Business Process Optimization

BUSINESS PROCESS OPTIMIZATION

Jan Stentoft Arlbjørn and Anders Haug

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Preface

For many years, the area of business process improvement has received much attention by academia, consultancies and software vendors. Many business process improvement concepts have emerged in various types of literature and often such concepts have been associated with various buzzwords and fads. However, in spite of this effort, when observing industry, we still experience much uncertainty about how to approach business process improvement projects and find that many such projects fail to achieve the expected benefits. This textbook on business process optimization is the result of our joint efforts over the last six months, based on a long period of conversations about the need for such a book.

This textbook does not present a general recipe for achieving business process improvements, but rather a generic perspective that has the robustness to go side-by-side with other management concepts. Furthermore, our aim was to make it practical. This means that the book contains several case-studies that demonstrate central points. The work also contains concrete analysis tools and techniques.

The manuscript is organized as a natural flow of steps from which a company proceeds, with the initial awareness that something needs to be done regarding the current business processes, over designing new systems and processes and their implementation to a final evaluation of whether the efforts were successful or not. All in all, the textbook is structured in 12 chapters divided into four parts:

Part 1: Analysis
Part 2: Design
Part 3: Implementation
Part 4: Evaluation

Part 1 provides a description of relevant aspects of the activity of analyzing business processes. It begins with providing an understanding of the nature of business processes. On this basis, we move on to describe the importance of mapping IT systems and how this can be done. Next, part 1 provides an overview of different diagramming techniques for describing business processes. In the subsequent chapters, the part deals with the topics of business data management and performance measurement.

Part 2 guides the reader through relevant aspects in relation to business process design. Part 2 begins with providing an overview of different strategies for approaching business process improvement projects. Next, part 2 provides an overview of relevant information technologies, which can be implemented for process improvement purposes. The subsequent chapter provides instruction in carrying out the activity of business process design on a concrete level.

Part 3 focuses on topics relevant for the implementation of the process design. The topics covered in this part are project management and change management.

Part 4 focuses on the evaluation of a business process improvement project and how to move on from here. Part 4 begins with describing how to evaluate business process improvement projects. Subsequently, we describe how to anchor an implemented process design in an organization and how to ensure that a solid basis is laid for future process improvements.

We hope you will enjoy reading the book.

April 2010

Jan Stentøft Arlbjørn
Anders Haug

About the Authors

Jan Stentoft Arlbjørn, Ph.D., is a professor in Supply Chain Management (SCM) at the Department of Entrepreneurship and Relationship Management, University of Southern Denmark. His research and teaching areas are within SCM, Supply Chain Innovation, Enterprise Resource Planning, and Corporate Social Responsibility. He has practical industry experience from positions as Director (Programme Management Office) at LEGO Systems A/S, ERP Project Manager at Gumlink A/S, and as management consultant in a wide number of industrial enterprises.

Anders Haug, Ph.D., is an assistant professor in Information Systems at the Department of Entrepreneurship and Relationship Management, University of Southern Denmark. His main research areas are information systems, ERP systems, data management, knowledge management, knowledge engineering and product configuration. He has practical industry experience from a number of projects on product configuration, process reengineering, product rationalization, software design and information systems.

PART 1: ANALYSIS

CHAPTER 1

Business Processes

Introduction

> It is not the strongest of the species that survives, nor the most intelligent that survives. It is the one that is the most adaptable to change. (Darwin)

The business processes of a company define the behavior of the company. Some companies behave wisely, while others do not. The success of a company is a result of the stream of inputs and outputs to and from the company. In fact, companies are dependent on the inputs from their external environment to survive, such as employees, money, materials, etc. Thus, it is not enough to have a solid net capital or possess valuable knowledge, but it is essential to be able to behave in accordance with the external environment.

To get a deeper understanding of the meaning of a 'business process', the next section clarifies this term. The subsequent section provides a brief look at the historical background for focusing on business processes. This is followed by a presentation of four views on the way in which business processes can be analyzed. Finally, this chapter provides a list of examples of possible occurrences of the need to improve business processes and possible observations of process inefficiency.

Defining a Business Process

To provide a definition of the term 'business process', the natural place to begin is a definition of the term 'process'. The Oxford English dictionary provides the definitions of the term 'process':

> "That which goes on or is carried on", "a continuous action, or series of actions or events", and "a course or mode of action, a procedure".

In other words, a process can be defined as something that happens during a course of time, and has a beginning and an end.

There are many types of processes. The ones in focus of this book are 'business processes'. Generally, business processes can be divided into:

- Core processes (or operational or primary)
- Support processes
- Management processes

Core processes are the processes that create the primary value stream (i.e. what produces value for customers) of an organization. So, this includes processes such as purchasing, manufacturing and sales. Support processes support the core processes and may be e.g. accounting, human resources, and IT. Management processes govern core processes and support processes.

There are many definitions of the term 'business process'. A traditional understanding of a business process is captured in the definition by Davenport:

> A structured, measured set of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how work is done within an organization, in contrast to a product focus's emphasis on what. A process is thus a specific ordering of work activities across time and space, with a beginning and an end, and clearly defined inputs and outputs: a structure for action. (Davenport, 1993)

Another definition, which incorporates the relation to the organization, is provided by Rummler and Brache:

> A business process is a series of steps designed to produce a product or service. Most processes … are cross-functional, spanning the 'white space' between the boxes on the organization chart. (Rummler and Brache, 1995)

Companies are filled with different business processes. Examples of business processes include: the development of a new product, ordering goods from a supplier, the creation of a marketing plan, recruiting new employees, closing accounts of unwanted customers, receiving items on stock, etc.

The Focus on Business Processes

The focus on business processes can be traced back to the Industrial Revolution. The Industrial Revolution broke with the primitive manufacturing forms that characterized handicraft production in which one person normally carries out all tasks. Instead, it represented a division of labor, implying that persons specialize in certain tasks. In this context, Adam Smith's "The Wealth of Nations" from 1776 promotes the view that growth is rooted in an increasing division of labor. Basically, the idea of the division of labor is to break down large jobs into many smaller tasks in order to make each worker an expert in one isolated area of production as a means to increase efficiency. This idea is much in line with the process-oriented perspective on the company in which business processes are decomposed into sub-processes. However, Smith's ideas may have some negative impacts, depending on the implementation. Also, Smith recognized the potential problems of a division of labor, namely that it may force individuals to perform boring and repetitious tasks, leading to dissatisfied workers. Another problem of a division of labor is that it may lead to a lack of focus on the underlying business processes. This is still seen, especially in large organizations, where departments are so strictly divided that they focus hard on their own goals and fail to recognize the greater picture.

The problem of departmentalization is a central problem that business process reengineering (BPR) literature attempts to solve by suggesting that companies should organize their activities around inter-departmental processes instead of focusing on department-specific processes. The ideas of BPR originate from Hammer (1990) and Davenport and Short (1990). Hammer defines BPR as follows:

> …a reengineering effort strives for dramatic levels of improvement. It must break away from conventional wisdom and the constraints of organizational boundaries and should be broad and cross-functional in scope. It should use information technology not to automate an existing process but to enable a new one. (Hammer, 1990, p. 108)

The customer focus is another central aspect of BPR, which argues that business processes should be defined with customer value in mind. In this context, customers also include internal customers. BPR emphasizes the use of information technology, which in many cases can reduce the need for human operations. According to Hammer (1990, p. 108), IT should not be seen as a means to automate existing processes, but rather to enable new and better ones.

Four Views on Business Processes

It is common to perceive organizations as a set of business processes that can be altered in order to improve efficiency. However, there is not one common view on the nature of business processes, but several diverging perspectives. A basic understanding of a business process is that it consists of a transformation of inputs from suppliers to outputs to customers, where the transformation can be decomposed into sub-processes. Although the input-transformation-output perspective may not be adequately nuanced in order to understand the complete nature of a business process, it represents a useful basic understanding. In this perspective, a business process is triggered by one or more external events and a set of conditions. The business process then transforms inputs to the relevant outputs. The inputs are the needed resources (materials, information, money, etc.), while the main output is the relevant goods and/or services. The transformation process is governed by policies, rules, culture, etc. Often business process performance is measured in terms of key performance indicators (KPIs, described in chapter 5).

One of the main criticisms of the input-transformation-output view is that real-world processes are less simple than suggested by this view. Ould (1995) argues for instance that business processes are best viewed as networks in which a number of roles collaborate and interact to achieve a business goal. In fact, there are many views on business processes. Melão and Pidd (2000) organize views on business processes in four themes that have different emphasis and illustrate different features of business processes: (1) business processes as deterministic machines, (2) business processes as complex dynamic systems, (3) business processes as interacting feedback loops, and (4) business processes as social constructs. These four views are described in the following subsections (based on Melão and Pidd, 2000). It should be noted that the four views are not strictly divided, but include some overlaps.

Business Processes as Deterministic Machines

The first view, business processes as deterministic machines (Figure 1.1) perceives business processes as fixed sequences of well-defined activities or tasks, in which humans convert inputs into outputs in order to accomplish some objectives. The view deals with business processes with a focus on structures (tasks and activities), procedures (methods and rules) and goals (i.e. related to process output). From this view, processes are evaluated in time, monetary and resource dimensions, while satisfying customer needs. The function of IT in this view is seen as a means of automating, coordinating and supporting the redesigned processes. The view may be described as hard and static. The view stresses mapping information flow, item flows, activities, dependencies, and recourses needed. In this view, flow charts are often used. The mechanic view holds several strengths, e.g. that it is easy to describe and evaluate processes from this perspective. On the other hand, it can be argued that the mechanistic view has two major drawbacks. Firstly, it perceives business processes in rational and technical terms, while neglecting human and organizational issues. Secondly, it perceives business processes in a static manner, and thereby ignores dynamic behavior, which may change over time.

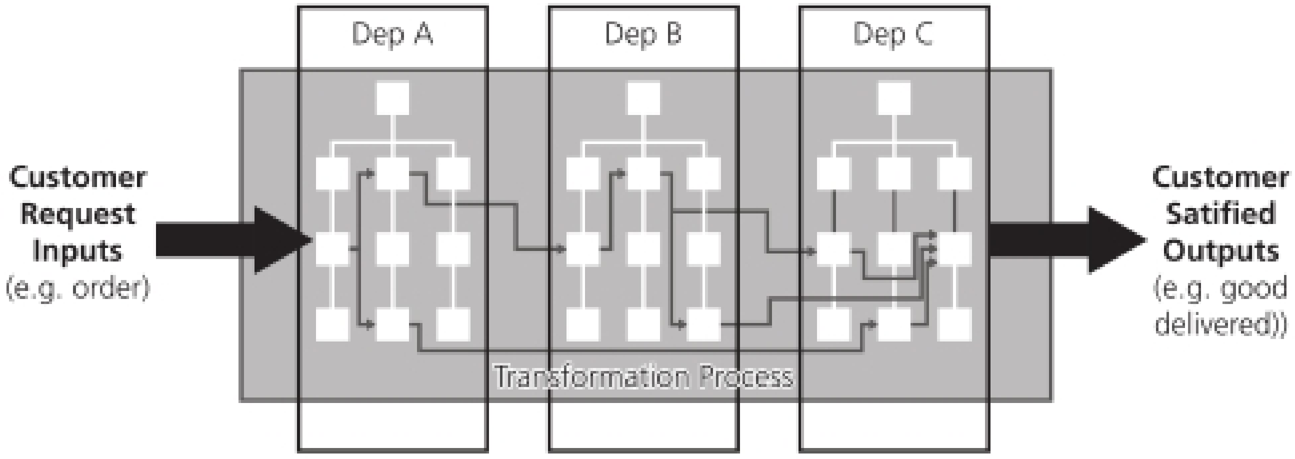


Figure 1.1: Business Processes as Deterministic Machines
Source: Melão and Pidd (2000)

Business Processes as Complex Dynamic Systems

The second view, business processes as complex dynamic systems (Figure 1.2), does not perceive a business process as an assembly of interchangeable components, but focuses on the complex, dynamic and interactive features of business processes. This idea, more than the mechanical view, perceives a business process as an open system which adapts to the environment, and the view emphasizes interaction and dynamic behavior. In some ways, this can be said to represent an 'organic' view on business processes. In this open-system perspective, a business process may have inputs, transformation, outputs and boundaries. A business process is defined as a set of subsystems (e.g. people, tasks, technology, etc.) that interact internally (the organization) and externally (the environment). While the mechanical view ignores interactions to a large extent, the complex dynamic systems view incorporates this aspect to some extent. This implies that the views represent a more holistic view in stressing the behavior of a business process as a whole rather than its parts. On the other hand, this view obviously makes analysis more complex, and may thus be more risky and require more resources. Another weakness of this view is that it may lead to the socio-political dimensions of a business process being ignored, because it focuses too strongly on the organization as a system in a rational manner. Furthermore, feedback loops are not emphasized much in this view, although such may determine the behavior of many real-world business processes.

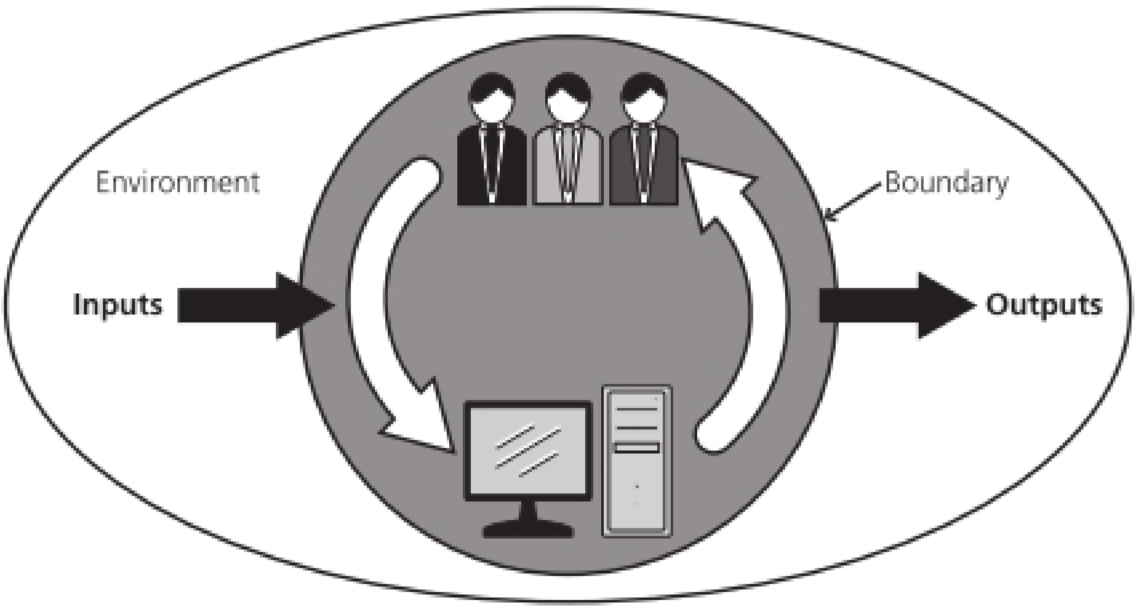


Figure 1.2: Business Processes as Complex Dynamic Systems
Source: Melão and Pidd (2000)

Business Processes as Interacting Feedback Loops

The third view, business processes as interacting feedback loops (Figure 1.3), can be seen as extending the complex dynamic systems view as it highlights the information feedback structure of business processes. Overall, this view resembles the complex dynamic system view by emphasizing interactive and dynamic features of business processes from a system theoretical perspective. However, opposed to the complex dynamic system view, which focuses on business processes with no loop systems, the interacting feedback loop view perceives business processes as closed loops with internal control. Thus, the view does not define the dynamic behavior of a business process in terms of individual components, but in terms of interactions between internal structure and policies. In Figure 1.3, business processes are illustrated as flows (rates) of resources (physical or non-physical), starting outside the system boundaries and moving through a sequence of stocks (levels). These 'levels' represent accumulations (e.g. materials and information) or transformations (e.g. components to assembly). The flows (rates) are regulated by policies that define the actions to be taken in order to achieve a desired result. Such actions are carried out based on information, which is where 'the information feedback loops' become relevant.

