnation of administrative evil. ERP users lose the ability to make their own ethical choices, because human interaction is replaced by interaction with the ERP system. According to the authors, ERP systems are fundamentally intended to maintain and strengthen control over the means of production through enhancing administrative control.

Some milder criticism of ERP is brought forward by Davenport [1999]. He sees two potential and opposite effects of ERP on the structure and the culture of the organisation, that both find their origin in the data integration that ERP brings. The first potential effect is streamlining of management layers, which creates a flatter, more democratic and more flexible organisation. The other, opposite effect of ERP is centralisation of control over information and standardisation of processes, which lead to hierarchical organisations with a uniform culture. The author describes examples of organisations that have used ERP to enforce more discipline by standardisation of processes, but also of organisations that have used ERP for breaking down hierarchical structures by giving all employees access to data to foster innovation and creativity.

In my opinion, the ERP data integration characteristic can certainly influence organisational culture, because ERP makes information available for more employees. This gives the organisation an opportunity to influence organisational culture. Whether ERP will lead to rigidity or creativity depends on the way in which ERP is implemented. I am convinced that people will always break away from shackles. If the ERP system works as a shackle it will be circumvented. For this reason it is in the interest of the organisation to set up both the ERP implementation project and the ERP system in such a way that ERP fosters creativity and innovation.

13.2 ERP best practice processes and competitive advantage

Another important stream of criticism of ERP is directed at the effect of the second characteristic of ERP systems: the support for best practice processes. A best practice was defined in Chapter 1 as a generally accepted way of working that has been adopted by many organisations and has proven its practical value.

The first important question to be asked here is what the quality of the best practice is. A best practice may be generally accepted, but is it also the optimal way of working? Many examples are available of best practices that are not optimal. Bloodletting for example, was a medieval best practice for all diseases for which no other therapy was available. Nowadays however, it is assumed that many patients died unnecessarily because of frequent bloodletting, while others passed away because of the usage of contaminated instruments used during the bloodletting [Wikipedia, 2007]. This example shows that bloodletting was a best practice, but is questionable whether it was the optimal practice for curing diseases. In the same way the question should always be asked whether a best practice offered by the ERP system is the optimal way of working for an organisation.

The second important question to be asked before the use of a best practice is the difference the best practice enables the organisation to make. When every organisation uses the same best practices, uniformity is created on the market, and individual companies can only distinguish themselves on the basis of price. In a uniform market where competition is based on price, profits will sooner or later become very low. The use of best practices is not recommended when this leads to a worsened competitive position.

Various authors identify downsides associated with the use of best practices. Dillard et al. [2006] see that ERP and business process redesign (or: BPR) go hand in hand. They state that in organisations that implement ERP the current processes are displaced by the best practice processes enforced by the ERP system. If large gaps exist between the existing and the enforced processes, the organisation has to change dramatically. The authors are of the opinion that this dominance of the system over the organisation is a large downside of ERP.

On the basis of five case studies of ERP implementations, de Koning [2004] draws a similar conclusion. He found that in only two of the five companies in his study the efficiency and effectiveness of business processes improved after the introduction of ERP; in the other three cases no improvements were found. In three of the cases many software modifications were required, in one case the number of software modifications was limited, and only one case required no changes to the ERP system. On the basis of these results, de Koning states that ERP was not an undivided success in his five cases. He concludes that best practices do not always lead to process improvements, and that best practices with a good functional fit are not always available in the ERP system.

Davenport [1999] considers best practices both a risk and an opportunity of ERP implementations. With ERP systems, process modification is often required. ERP suppliers try to support business processes in the best possible way with best practices, which means that in the systems the supplier's opinion of the best practice process is built, which does not necessarily concur with the organisation's opinion of the best practice process. For this reason, the organisation's management has to investigate to what extent the processes can be identical to those of competitors if the organisation still wants to be competitive in the market. Davenport identifies several scenarios. Organisations that have a unique product do not erode their competitive position when they use the ERP best practices. Organisations that compete on the basis of time to market can use ERP best practices, but may have to extend the software with a refined planning module to retain their competitive advantage. Organisations that compete on costs should thoroughly investigate if the high ERP implementation costs of ERP suit their competitive approach.

In my opinion, the best practices offered by ERP systems are not usable in all cases. Extensive standardisation of processes on the basis of best practices can erode an organisation's distinctive ability and competitive position. For this reason, organisations should make sharp decisions on which best practices to implement: they should use best practices offered by the ERP system for processes for which standardisation will improve efficiency, and software modifications or manual procedures for those processes which distinguish the organisation from its competitors. The recommended ex ante evaluation project described in Part 2 of this book supports this sharp decision making.

13.3 Summary

The criticism of the data integration characteristic of ERP is very outspoken. Van der Reep & van den Heuvel state that ERP creates exanimate organisations with departmental silos. Van der Reep considers ERP suitable for goods flow or routine high-volume processes only. Dillard et al. do not see a positive role for ERP at all; they consider ERP the incarnation of administrative evil. More balanced criticism on ERP is given by Davenport, who sees two potential effects of ERP on the organisation: data integration can either lead to flatter, more democratic and more flexible organisations, or to hierarchical organisations with a uniform culture.

In my opinion, ERP certainly impacts organisational culture, because data integration potentially enables more employees to have access to and share information. Whether this leads to rigidity or to creativity in the organisation depends on the way in which ERP is implemented.

The criticism of the second ERP characteristic, the support for best practice processes is directed at the organisation's competitive power. Dillard et al. expect that the implementation of best practices lead to dominance of the ERP system over the organisation. De Koning concludes on the basis of five case studies that the efficiency and effectiveness of organisations do not always improve after an ERP implementation, and that often extensive software modification is required. Davenport thinks that best practices can be both an opportunity and a threat. Organisations that have a unique product will not diminish their competitive power with the implementation of best practices. Organisations that compete on the basis of time-to-market can use ERP, but they will probably need software modifications for the planning modules of ERP to retain their competitive advantage. Companies that compete on the basis of price should thoroughly investigate whether an expensive ERP implementation will not erode their competitive position.

In my opinion, ERP best practices are not usable in all organisations. Extensive standardisation with best practices can mean loss of competitive power. For this reason, organisations should make sharp decisions on which best practices to implement: they should use best practices offered by the ERP system for processes for which standardisation will improve efficiency, and software modifications or manual procedures for those processes which distinguish the organisation from its competitors.

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Endnotes

1. In this stylised example taxes are not taken into account
2. The principles are described in more detail in Chapter 5 of this book
3. The functional fit analysis is described in more detail in Chapter 6 of this book
4. The risk analysis is described in more detail in Chapter 7 of this book
5. The cost benefit analysis is described in more detail in Chapter 8 of this book
6. Risk is a context-specific concept. In Part 2 of this book, the term *risk* was defined in relation to ex ante evaluation of ERP: a risk was defined as the potential occurrence of an event that will have a negative impact on achieving the objectives of an ERP implementation.