While solving a problem of the complex system view, the feedback loop view holds the weakness that it may result in human factors being considered as instruments to be controlled or to exercise control. Also, although the view may be easy to understand, it may be difficult to use properly in practice.

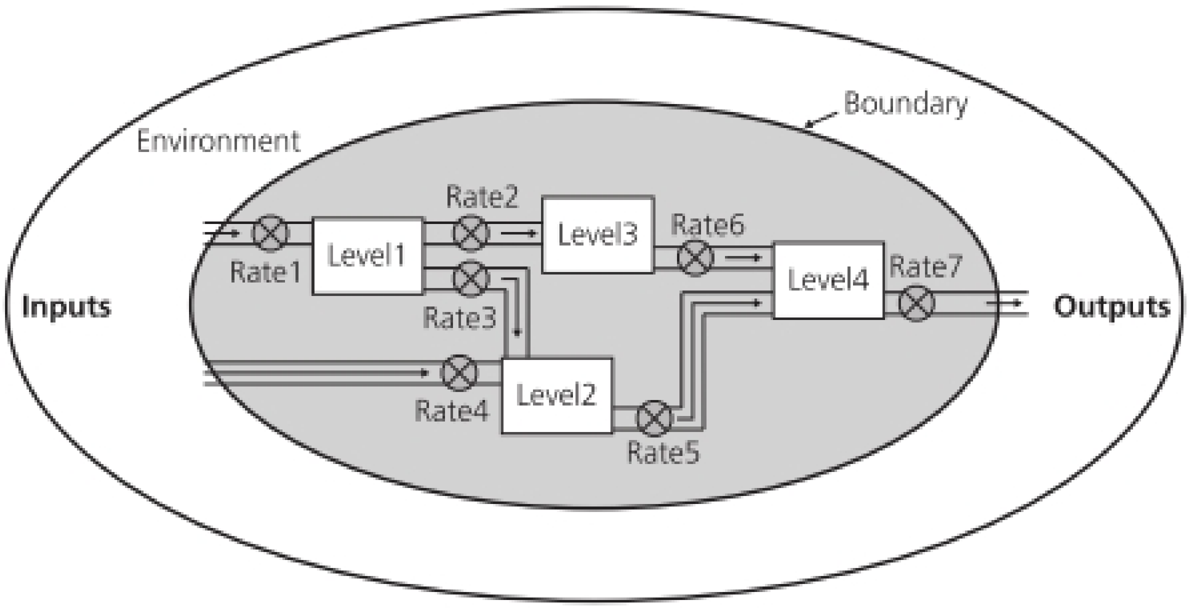


Figure 1.3: Business Processes as Interacting Feedback Loops
Source: Melão and Pidd (2000)

Business Processes as Social Constructs

The fourth view, business processes as social constructs (Figure 1.4), turns away from perceiving a business process as a predictable machine or as a dynamic organism with clear objectives. Instead, this view emphasizes business processes as being carried out and enacted by people who, by definition, have different values, expectations, agendas, etc. Thus, business processes are not seen as objective and concrete as in the previous three views. Instead, business processes are abstractions, meanings and judgments, i.e. a result of a process of subjective construction in the minds of people. Therefore, in this view, a business process can be defined in terms of perceptions by individuals and groups with different frames of interpretation. Such frames are shaped by beliefs, values, expectations and previous experience for which reason different people perceive some aspects and ignore others. The different views on a business process by different people imply that different views of changes are required. Thus, changes become a result of a process of negotiation of conflicting interests.

Although solving the problem of irrational human nature, the social construct view has the drawback that the view, if used alone, can hardly provide a useful quantitative assessment of business process changes. Furthermore, although the view recognizes the socio-political aspects, it offers no way of dealing with this aspect besides conducting analyses.

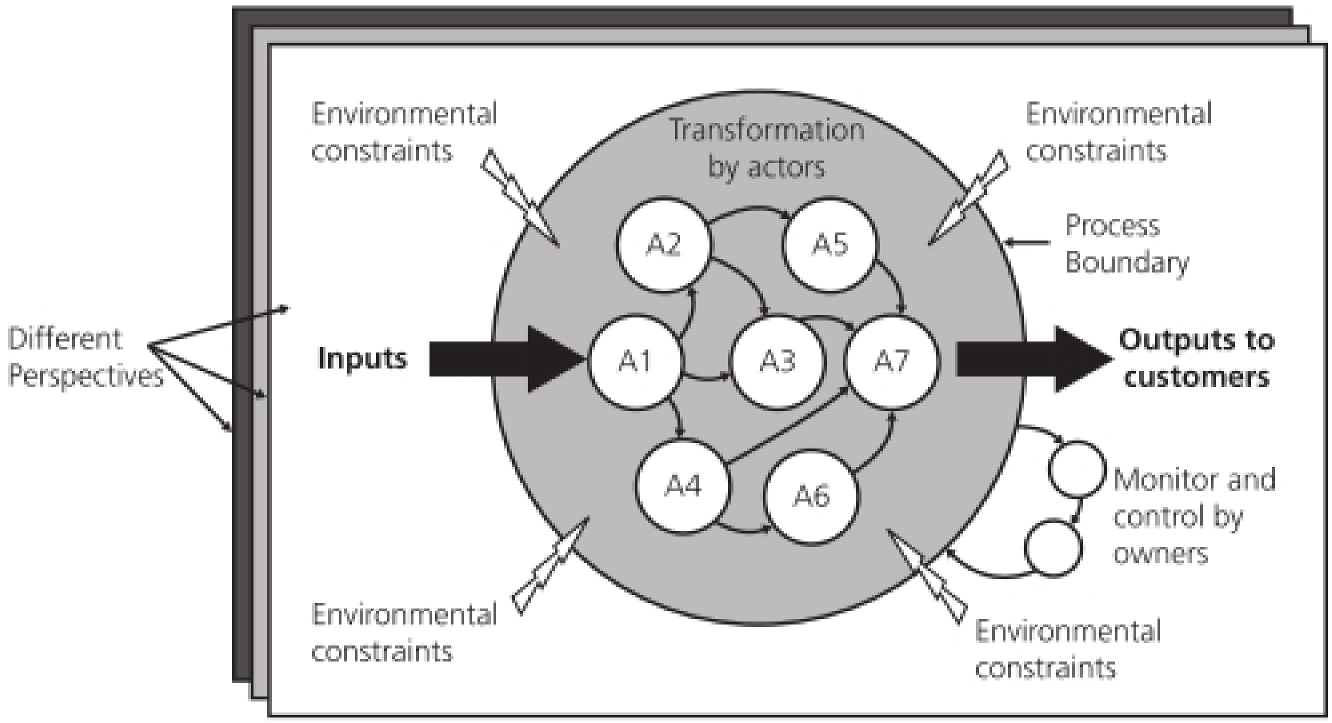


Figure 1.4: Business Processes as Social Constructs
Source: Melão and Pidd (2000)

Application of the Four Views

The four presented views on how to understand business processes imply very different approaches to the analysis of processes. Thus, if choosing one view, certain aspects are emphasized while others may be neglected. However, since the use of one view does not rule out using other views, or at least parts of these, in many cases it may be advantageous to include aspects of multiple views when analyzing business processes. Here, it is of major importance that all relevant aspects of business processes in focus receive adequate focus.

The Need to Improve Business Processes

Efficient business processes are tightly linked with the competitiveness of a company. Usually, the companies with the most efficient processes survive, while the ones with inefficient processes lose ground. The need for improving business processes may occur in different areas of a company and have multiple causes. Sometimes, such needs are easily spotted, while in other cases it is more difficult. To provide a better understanding of the multiple types of situations where business improvements can be called for, Table 1.1 shows a list of examples of potential causes and indicators in relation to business process inefficiency.

Area	Examples
Organization	• If a company is growing, many decisions need to be made within short periods of time and therefore, thought-through strategies for the execution of business processes may not have been made. • If companies merge, this, among other things, implies that some of their IT systems must work together and that the processes of the companies, to some extent, should match each other. • If the strategy of a company is changed, business processes need to be adapted to fit this purpose. • If a company does not reach its goals, this may be a strong indicator that something is wrong with the business processes.
Management	• If managers give conflicting information to employees, this is a sign of poorly executed business processes. • If managers lack a proper overall view of the daily operations, this may be explained by business processes not being carried out in an sufficiently predictable manner. • If managers aim at creating a high-performance culture to ensure smooth running, business processes may be the most important means to achieve this. • If managers are faced with demands for budget cuts, business-process changes can be a means to meet these demands.
Employees	• If there is a high turnover of employees (often seen in relation to jobs consisting of monotone work tasks), there is an increased demand for simple and well-defined processes in order to minimize learning time and errors. • If the job satisfaction of employees is low, this issue may be solved by reorganizing the processes in which the employees are involved. • If the employees experience difficulties because of complexity in their jobs, a change of business processes may be called for. • If a significant increase in the number of employees is expected, it should be ensured that business processes are ready to support this situation.
Customers	• If it is not possible to answer questions from customers within satisfactory time frames, the processes in this context are not functioning as they should. • If there is an expected increase in the number of customers, the business processes need to be prepared for this. • If there are unfulfilled goals of a certain degree of customer satisfaction, the processes need to be altered to support this. • If many customers require unique processes, the processes may be redefined in order to cover a broader range of requests.
Suppliers	• If it is not possible to answer questions from suppliers within satisfactory time frames, the processes in this context are not functioning as they should. • If there is little control over the time of arrival of deliveries, relevant processes may be redesigned in order to provide more detailed and timely information. • If closer cooperation is desired with certain suppliers, relevant processes and systems may be redesigned to enable such cooperation. • If many suppliers require unique processes, the processes may be redefined in order to cover a broader range of needs.

Products/ services	• If products have an unsatisfactory long time to market, the existing processes may be defined in a more flexible manner. • If each or many products have their own processes in spite of many similarities, it would be possible to make processes more efficient by integrating some processes. • If there are poor stakeholder service levels, a change of relevant processes may solve this. • If production processes are found to be too complex, attempts should be made to simplify these processes.
Information technology	• If introducing new IT systems (e.g. an ERP system), there is a need for refining processes in order to be able to use the system efficiently. • If IT costs seem to be out of control, there may be a need for redefining relevant processes. • If IT is perceived as not meeting expectations, this may be caused by poor use-processes. • If IT systems overlap, there may be a potential gain from redefining such processes.
Process management	• If there is a need for better visibility of relevant processes, the work of documenting such processes may be improved. • If there are many handovers in a process, such processes may be integrated. • If the roles of the people involved in a process are unclear, such processes may be more clearly defined. • If processes are very different, the company may benefit from process standardization.

Table 1.1: Examples of Causes and Indicators in Relation to Inefficient Business Processes
Source: Partly based on Jeston and Nelis (2006)

Discussion Questions

1. What is a business process?
2. Why should a company invest resources in business processes?
3. Besides the processes mentioned in this chapter, give some examples of business processes.
4. What is the main danger of a division of labor?
5. What are the main ideas of business process reengineering?
6. Explain the business processes according to the deterministic machine view.
7. Explain the business processes according to the complex dynamic system view.
8. Explain the business processes according to the interacting feedback loop view.
9. Explain the business processes according to the social construct view.
10. What are the consequences of applying each of the four process views?

CHAPTER 2

IT System Mapping

Introduction

> Documentation is like sex: when it is good, it is very, very good; and when it is bad, it is better than nothing. (Dick Brandon)

In the daily business operations in companies, many different systems are being used in order to do the work. Actually, we are totally dependent on the fact that the systems work in many instances. Systems are being used both in administrative work and in production, warehousing and transportation. If we follow a physical product from cradle to grave through global supply chains, a huge number of people and IT systems have been involved in sourcing, manufacturing, controlling, storing and moving the goods. However, few are aware of exactly how many systems are actually operating in a given company. In order to find out, we first need to clarify the meaning of a system. Basically, a system is an array of components that work together to achieve an objective by processing data to information. In this textbook, a system ranges from all traditional systems and software packages for which a company pays license to flat files stored at local hard disks on workstations and manual paper-based systems (see Figure 2.1).

Figure 2.1: Range of Different Systems

As shown in Figure 2.1, Enterprise Resource Planning (ERP) systems, Business Intelligence (BI) and Manufacturing Execution Systems (MES) are located to the left (systems with databases). In the middle, local systems developed in spreadsheets and local databases are portrayed. In practice, spreadsheets are used in many different ways by employees who have stored them on local PCs. These spreadsheets are used for many different purposes in daily operations. Finally, to the right, manual paper-based systems are listed. Such systems are typically stored on paper in binders in the shape of, for example, a quality system or a document system (e.g. drawings of customer-specific goods in stainless steel). Thus, companies often have a huge number of systems. We have experienced that in many companies, people are not aware of how many systems are functioning each day. During a presentation about master-data management at Microsoft EMEA Convergence in Munich in 2006, the audience was asked if they knew how many systems existed in their companies. Many among the audience put up their hands to indicate that they knew. However, they were told what was meant by a system as shown in Figure 2.1. Then, the audience was asked again if they knew the number of systems in their companies. This time no one put up their hands. This small example shows that many companies are not aware of the number of systems and how they are used in different work processes. The objective is not to rationalize these systems. Of course, if some of the subsystems could be replaced by using core functionality in the ERP system instead, this would make the company less vulnerable. The opening message with this discussion of the number of systems is that managers should be conscious about the number of systems in the company. A way to become conscious of this is through mapping the IT systems. This is what this chapter has set out to examine. A fundamental requirement for all types of systems is that they must be able to provide useful information. Useful information can be explained by TRACE, as shown in Table 2.1. Information must be Timely, Relevant, Accurate, Complete and Economical.

Characteristic	**Brief explanation**
Timely	Strategic, tactical and operational decisions are being made on information. In decision situations, information must be timely, e.g. actual sales figures, actual inventory levels or actual level of orders.
Relevant	Information must be concerned with the specific problem that is to be solved. If you are planning a cheap trip to Rome with an airplane, you need information about departure times, airports, airline company and how to get to and from the airports in the cheapest way.
Accurate	Information must be without errors. Information must be reliable. Many strategic decisions are taken in companies, such as outsourcing production to China or India, bringing new products to markets and acquiring companies through acquisitions. Each of these examples requires information in order for decisions to be made. Errors in such decision-relevant information can lead to fatal consequences for companies.
Complete	Information must be without missing parts. If sales figures are missing for part of the entire product program it does not constitute the best foundation for decisions on where to increase marketing efforts.

Economical	Like in all other business-related areas, a cost-benefit calculation may also be present when demand for more information is needed. In other words, the benefits of getting the information should be higher than the cost of providing it.
In a Danish company, there was a story about their ERP system and how fast it was. They used the word monthly accounts – i.e. twelve accounts per year (compared with an annual account). That was really impressing until it became clear that the term was used because it took one month to develop the monthly reports. This company worked for a long period with old data when taking decisions. This situation was caused by an inappropriate ERP system and a lot of manual work in spreadsheets. Today, this problem is solved through a new ERP implementation that now provides top management with up-to-date information.	

Table 2.1: Useful Information

In order to fulfill the purpose of this chapter, it is further organized into four sections. The next section discusses what mapping is about. Then follows a section that introduces the term 'the hidden system factory'. Next, a section describing a process for creating an overview of systems through mapping. The last section discusses cost and benefit considerations with this mapping activity.

Visualization

When a company decides to make a development within a given area (such as business processes and inventory optimization) much data is typically collected. The next question might then be how to process all this data? How can we share the data with other colleagues in order to get their views and feedback? How do we develop a common understanding of the development project? This is what visualization is about. Based on visualization tools, a mental model can be formed from the data that enables the staff to get insight into the data. Visual presentations transform data into pictures which help people to understand the domain of problems more quickly (Lohse et al., 1994; Fiol and Huff, 1992). The visual displays also support change processes. They can enable participants to see how it will affect their daily work (Fenton, 2007). Through this involvement, ownership of the change initiative may be created. Visualization is closely linked to cognition which is a term for the process of thought to knowing. Cognitive maps stimulate a mental processing by which an individual can acquire, code, store, recall, and decode information about the specific domain of problems being investigated. The cognitive processes describe what happens in our brains when we sense, perceive, remember, think, solve problems, learn and make decisions. Visual presentations can help managers to make sense of a complex amount of data. It can simplify ideas and facilitate the transmission of complex ideas among those who are part of the visualization process (Platts and Tan, 2004). The visualization process also provides room for debunking myths because visualization provides facts about actual processes that are to be collectively validated. There are also other functions of visualization, besides the above-mentioned functions, as shown in Table 2.2.

Cognitive functions	Description
Focuses attention	Allows managers to identify the areas of interest.
Triggers memory	Allows managers to make connections among past events.
Shares thinking	Enables managers to share their thinking with colleagues.
Stimulates thinking	Provides an invitation to view a situation in a way that often stimulates fresh thinking.
Bridges missing information	Exploits the human visual system to extract information from incomplete data.
Challenges self-imposed constraint (perception)	Enables managers to look at a problem in a new way.

Operational functions	Description
Identifies structure, trends, and relationships	Identifies structure, patterns, trends, anomalies, and relationships in data.
Displays multivariate performance	Enables managers to analyze complex performance.
Highlights key factors	Allows managers to specify explicitly their views on the importance weighting of variables.
Provides an overview of complex data sets	Provides a picture of the problem that is relatively easily examined, explored, and, if appropriate, changed. Managers often have difficulties perceiving the dependencies among choices, uncertainties, and outcomes.

Table 2.2: Functions of Visualization
Source: Based on Platts and Tan (2004)

Visualization can take many forms. Lohse et al. (1994) have examined sixty graphical items and, based on these, provided eleven clusters of presentations to graphs, tables, time charts, networks, structure diagrams, process diagrams, maps, cartograms, icons and pictures. Visualization can be used in a wide range of situations. It spans many academic disciplines, scientific fields and multiple domains of inquiry (Lohse et al., 1994).

Mapping

The mapping technique is a simple but powerful tool to visualize what actually happens in daily work life. The need for maps has increased with the globalization of trade. In the early industrial age, value was created by companies by transforming raw materials into finished products. The economy was primarily based on tangible assets such as inventory, land, facilities and equipment (Kaplan and Norton, 2000). The strategy was easier to document by use of financial instruments. Contrary to this, the information age is characterized by creating a higher proportion of intangible assets such as relationship management, employee skills, knowledge management, information technology and a corporate culture that sustains innovation and continuous improvement. This move makes mapping even more important in order to explicate where true value is created within the company and between companies. Mapping can be executed in different ways and using different symbols. It can be applied everywhere for physical activities and processes and for systems. Basically, we know mapping from other areas like engineer drawings of houses, factories and process systems. The maps help us to make often implicit assumptions more explicit. In daily work, we are not able to see the whole picture of a workflow and how we, for example, due to inefficient processes, may be creating problems for each other between different departments. Different mapping techniques exist, cf. chapter 2. In a practical situation, one should use the technique one is most comfortable with, and the technique should, of course, also be appropriate for mapping the given processes. The most important thing is consistency in the symbols being used. Before starting the mapping process, the level of details should be taken into consideration. It is like the zoom in a camera. If you zoom too much you can really see the details, but you can easily be 'drowned' in details at the expense of an overall view. On the other hand, you can also zoom out too much so that the maps are at a general level that does not allow you to identify specific problem areas. Normally, one has to do some test maps of a specific area in order to find the right level of details.

At Tresu Production System, they agreed to analyze the order and paper flow in the company since they perceived that these flows needed optimization. They allocated a person to map the process flows. This person started with interviewing people in the total order flow from sales, R/D, production techniques, logistics, purchasing manufacturing, assembly, shipping and service about their views on the daily problem areas during the flow. The interviews were supplemented with a simple Excel spreadsheet that listed a long line of causes of interruptions about which the individual employee was to report during a working day. These data were gathered over a five-week period. Overall, the predominant problem areas centered on the shipping function. The four biggest problem areas identified by the mapping process:

1. A huge amount of time was used gathering missing information from previous steps in the order flow.
2. Too much time was spent identifying and changing wrong information from previous steps.
3. Much time was used looking for lost components and packages that were to be prepared for shipping.
4. Too much time was used moving paper and documents (one employee stated that one day, he had spent over two hours moving paper from one location to another.

Table 2.3: Identification of Problems through Mapping

When the mapping takes place it may be a suggestion to involve the employees who work in the area being mapped. The mapping process not only creates an overview of what is going on. The process of doing the maps is also a strong collegial exercise that increases the employees' level of knowledge of what is actually going on in their companies. Very often, people are stuck in their functional silos. They do not have a holistic view of the company and therefore, they are not aware of how they may interrupt the next steps in the process flow by e.g. not covering all information about a customer and/or products. When some tasks are handed over to the next people in the internal value chain and they experience that vital information is missing, they have to return the task (sometimes several steps back). This return-flow is a non-value adding activity that often creates a lot of noise in companies (in terms of problems of collaboration and stopping ongoing work in order to generate missing information). Different mapping techniques exist which will be examined in detail in chapter 3.

Value Stream Mapping is a visualization tool which is part of the lean tool box. It helps to understand and optimize work processes. The overall purpose is to identify and eliminate waste in all work processes (for a comprehensive presentation of the lean concept we refer to Arlbjørn et al. (2008)). The mapping technique uses a set of symbols to portray both the current and future state. Information about the mapping technique can be found in Rother and Shook (2003). Seven specific mapping tools can be found in Hines and Rich (1997).

Table 2.4: Value Stream Mapping

The Hidden System Factory

The hidden factory is a concept that was introduced to symbolize all the hidden manufacturing overhead costs that exist in manufacturing companies (Miller and Vollmann, 1985). The term is borrowed to this system context to symbolize an often unknown amount of costs associated with running and maintaining a high number of systems. One could ask how come so many systems exist? There are several plausible explanations to this. Firstly, software can be acquired simply because it is needed and because its functionality does not lie within, for example, the company's ERP system. Such a system could be a wage system like Lessor. Another explanation could be that some people find that the existing system (e.g. an ERP system) constrains them in their daily work. Instead of following the processes, they create their own sub-processes and develop systems, in for example Excel, where they copy data from the main ERP system for further process in Excel. A third explanation could be that some employees do not have acceptance of an application for a new system or adjustments to the existing system that can fulfill their requirements. What else can they do then? They could develop their own system fulfilling all or part of their needs. Over time, the number of systems slowly grows. The hidden system factory is at work.

Behind each system, there is an 'owner'. This person will typically go a long way in order to defend the system. Over time, they can take the form os small 'kingdoms'. The mapping of systems is a way out of the hidden system factory problem. The mapping process helps in making all systems visible, making it possible to judge which systems should continue and which systems should be closed down (data integration with the ERP system). Furthermore, it helps to address who is responsible for which systems and how many resources are used to work and maintain the systems.

The company has completed a study on their use of IT systems. The analysis focused on an AS-IS mapping of the IT systems and the level of integration, how they were applied and how much was applied and where the systems were applied. In order to provide information about the applied systems, forty-five interviews were carried out with twenty-five employees from different departments (quality, logistics, planning, technical development, marketing, sales, product introduction, IT, R&D, finance and HR). The analysis concluded that the company had a complex IT structure with a large number of stand-alone systems without any integration into other systems. The previous ERP system was BPCS (Business Planning and Control System). The analysis found that only 20% of its functionality was utilized. Instead of using the functionality of the BPCS system, either self-developed or other third-party products were developed and implemented around the core ERP system. Thus, over 117 systems were identified, including the systems for the core, supporting and assisting processes. The high number of different IT systems led to the following conclusions on information integration problems:

- When information is needed for decision-making processes, it has to be collected and worked up from many different systems, leading to inaccurate, slow and resource-intensive work processes.
- Due to the high number of IT systems, there was a high level of local knowledge stored in different individuals. This made the company vulnerable when these employees were absent from the company.
- There were many non-value-added activities related to asking, storing, retrieving, re-formation, interpretation of information, and error-checking processes, due to the many different non-integrated IT systems.

The lack of information integration could be one of the main reasons for long lead-time and the many re-planning activities. Due to pressure from the customers, the company had to engage in a company-wide ERP implementation with a substantial amount of business process reengineering (BPR) to ensure greater information and process integration.

Table 2.5: Example of System Mapping
Source: Arlbjørn et al. (2007)

Process for Creating an Overview of Systems

This section introduces a structured process flow of activities to be carried out from the initial stage of being aware of a need for system mapping through the final phase with delivering a report containing a complete documentation of the identified systems. The scope of this task varies between companies depending on size, type of industry and complexity. In order to give some examples, it took

2 persons 3 months to map 90 systems at a manufacturer with 400 employees (300 blue collars and 100 white collars) and it took 4 persons 3 months to map and document over 140 systems at a Danish manufacturer with 700 employees (550 blue collars and 150 white collars). These are of course only indications, but the examples serve to illustrate that this mapping task contains quite a work load. Hopefully, this will be clearer after reading the steps described in the following sub-sections. The seven steps are: 1) Be aware of the need, 2) Identify main processes and key staff to be involved, 3) Prepare a plan for interviews and conduct interviews, 4) Map the systems and their interconnection, and 5) Verify the systems and their interconnections.

Be Aware of the Need

The first step in this overall process flow to generate an overview of the systems utilized in the company is to be aware of the need for the mapping. A natural starting point could be to contact the IT manager and ask for an overview of the systems that are in use. In many cases, such documents do not exist. Even an IT strategy can be difficult to get. Thus, this awareness phase should end up with formulating specific purposes with the mapping exercise. Such purposes may be:

- To create a visual overview of the IT systems that are utilized
- To identify which systems that are used where
- To make a short description of each system
- To identify to which degree the systems are integrated
- To describe the main process flow from receiving orders to actual shipment of the goods
- To create an overview of the servers being used.

There may be different reasons for the need to map the running systems. Firstly, it might be the case that the company has decided to implement a new ERP system. In order to secure a good platform for such a project and also to investigate what should be included in the ERP and not, an overview of which systems operated in the daily work is needed. Another reason could be that the company has decided to formulate an IT strategy and procedures for master-data management. Such an overview could provide input for a system rationalization process and for policies about where to store and maintain data. Thirdly, the mapping process could be initiated as part of an overall business process optimization project (e.g. reengineering the overall business processes in the company as described by Hammer, 1990).

Identify Main Processes and Key Staff to be Involved

The second step concerns identifying the main processes that constitute the major work flow in the company. As described in chapter 1, 'business process' is a wide term that needs to be operationalized in the specific company. In textbooks, articles and other written documents, examples of business processes (often named after their specific topic area) are provided. However, these business processes must be built up from the actual practice and named accordingly. Thus, this step contains a process that takes a holistic view of the company and then identifies its main processes from customer contact (sales and order processes) over order fulfillment and manufacturing to sourcing and purchasing. Arlbjørn et al. (2010) propose eight such general business processes for demand management, order fulfillment, customer relationship management, R&D management, manufacturing management, supplier relationship management, sourcing management and return management. Another important task in this step is to identify the staff that can assist in providing data and information about the systems in the different processes. In the sampling criteria, the selection of staff should be based on best insight. This might not be really clear from the beginning. One should therefore be prepared for several loops in identifying the people relevant for these tasks. As the interviews begin and thus also the system mapping, it is normal that additional systems not identified in the beginning crop up which also often leads to additional people to be included.

Prepare a Plan for Interviews and Conduct Interviews

The third step contains detailed planning for a series of interviews to be carried out with the people identified in step two. A natural sequence of the interviews will be to follow an order. This means that the interviews begin with the sales processes and the R&D over planning, production and sourcing. It is not only people from the core process flows that have to be interviewed. Also staff from, for example, finance, HR and IT can be included as they are also users of different types of systems. The actual list of people is very specific for the specific situation. When the interviews are planned (or the first of them) the interviews can begin. The interview begins by explaining the overall purpose with the mapping exercise and also explaining the types of systems that need to be identified (see Figure 2.1). The interview should focus on an identification of all the systems that the person interviewed knows. The interview can be guided from a fact sheet as shown in Table 2.6.

Descriptive elements	System name: 'XXX'
Purpose	
System	
Type of system (standard vs. high level of programming)	
Data input	
Unused data input	
Data output (type and applied where)	
Unused data output	
Where in the organization is the system used?	
Background for acquiring the system	
When is the system acquired?	
Link to other systems	
Reliability (uptime)	
Server	
Contact person (initials)	

Table 2.6: Fact Sheet for a Rough Description of a System

This step ends with returning the filled-out fact sheets to the contact person being interviewed for a validation of the information.

Map the Systems and their Interconnection

This step is concerned with mapping all the systems identified. An example of such a mapping system can be seen in Figure 2.2. Different techniques can be applied in this mapping. There is not only one right technique. However, it is important that there is consistency in the symbols being used and that the symbols are explained. The mapping can be used in software like Microsoft Office PowerPoint or Microsoft Office Visio. The relations between the systems should also be portrayed, e.g. connecting the systems with lines. In this way, the map will show how many of the systems are connected and how many are standalone systems without any integration. Not only the systems have to be mapped, also the different servers that the company utilizes should be mapped.

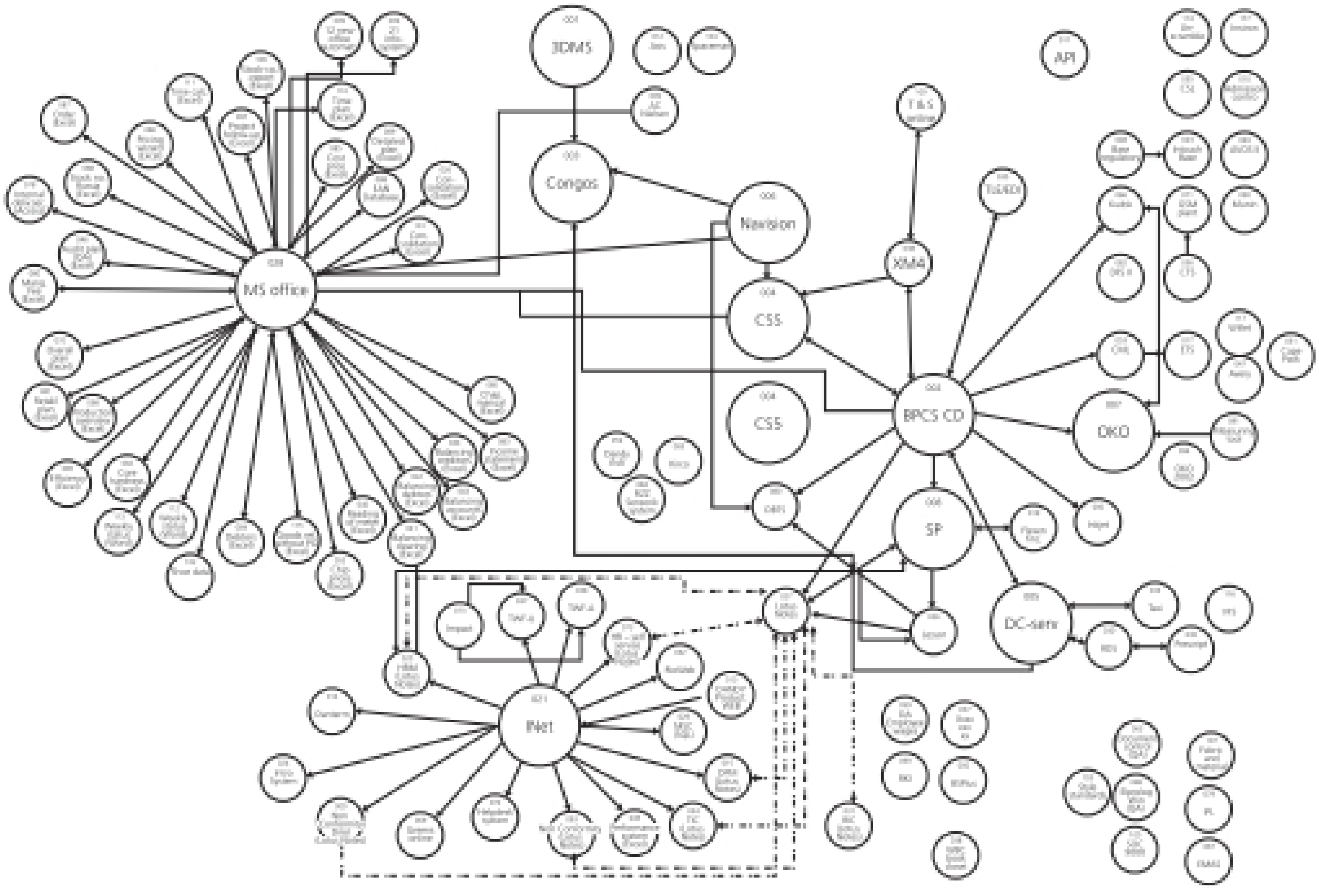


Figure 2.2: Example of IT System Mapping
Source: Arlbjørn et al. (2006, p. 114)

Verify the Systems and their Interconnections

When all the systems and their interconnection have been mapped it is important to set up verification meetings. Validation could also take place during the data collection/interview process. However, the final validation is important to secure that all systems and their interconnections are true. This final verification round may lead to an identification of further systems, relations between systems and/or changes to portrayed links between the systems. The verification can take place individually with the person being interviewed or collectively at, for example, department meetings. Also the server mapping must be improved. However, typically only a few people have the knowledge to verify such maps and they are typically from the IT department.

Cost and Benefit Considerations

Before starting such a mapping process as described in this chapter, it is recommended to begin with completing a simple cost and benefit calculation. Doing such a mapping project is not free of cost. However, the costs to run such a project are basically related to the work group's time consumption with planning and accomplishing interviews and processing all the data received. The costs of carrying out an IT mapping project should be viewed in the light of the benefits it also creates. They can be both tangible and intangible. Tangible benefits can be realized if the mapping process, for example, identifies systems that need to be closed down because its core functionality could be moved to the main ERP system. Licenses and other maintenance costs could be saved. The mapping may also lead to initiating reengineering projects of processes in the company that might reduce the staff to complete given tasks. Furthermore, the mapping process may identify areas in which data redundancy exists. Instead of storing and maintaining the same data in more than one system, this can be changed to one system. There are also intangible benefits of such a mapping exercise. If the company is close to starting up a new ERP implementation, the mapping project provides useful information about which systems need to be included in the new systems and about which systems need integration. Thus, the mapping process can provide important information for user requirement specifications for the new system. The value of this is difficult to estimate and is therefore included as an intangible benefit. Another intangible benefit is that the mapping process can provide the foundation for developing and implementing new procedures for the operation of company systems. Finally, the project may lead to more focus on master-data management by assigning responsibility for master data to different persons in the organization.

Discussion Questions

1. Explain the difference between manual and computer-based systems.
2. Explain the acronym TRACE.
3. What are the functions of visualization?
4. What is mapping and what can it be used for regarding IT systems?
5. Provide examples of the purposes with mapping IT systems.
6. What is meant by the hidden system factory?
7. What are the steps that one can go through in order to map systems?
8. What is cost and benefit of system mapping?
9. How can a system be described?
10. What type of measurement challenges exist when developing benefits as well as costs of system mapping?

CHAPTER 3

Process Diagramming Techniques

Introduction

> Sometimes a picture is worth more than a thousand words.
> (Unknown)

Instead of describing a business process in textual format, such information is often better described and shared using graphical symbols. A diagrammatic representation of a business process is a way of gaining an overview of the activities, persons, technology and documents involved. In business process improvement projects, diagrams are used for mapping the current situation, as a basis for analysis. The analysis activity makes it possible to create diagrammatic representations of the desired future state. After having improved relevant business processes, process diagrams may be used for documentation of business processes. Such documentation can be used for further analysis of processes and for training/instruction of employees.

There is a range of benefits using diagrammatic representations of business processes, such as:

- It forces the employees to think through their understanding of current processes.
- A common understanding is achieved of which activities should be carried out in a business process.
- Regulations and procedures can be simplified.
- It becomes easier to spot potential improvements.

The potential positive effects of this include:

- Increased productivity
- Decreased head count
- Solved bottlenecks
- Improved communication
- Improved data quality
- Fewer misunderstandings

- Fewer errors
- Better work environment.

Many different business process diagramming techniques exist. In the following sections, three of the most important process diagramming techniques are described:

- Data Flow Diagram
- Data Flowchart (ISO definition)
- Business Process Modeling Notation/Business Process Diagram

Over the last decade, there has been a high interest in the implementation of LEAN techniques in both manufacturing and administrative processes. One central component of LEAN is value stream mapping. Due to the popularity of the LEAN concept, the value stream mapping techniques have been included in this chapter.

Data Flow Diagrams

One of the most common diagramming techniques for representing business processes is the 'Data Flow Diagram' (DFD). DFDs are used for describing business processes in a manner that enables analysis of an existing system (i.e. the processes, data flows, data stores, persons, groups, etc., in focus). DFDs are most often used for describing the 'flow' of data through an information system. However, DFDs can be used for describing any type of business process in a company.

There are three basic forms of DFDs which differ in the perspective of the system they provide:

- Context diagram
- Logical Data Flow Diagram
- Physical Data Flow Diagram

Context Diagram

The context diagram is a high-level overview of the interaction with the external entities of a system. A context diagram defines the system of interest and the external entities with which it interacts by providing inputs or receiving outputs. The context diagram only includes one process which represents the system of interest. The overall picture provided by the context diagram is later decomposed in logical and physical DFDs to describe further details.

Logical DFDs

Logical DFDs focus on the way in which a business operates by describing the business events that take place and the data required. Logical DFDs show processes, data stores, and the flows of data into and out of the processes and data stores. Logical DFDs are used for documenting the logical nature of a system, i.e. which tasks the system is doing. Thus, a logical DFD does not specify how, where, or by whom/what these tasks are accomplished.

Physical DFDs

A physical Data Flow Diagram is typically developed from a logical DFD to show how a system is or should be implemented. Physical DFDs focus on how systems work, for which reason they describe the entities of the system which transforms data, i.e. departments, individuals, programs, program modules, etc. Also, physical DFDs describe the actual data stores (files, databases, reports, etc.) of a system, which is or is to be implemented.

Elements of DFDs

There are four basic symbols in DFDs:

- Process/Entity (Logical/Physical)
- Dataflow
- Data source/destination
- Data store.

A process/entity has incoming and outgoing data flows, and it represents a transformation of data in a system. In logical DFDs, the process/entity symbol represents processes and in physical DFDs it represents entities. In logical DFDs, the name of the process should include verbs (logical) as update, receive, prepare, etc. In physical DFDs, entities can be individuals, groups and organizations.

A data flow represents a pathway for data, and a single data flow can include more than one piece of data. Data flows connect processes, entities, data sources and data destinations. However, data cannot flow directly from a data source to a data destination, but has to pass through an intermediate process. Multiple data flows between two elements can be shown by using two data flow lines or by using a two-headed arrow. One way of doing this is to use two flow lines when the input and output data flows are different and a single two-headed arrow when they are the same. Data flows to data stores do not require a name, while other data flows must have unique names.

Data sources and data destinations are external entities that start and end the process in the system in focus. Data sources/destination can be organizations, groups or individuals who send/receive data used/produced by the system in focus, e.g. customer, supplier, credit manager, financial department, etc. The same data source/destination can be shown multiple times in the same diagram.

A data store is a place where data are stored and can be either of a permanent or temporary nature. Data stores can be media such as databases, files, books, sheets of paper, etc. The type of medium does not need to be specified in a logical DFD, but is often specified in a physical DFD. A data store is always within the system being modeled and can have several input/output flows. Often, the letter D followed by a number is used to identify data stores, e.g. 'D3'.

In Table 3.1 the symbols of Data Flow Diagrams are described and depicted in two of the most common notations, namely the DeMarco notation (Demarco, 1978) and the Gane and Sarson notation (Gane and Sarson, 1979).

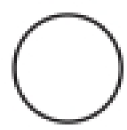
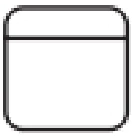
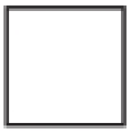
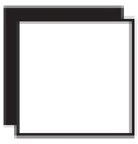
Name	**Description**	**Symbol (DeMarco)**	**Symbol (Gane and Sarson)**
Process/Entity	Represents a process in a logical DFD and a physical entity in a physical DFD.		
Data flow	Represents a pathway for data flows.		
Data source or destination	Represents a source or a destination for data outside the system.		
Data store	Represents a place where data is stored, e.g. file, database, etc.		

Table 3.1: Data Flow Diagram Elements

Examples of a logical DFD using these notations are shown in Figure 3.1 and 3.2. The example begins with a customer requesting a particular product. This initiates the processes: 1) Design, 2) Price calculation, and 3) Quotation letter creation. Finally, the customer receives a quotation letter. During the price calculation, prices are retrieved from the 'Prices' data store.

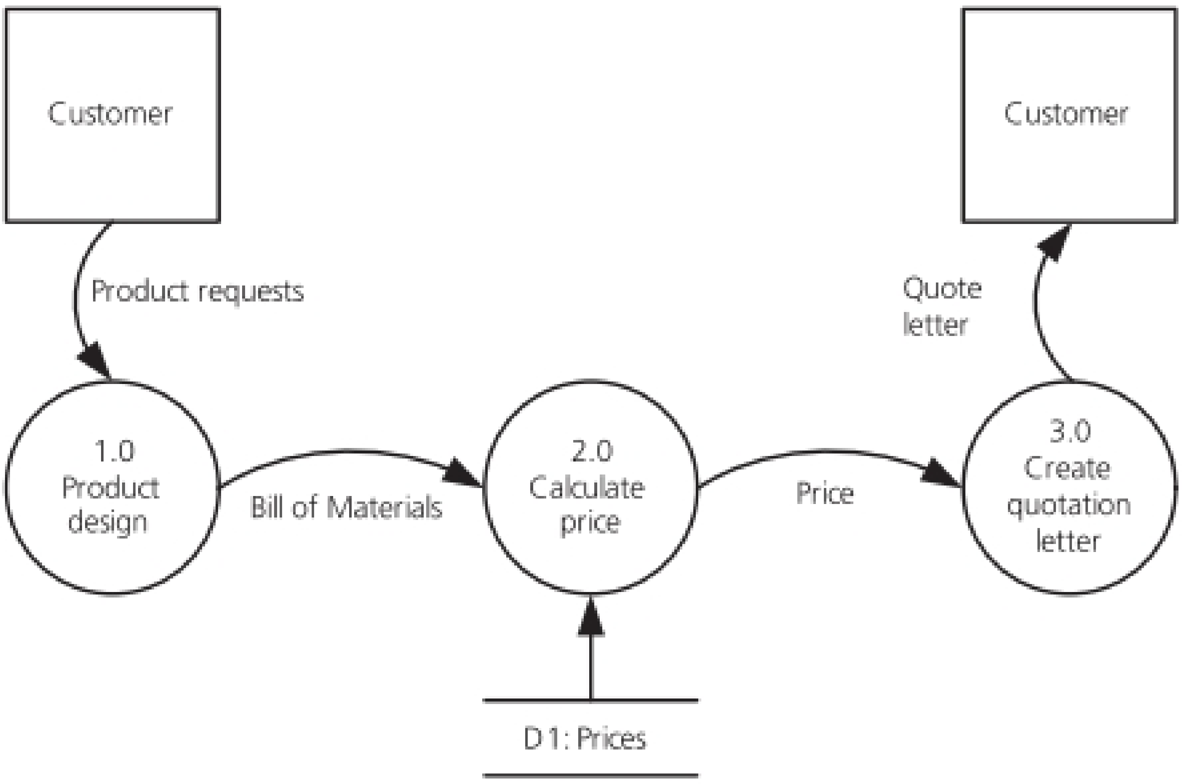


Figure 3.1: Logical DFD (DeMarco Notation)

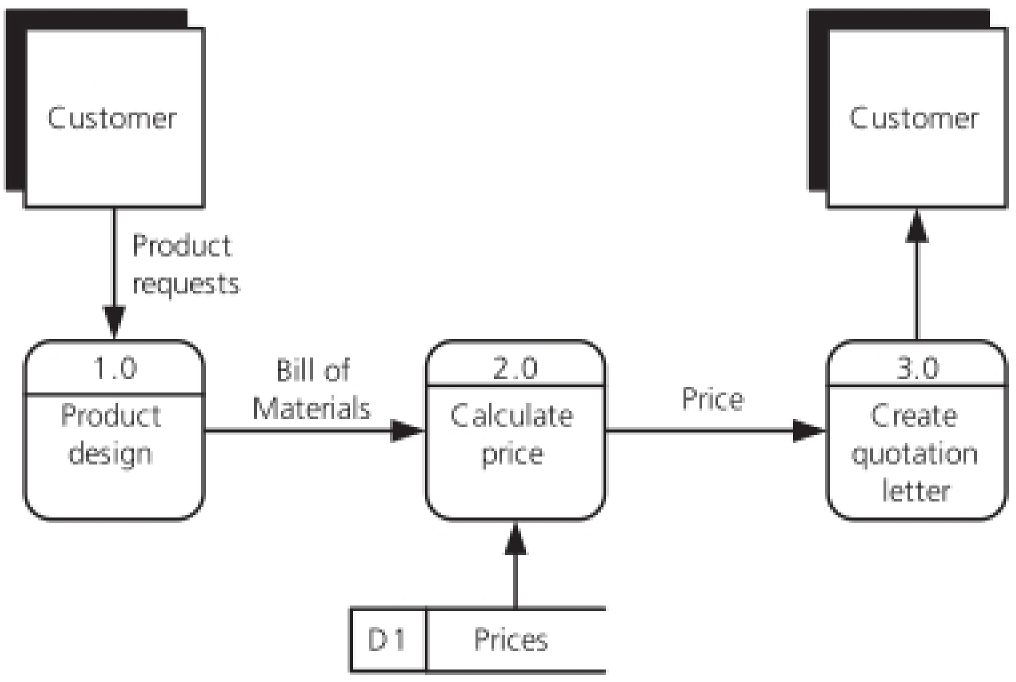


Figure 3.2: Logical DFD (Gane and Sarson Notation)

Besides the already defined symbols of DFDs, sometimes also a thick arrow is used to represent material flows in a DFD, as shown in Figure 3.3.

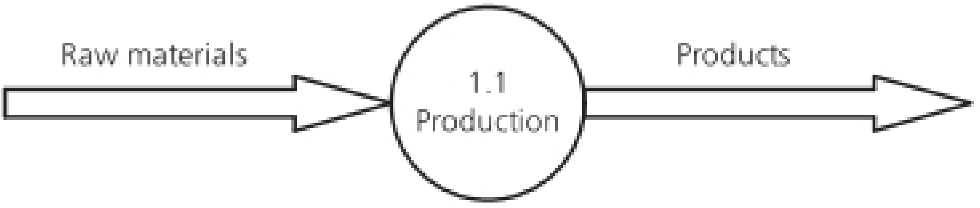


Figure 3.3: Material Flow Notation

Modeling on Multiple Levels

A data flow diagram can be subdivided into several levels. The first level is the mentioned context level, described in the context diagram. The processes/entities of logical, physical and child DFDs are usually numbered in order to be able to move up and down through levels of diagrams. Some of the literature places the context diagram at 'level 0' and other places the first logical and physical DFD at 'level 0'. For the sake of understanding we recommend referring to the context diagram level as level 0.

Based on the context diagram, a logical DFD can be elaborated. To ensure clear communication, it is often best not to include more than 5-10 processes in a single DFD, but to decompose the processes into child diagrams instead. Child diagrams can be further exploded until all of the processes and subsystems are identified. The processes of child diagrams are named according to the parent diagram, i.e. if the parent process is named '1.2', the child processes will be named '1.2.1', 1.2.2', 1.2.3', etc. Lastly, a physical DFD can be created to describe the physical elements of the system.

To sum up, a procedure for the use of DFDs could be:

1. Create a list of relevant business activities, external entities, data flows, processes, and data stores.
2. Create a context diagram of the socio-technical system in focus. This diagram has only one process, at least one in-flow, at least one out-flow, no data stores, and one or more external entities.
3. Create a logical data flow diagram, which shows the sub-processes of the process in the context diagram and includes data stores.
4. If needed, explode processes of the logical data flow diagram from step 3.
5. Create a physical data flow diagram
6. If needed, explode processes of the physical data flow diagram from step 5.

The procedure described above is illustrated in the following figures. First in Figure 3.4, a context diagram is shown. As seen, the process starts by a customer making an order. The order processing system receives this order and produces the data flow 'Receipt' to the customer and the data flow 'Bill of materials' to the manufacturing department.

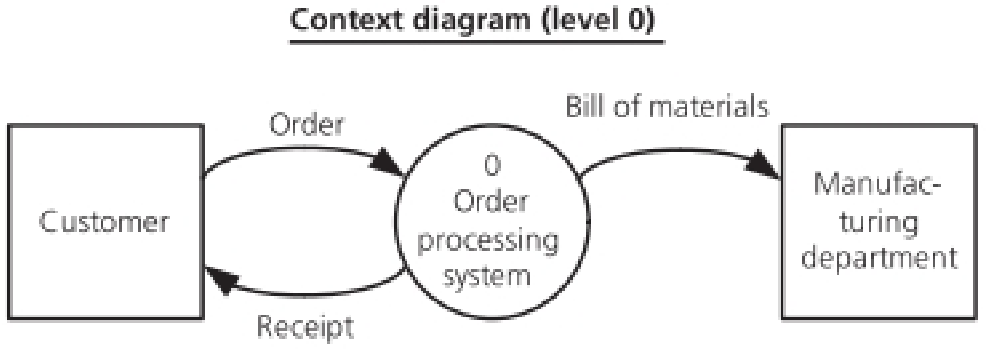


Figure 3.4: Context Diagram

Figure 3.5 illustrates the logical data flow diagram for the context diagram in Figure 3.4. As seen, the overall process 'Order processing system' is unfolded into three processes, five data flows and three data stores. First, the order from the customer is registered in the order data base and an order description is provided to initiate the process of defining an overall solution. The process of defining an overall solution produces a product description which initiates the process of making a bill of materials. The process of making a bill of materials gets data from the 'Item database' and provides data to the 'BOM database' and the manufacturing department.

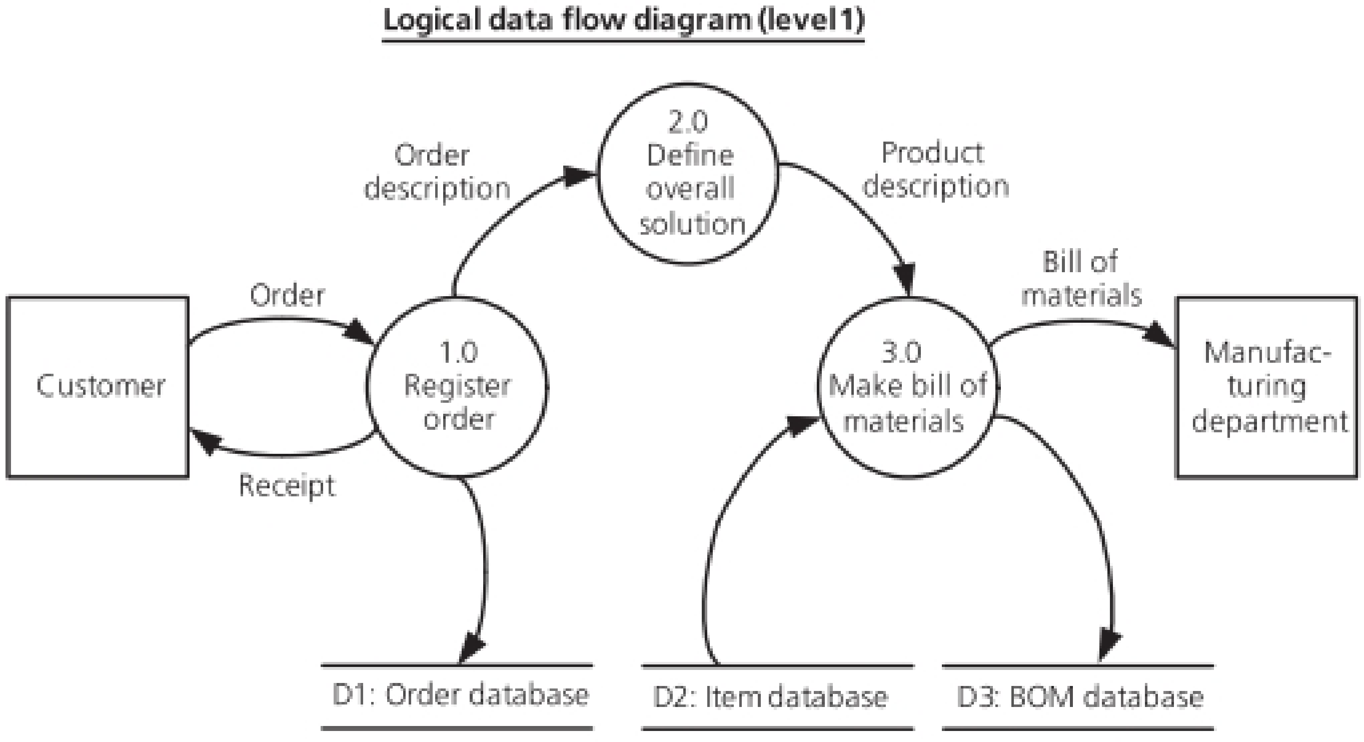


Figure 3.5: Logical DFD

Figure 3.6 shows a child DFD for process '3.0' of Figure 3.5. As seen, the input data flow 'Product description' and the output data flow 'Bill of materials' are the same as for process '3.0' in Figure 3.5. Also the data sources are the same as for process '3.0'. In the child diagram, process '3.0' is exploded into the child processes '3.1 Find item numbers', '3.2 Structure items list', and '3.3 Register bill-of-materials'.

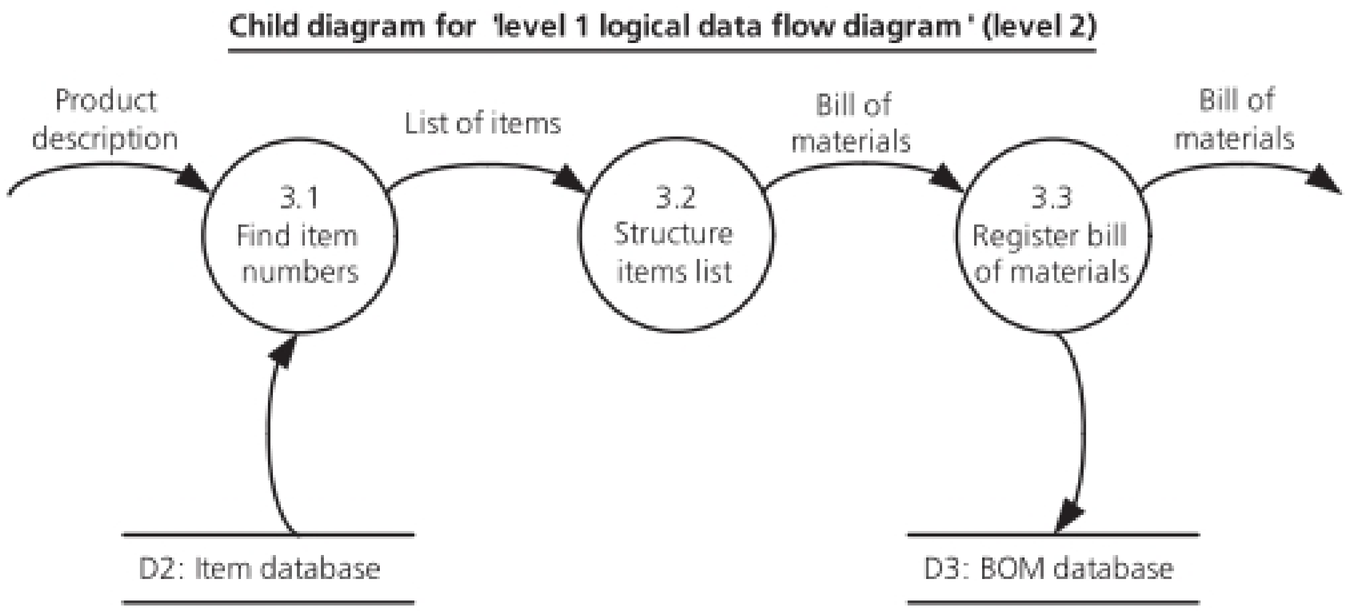


Figure 3.6: Child DFD

Figure 3.7 shows the physical DFD corresponding to the logical DFD in Figure 3.5. First an order form from the customer is received. Then a sales assistant registers these data in the order database and an internal order document is passed on to a product designer. The product designer delivers a CAD file to a product engineer who retrieves data from the stock module of the ERP system, registers data in the project module of the ERP system, and delivers a BOM document to the manufacturing department.

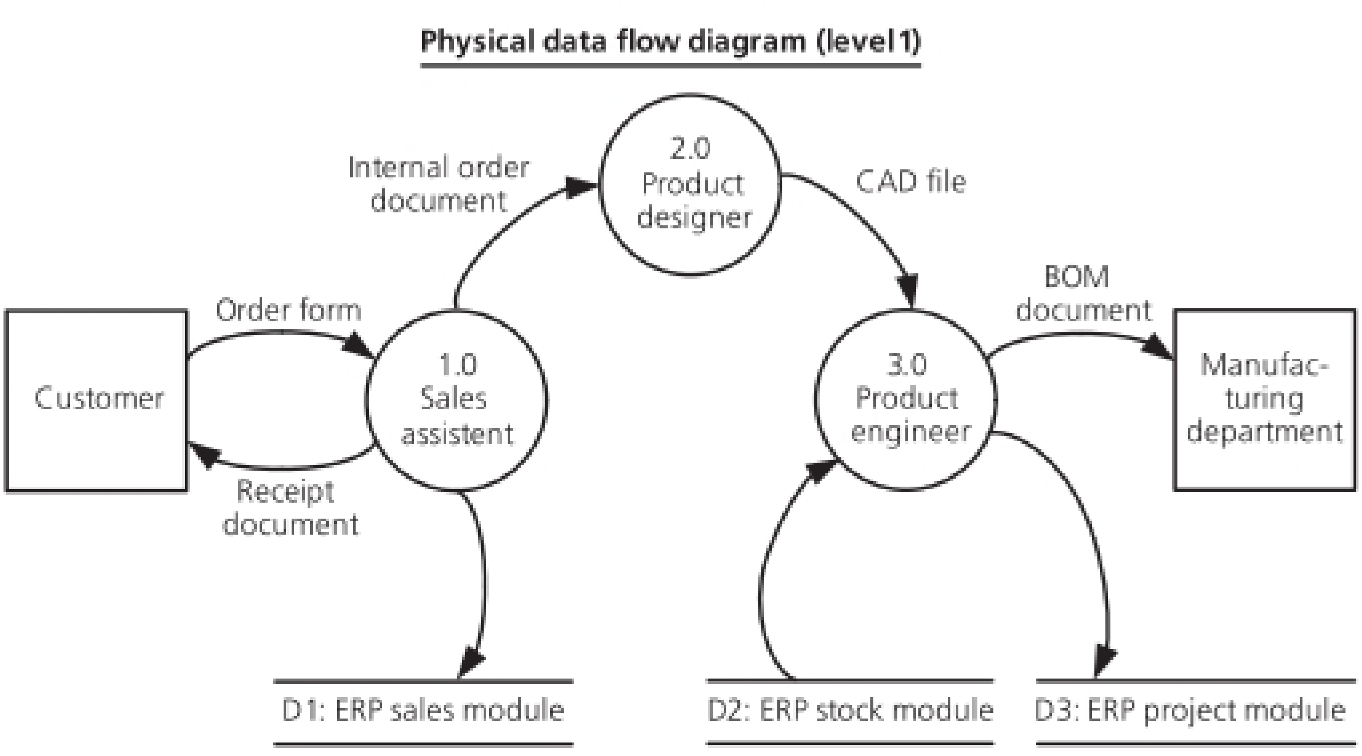


Figure 3.7: Physical DFD

Because of the simple symbols of DFDs, they can be created in most vector-based drawing programs, e.g. Visio. Furthermore, much software includes the DFD symbols, e.g. MS Visio and SmartDraw.

ISO Data Flowcharts

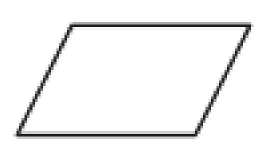
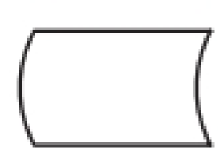
Another commonly used technique for modeling business processes are data flowcharts. Data flowcharts are typically used to describe a process by showing the steps as boxes of various kinds, and their order by connecting these with arrows. This can produce a step-by-step solution to a given problem. Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields.

One of the most widespread notations for data flowcharts is defined by ISO (International Organization for Standardization). The ISO 5807-1985 standard defines a set of symbols for the creation of:

- Data flowcharts
- Program flowcharts
- System flowcharts
- Program network charts
- System resource charts

ISO defines data flowcharts as diagrams for describing the path of data, processing steps, and the various data media used. Program flowcharts are defined as describing the sequence of operations in a program. System flowcharts are defined as describing the data flow of a system. Program network charts are for describing the path of program activations and interaction with related data. System resource charts are for describing data configuration and processes that can be used for solving the problems in focus. In this book, only data flowcharts are in focus.

Some of the most common symbols included in the ISO definition for representing various forms of data are shown in Table 3.2.

Name	Description	Symbol
Data	Data in an unspecified medium, e.g. used to represent an information handover	
Stored data	Data storage in an unspecified medium	

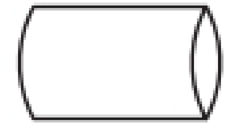
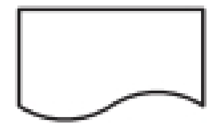
Direct access storage	Data directly accessible, e.g. a hard disk drive	
Document	Human readable data, data represented in a physical or electronic format	
Manual input	Data in a medium where data is entered manually during processing, e.g. a keyboard	

Table 3.2: ISO Data Symbols

Some of the most common symbols included in the ISO definition for illustrating different types of process are shown in Table 3.3.

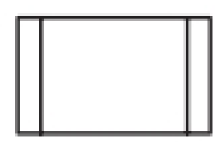
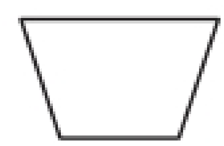
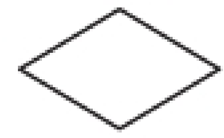
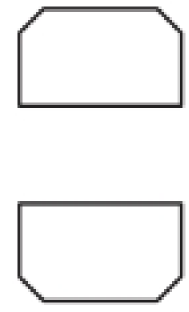
Name	**Description**	**Symbol**
Process	Any kind of process	
Predefined process	A named process, which is described elsewhere	
Manual operation	A process performed by a human	
Decision	A decision between a set of alternatives, where the one chosen determines the path	
Parallel mode	An indicator which says that processes behind this needs to be completed before the next process can be initiated	
Loop limit	A set of symbols on each side of a process, where one describes the loop name and the other the termination condition.	

Table 3.3: ISO Process Symbols

The most common line symbols included in the ISO definition are shown in Table 3.4.

Name	Description	Symbol
Line	A flow of data or control	
Communication link	A data transfer by telecommunication	
Dashed line	An alternative relationship between two symbols	

Table 3.4: ISO Line Symbols

Some of the most common special symbols included in the ISO definition are shown in Table 3.5.

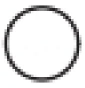
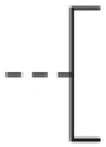
Name	Description	Symbol
Connector	An exit to (or entry from) another part of the same flowchart which has a connector of the same ID.	
Terminator	An exit to (or an entry from) the external environment	
Annotation	A symbol for adding comments or additional information	

Table 3.5: ISO Special Symbols

In Figure 3.8 is an example that illustrates the use of some of the ISO symbols. In the example, first a customer order (delivered by post or e-mail) is registered and a department to handle the order is selected. Then the order is stored in the order database and data (in an unspecified medium) is provided to perform the process of analyzing the order. This analysis can either lead to an order being produced or not. If the order is to be produced, the order is updated and then stored in the order database and is the basis for creating a bill of materials. As the parallel mode symbol shows, both the storing of the order in the order database and the creation of the bill of materials need to be completed before production can be initiated. Notice that the 'order rejection process' and the 'create bill of materials' process, are represented as processes described elsewhere, i.e. the 'pre-defined process' symbol. Thus diagrams can be connected both horizontally (as an extension of each other) and vertically (as levels of different detail).

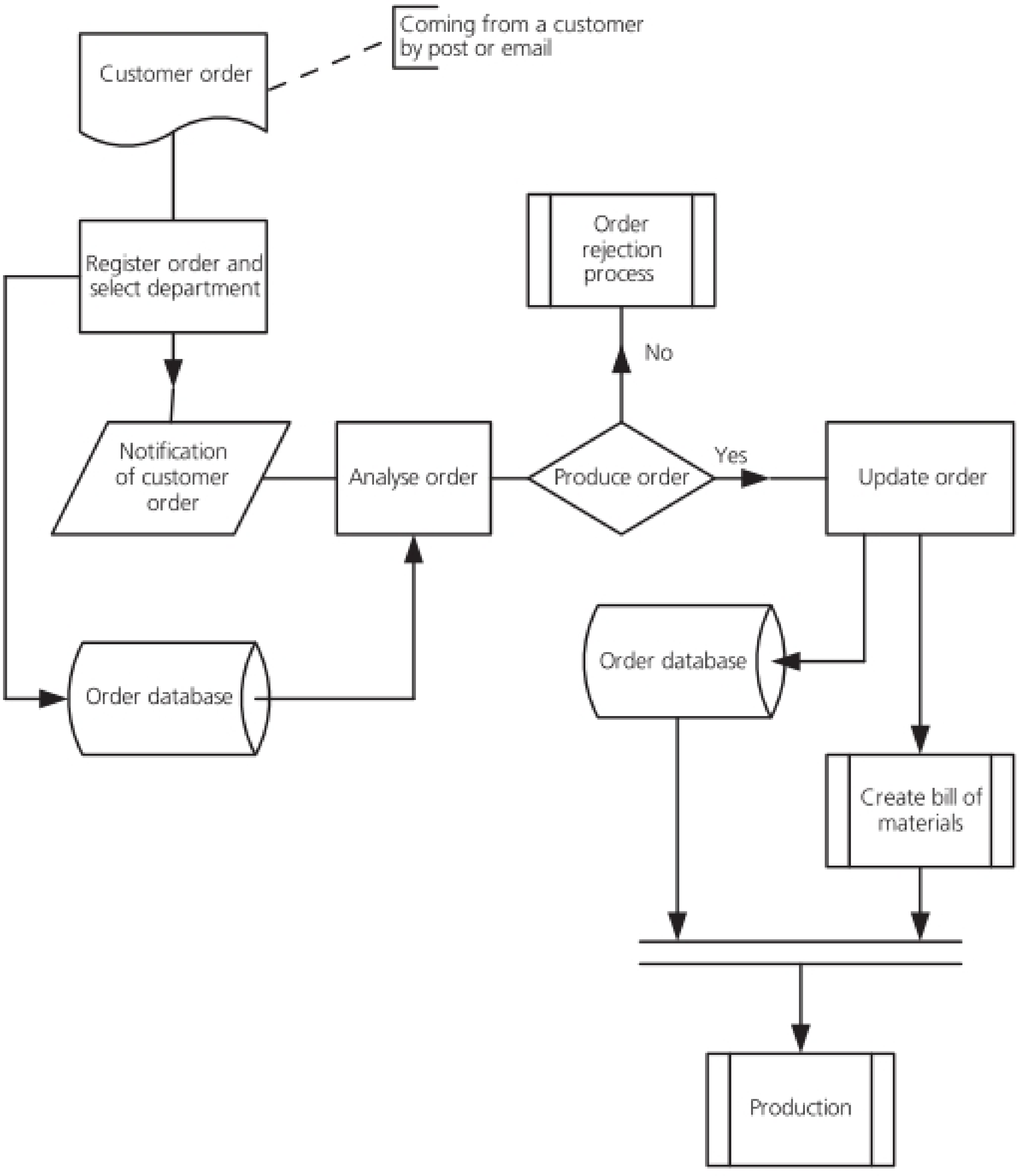


Figure 3.8: Example of a Data Flowchart using the ISO Definition

Data Flowcharts can be created in any vector-based drawing program. Also, some tools offer special support for flowchart drawing, e.g. MS Visio and OmniGraffle.

The ISO definition includes a relatively extensive range of symbols, of which many represent obsolete technologies. Thus, this chapter moves on to describe a more up-to-date process diagramming language, namely the Business Process Modeling Notation. For descriptions of the other four types of flowcharts, more ISO symbols and more examples, see the ISO 5807-1985 standard.

Business Process Modeling Notation

For the modeling of business processes, many consider the Business Process Modeling Notation (BPMN) to be state of the art. The BPMN originates from the Business Process Management Initiative (BMPI) and Object Management Group (OMG). OMG/BPMI provides a wide range of languages for various purposes. In the context of this book, the BPMN is the most relevant. The BPMN is a graphical flowchart language aimed at business analysts and developers for the representation of business processes to build business process diagrams. BPMN is mapped to an execution language of BPM Systems, named BPEL4WS. BPEL4WS is an XML-based language for the execution of business processes, i.e. the creation of software applications. However, in this book, the focus is only on the BPMN.

The BPMN 1.0 specification was released in May 2004 with the primary goal of providing a notation which is readily understandable by all business users; all the way from business analysts who create initial drafts of processes to the technical developers who implement technology that performs these processes. The BPMN is a direct descendent of the Rummler-Brache diagram (also known as the swim-lane diagram) (Rummler and Brache, 1995). However, compared to the Rummler-Brache diagram, the BPMN is a much richer and more formalized language. The BPMN is used for modeling business processes of any kind. However, it should be noted that the BPMN does not include symbols for differentiating between physical and data/information flows which therefore need to be stated by text.

Diagrams created using the BPMN are named business process diagrams. There are four basic categories of elements in BPDs:

- Flow Objects (events, activities and gateways)
- Connecting Objects (flows and associations)
- Swim lanes (pools and lanes)
- Artifacts (data objects, groups and annotations)

In the following sections, the basic elements of BPMN are described based on the BPMN 1.2 Specification. Subsequently, a set of examples of the use of these elements are provided. In order to fully understand the BPMN, it may be necessary to move back and forth between the element descriptions and the examples.

BPD Elements

Flow objects come in three basic types, as shown in Table 3.6. It should be noted that a wide range of special events and gateway types exist which are not resumed in this book.

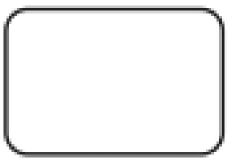
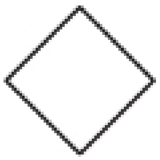
Flow object type	Description	Symbol
Events	Events come in three basic forms, start intermediate and end. A start-event indicates where a particular process starts, while an end-event indicates where the process ends. An intermediate-event occurs between a start-event and an end-event and is used to respond to a trigger in order to trigger another element.	
Activities	An activity is a step in a process that performs work. There are three types of activities: process, sub-process and task. A task is an atomic activity (i.e. cannot be broken down into smaller parts). Processes and sub-processes are non-atomic entities (i.e. they can be divided into smaller parts).	
Gateways	A gateway can be used for splitting and joining flows. Typically gateways are used for if-then-else decisions, while only in special situations there is a need for using it for joining.	

Table 3.6: Flow Objects

Connecting objects come in three basic types, as shown in Table 3.7.

Connecting objects type	Description	Symbol
Sequence Flow	Sequence flows define the sequence of the activities to be performed in a process.	
Message Flow	Message flows show the flows of messages between two participants. A message flow connects two separate pools or objects within the separate pools, but never two objects within the same pool.	
Association	Associations associate data, text, and other artifacts with flow objects. Associations show the inputs and outputs of activities. The arrow head can be used to show sequences of association.	

Table 3.7: Connecting Objects (1)

Besides basic sequence flow there are two other variants, as shown in Table 3.8.

Sequence flow type	Description	Symbol
Conditional	A conditional sequence flow has a condition that determines whether or not the flow will be used	
Default	A default sequence flow is only activated if all outgoing conditional flows are not true.	

Table 3.8: Connecting Objects (2)

There are two types of swim-lane objects, as shown in Table 3.9.

Swim lane type	Description	Symbol
Pool	The pool symbol is used to represent a participant in a process. Thus, it can partition a set of activities from others, e.g. activities in different companies. Different pools can be connected by message flows.	
Lane	A lane is used for sub-partitions within a pool. Lanes can divide activities, e.g. according to executing department.	

Table 3.9: Connecting Objects (3)

BPMN includes three types of artefacts, as shown in Table 3.10.

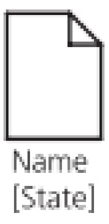
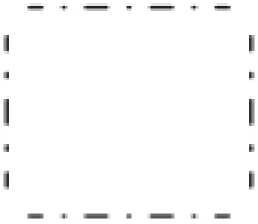
Artifact	Description	Symbol
Data object	Data objects show the way in which data are required or produced by activities. Associations connect data objects to activities and flows. A data object can have a state which can change during a process.	
Group	Groups are used for documentation or analysis purposes, and they do not affect sequence flows.	
Annotation	Annotations are used for providing additional text information to the reader of a BPD.	

Table 3.10: Connecting Objects (4)

There are two ways of creating loops in BPMN, as shown in Table 3.11.

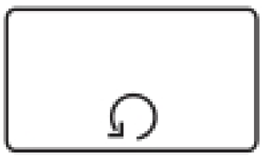
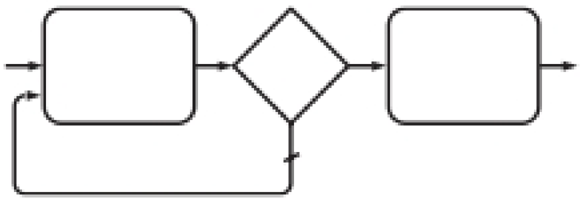
Loop	Description	Symbol
Activity looping	The loop is repeated as many times as indicated in the attributes of the task or sub-processes it is placed in.	
Sequence looping	Loops can be made by the use of gateways which connect to an upstream object by a sequence flow.	

Table 3.11: Looping

BPMN Examples

A basic BPD includes a start event, a set of activities and an end event which are connected by sequence flows. An example of a basic BPD is shown in Figure 3.9. As seen, the process starts with a 'start event' followed by the activity of gathering customer requirements. Then the dimensions (of some product) are defined and the product specifications are passed on. The process is terminated by an 'end event'.

Figure 3.9: Basic BPD

Figure 3.10 shows an example that illustrates the basic use of gateways. As seen, first a quote is received after which a gateway is used to illustrate that it has to be evaluated if the price in the quote is fair. If the price is not fair, the offer is rejected and the process ends. If the price is fair, the quote is accepted, and it needs to be decided which product type it is. If it is a type A product, department A needs to be informed and if it is a type B product, department B needs to be informed.

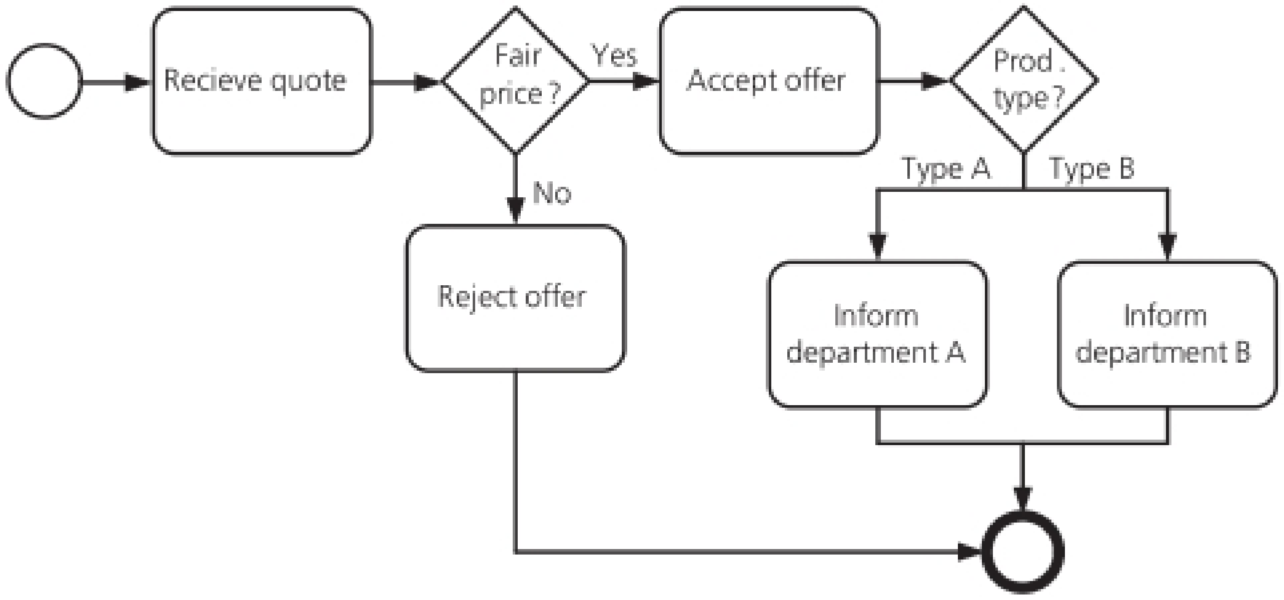


Figure 3.10: Gateways

Figure 3.11 gives an example of the use of the elements association, data object and data object state. As seen, the process starts with the activity of gathering customer requirements. Then the product is defined and a product specification with the status created (using the data object symbol) is passed on to the next process. In the last process, the product specification is passed on for which reason the product specification gets the status 'passed on'.

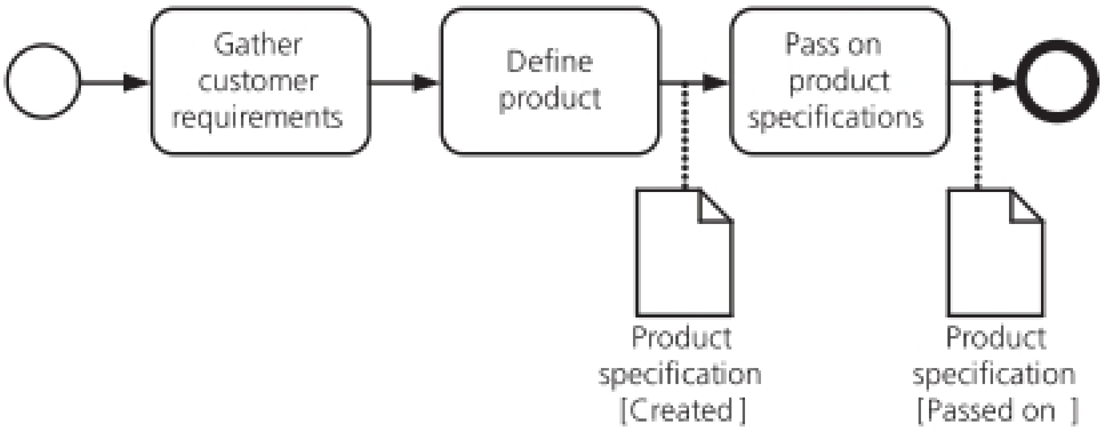


Figure 3.11: Association and Data Objects

Figure 3.12 illustrates the use of message flows, swim lanes and pools. In the figure, there are two pools, i.e. 'Company' and 'Customer'. The pool 'Company' includes the two swim lanes 'Manufacturing' and 'Product design'. In the 'Product design' lane in the 'Company' pool, customer requirements are gathered, the product is defined, and the product specifications are passed on to the manufacturing department. It should be noted that an alternative way of using the data object and association is used compared to Figure 3.11. In the 'Manufacturing' lane of the 'Company' pool, the product specification is received and the product is delivered. Then the process of the company ends. In the 'Customer' pool, requirements are provided and the product later received after which the process of the customer ends. As seen, there are three message flows between the two pools. Message flows can connect to a pool boundary or to flow objects within the pool boundary, but, as mentioned, cannot connect two objects within the same pool. Message flows can include text, as exemplified on the message flow 'Your product is delivered'.

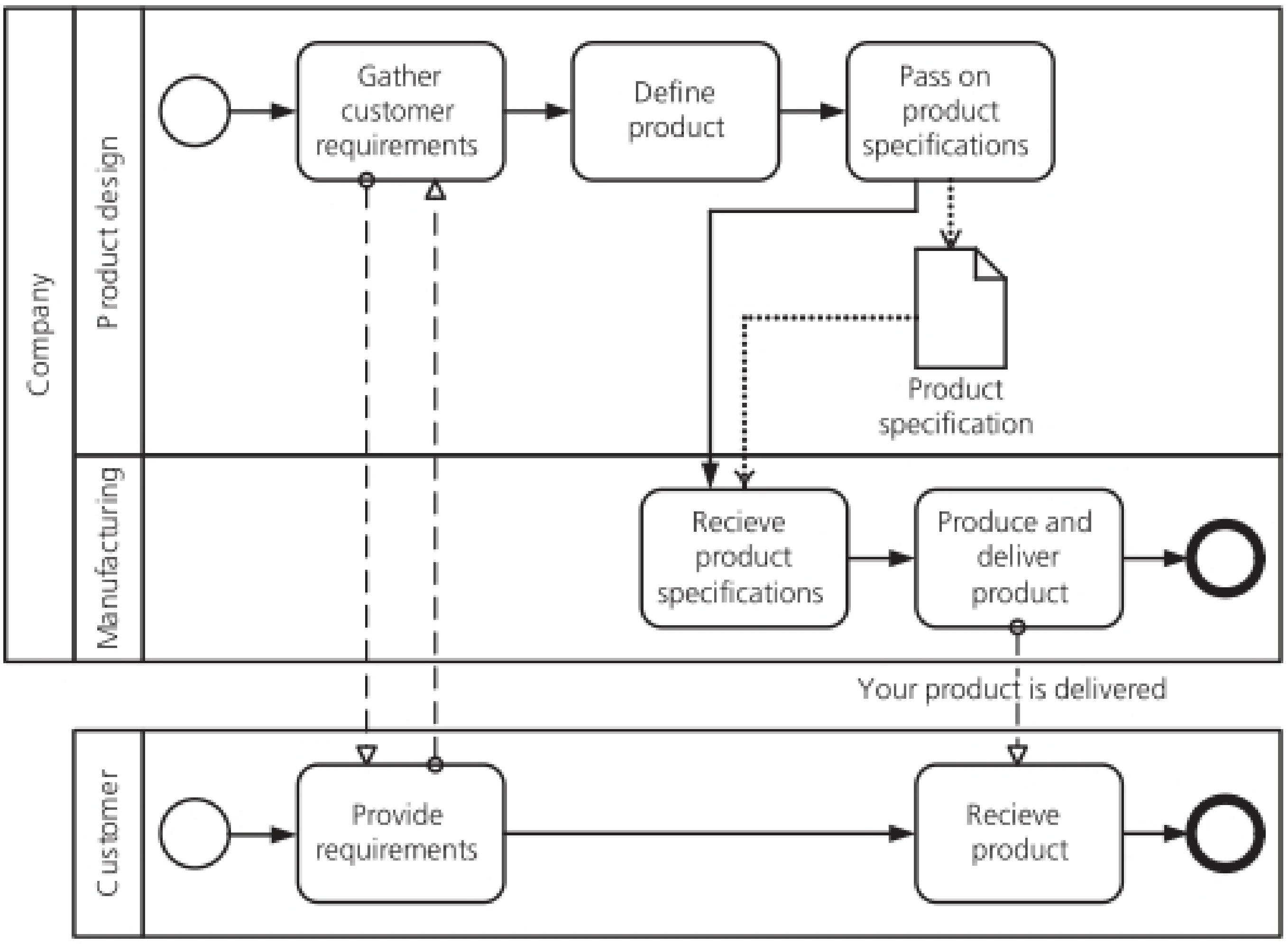


Figure 3.12: Swim Lanes

Figure 3.13 illustrates the use of conditional flows and default flows. The use of default sequence flows allows information to be shown about what the typical path is. As seen, the process starts with money being at hand. This leads to the activity of deciding where to place the money. The default action is to place the money in a bank account. However, it is also an option to take in shares and to take in bonds.

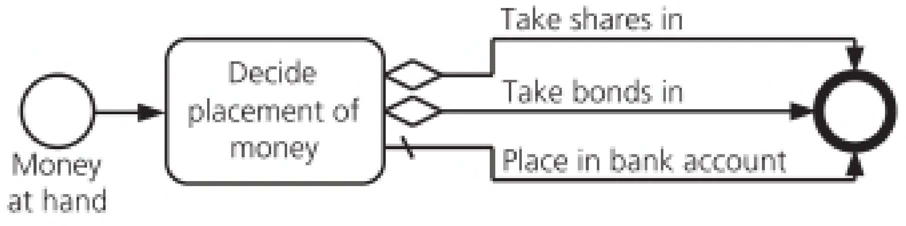


Figure 3.13: Conditional and Default Flow

Figure 3.14 illustrates the use of sub-processes and loops. The process starts with a new product being created. Then a decision whether there is a need for a campaign has to be taken. The default action is to do so, but it can also be decided not to. If a campaign is initiated, the two activities in the sub-process are to be repeated until there are no more potential customers. As seen, it is stated that between sending product information and phoning the customer 5-10 days pass by.

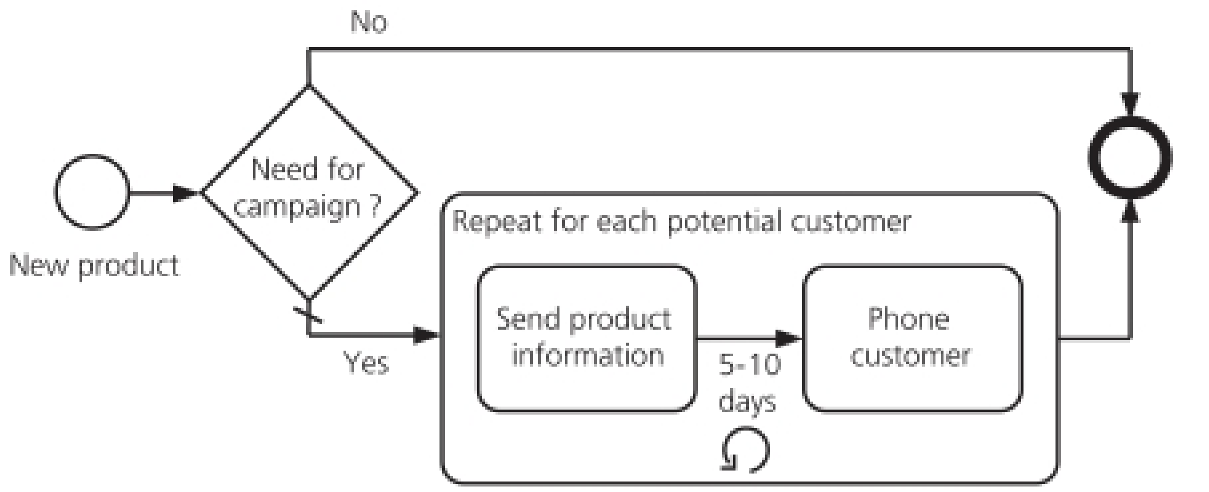


Figure 3.14: Sub Processes and Loops

Figure 3.15 illustrates the use of the group and annotation symbol. As mentioned, groups are only for documentation purposes, while annotations are merely for providing extra information. Thus, they do not affect the sequence flow. The process starts with a new product being specified. Next, the product has to be prepared for manufacturing and marketing materials must be created. As the group and annotation symbol say, these two activities can be started at the same time. After having manufactured the product and sent out marketing material, the process ends.

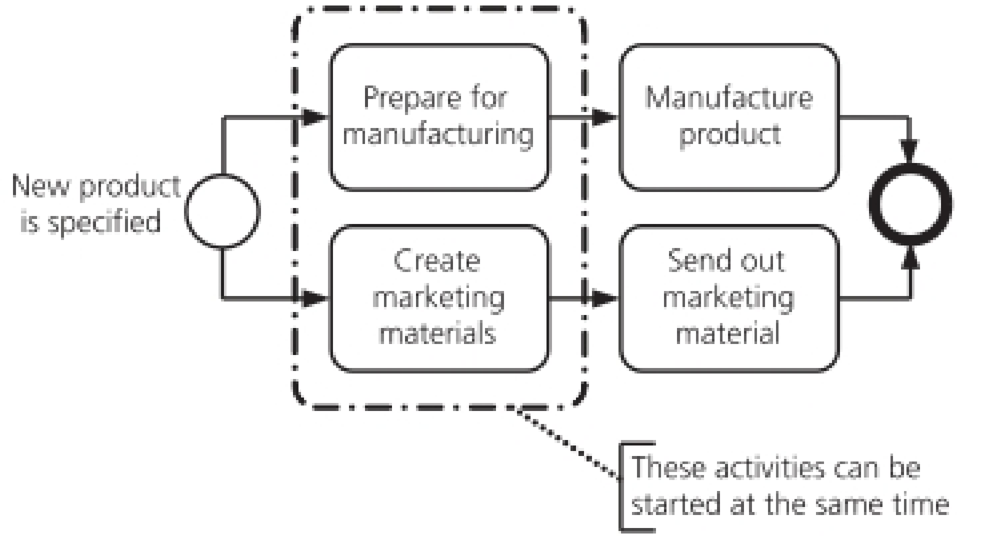


Figure 3.15: Group and Annotation

Finally, Figure 3.16 shows how the intermediate element can be used for differentiating between processes and events. As seen in the 'Customer' pool, after an order is made, the intermediate event of receiving a notification occurs before the customer process ends. In the 'Sales' lane of the 'Company' pool, the customer order is registered based on the message flow from the customer. Then a gateway shows a decision of it being classified as a standard product or not. If it is not a standard product, the product-design department uses 2-5 days to define the product. Then product data is registered and printed which lasts 30 minutes. Next, the manufacturing department receives a bill of materials which is shown as an intermediate event. Then the product is produced (5-10 days) and shipped to the customer. The message flow shows that this information is sent to the customer.

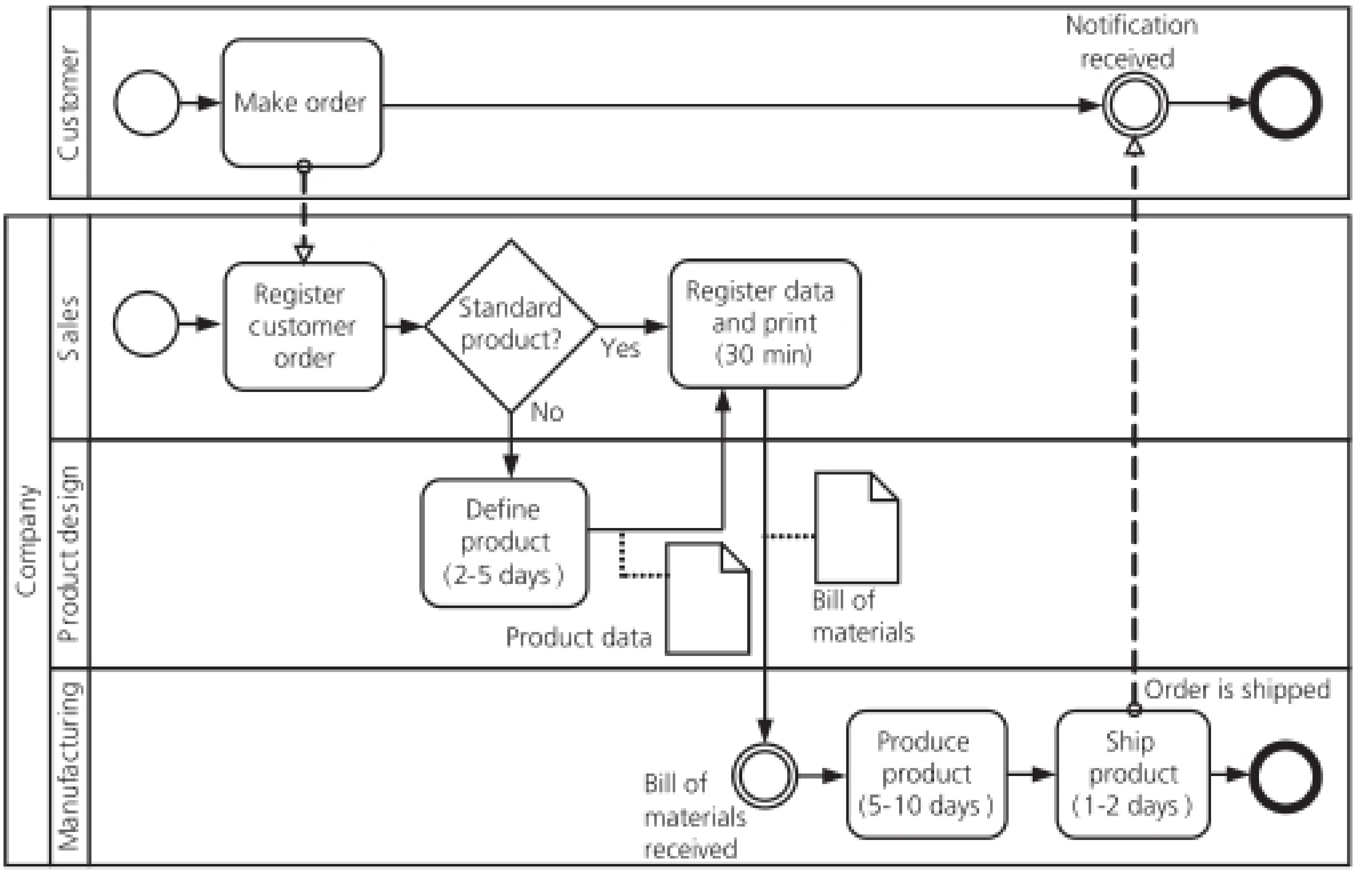


Figure 3.16: Intermediate Events

Additional model elements and further examples can be found in the BPMN 1.2 Specification which can be downloaded from: www.omg.org/spec/BPMN/1.2/. BPDs can be created in any vector-based drawing program. However, also a wide range of software offers special support for the BPMN, such as MS Visio (add-on), Borland Together, iGrafx FlowCharter and even freeware (e.g. BizAgi Process Modeler).

Recommendations

The BPMN notation is very extensive and in most cases, a minor subset of the elements of the BPMN would be adequate to map business processes in a satisfactory manner. Thus, it is recommended to use a minor subset of the BPMN when describing processes in diagrams to be shared across an organization of non-expert users.

As mentioned, the BPMN is a direct descendent of the Rummler-Brache diagram. In many cases, the Rummler-Brache way of mapping processes may be an adequate notation. The example in Figure 3.16 is shown in Figure 3.17 in the notation used by Rummler and Brache (1995).

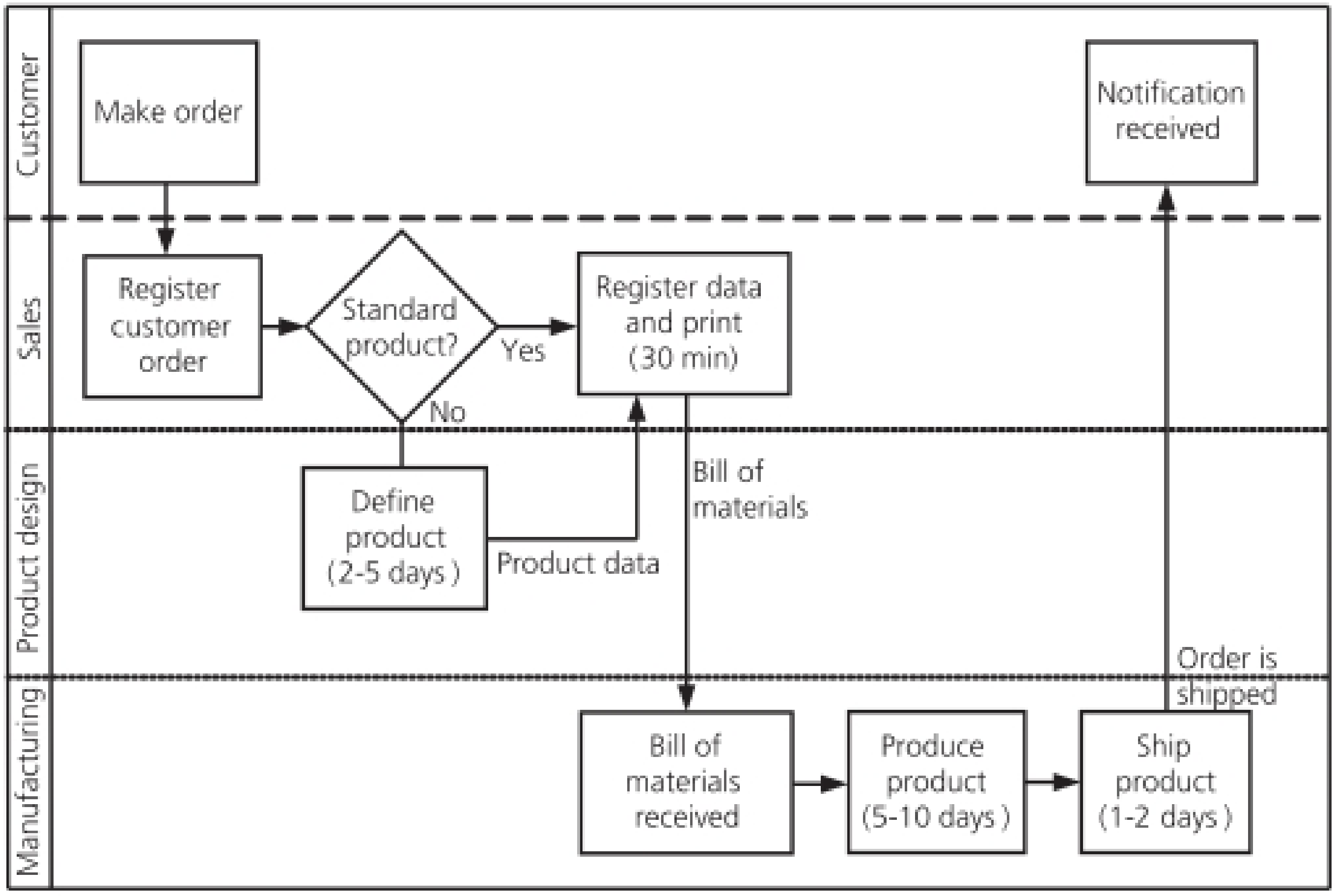
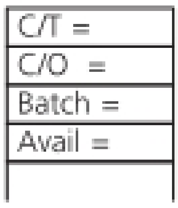
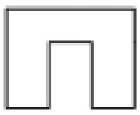
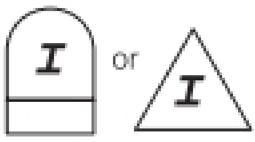
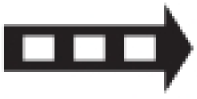
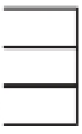
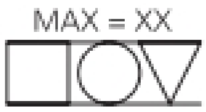


Figure 3.17: The Rummler-Brache Notation

Value Stream Mapping

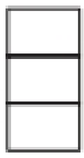
Value stream mapping (VSM) is an approach originating from Toyota. VSM is also known as 'material and information flow mapping'. The original aim of VSM was to uncover waste and reveal how to streamline a manufacturing process. However, although VSM is primarily associated with manufacturing, it is also applied in other contexts. There is not a single standard for VSM symbols for which reason they can be found in various definitions. Figure 3.12 shows the definition by Lee and Snyder (2006). The VSM notation includes symbols for various Lean concepts for which a more detailed explanation can be found in most Lean literature.

 Customer/Supplier	The ‘Customer/Supplier’ symbol represents a supplier or a customer. A supplier is usually placed in the upper left corner and is the usual starting point for a material flow. A customer is usually placed in the upper right and is usually the end point of a material flow.
 Dedicated Process	The ‘Dedicated Process’ symbol represents a process, operation, machine or department, through which material flows.
 Shared Process	The ‘Shared Process’ symbol represents a process operation, department or work centre, which is shared by other value stream families.
 Data Box	A ‘Data Box’ contains significant information required for analysis.
 Work cell	The ‘Work cell’ symbol is used for indicating that multiple processes are integrated in a manufacturing work cell.
 Inventory	The ‘Inventory’ symbols show inventory between two processes. It also represents storage for raw materials and finished goods.
 Shipment	The ‘Shipment’ symbol represents movement of raw materials.
 Push Arrow	The ‘Push Arrow’ symbol represents the ‘pushing’ of material from one process to the next.
 Supermarket	The ‘Supermarket’ symbol represents an inventory supermarket (kanban stock point).
 Material Pull	The ‘Material Pull’ symbol indicates physical removal and connects supermarkets to downstream processes.



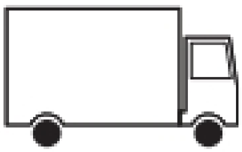
FIFO Lane

The 'FIFO Lane' symbol is used when processes are connected with a FIFO system that limits input.



Safety Stock

The 'Safety Stock' symbol represents a safety stock against problems such as downtime.



External Shipment

The 'External Shipment' symbol represents shipments from suppliers or to customers using external transport.

Production Control

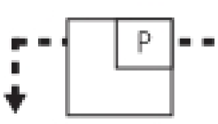
The 'Production Control' symbol represents a central production scheduling or control department, person or operation.

Manual Info

The 'Manual Info' symbol shows a flow of information in non-electronic form.

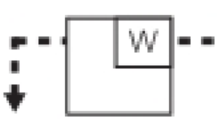
Electronic Info

The 'Electronic Info' symbol represents an electronic flow of data/ information.



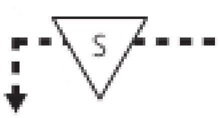
Production Kanban

The 'Production Kanban' symbol triggers the production of a predefined number of parts.



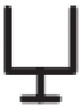
Withdrawal Kanban

The 'Withdrawal Kanban' symbol represents a card or device that instructs a material handler to transfer parts from a supermarket to the receiving process.



Signal Kanban

The 'Signal Kanban' is used when the on-hand inventory levels in the supermarket between two processes drops to a trigger or minimum point.



Kanban Post

The 'Kanban Post' symbol represents a location where Kanban signals reside for pickup.

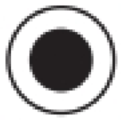
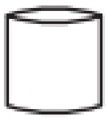
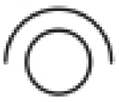
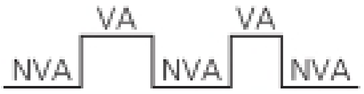
 Sequenced Pull	The 'Sequenced Pull' symbol represents a pull system that gives instruction to sub-assembly processes to produce a quantity of a product.
XOXO Load Leveling	The 'Load Leveling' symbol is a tool to batch Kanbans in order to level the production volume and mix over a period of time.
 MRP/ERP	The 'MRP/ERP' symbol represents scheduling using MRP/ERP or other centralized systems.
 Go See	The 'Go See' symbol illustrates gathering of information through visual means.
 Verbal Information	The 'Verbal Information' symbol represents verbal or personal information flow.
 Kaizen Burst	The 'Kaizen Burst' symbol highlights improvement needs and to plan Kaizen workshops at specific processes that are critical to achieving the future state of the value stream.
 Operator	The 'Operator' symbol represents an operator.
Other Information Other	The 'Other' symbol represents other potentially useful information.
 Timeline	The 'Timeline' symbol shows value-added times and non-value-added times. It is used to calculate lead time and total cycle time.

Table 3.12: VSM Symbols
Source: Lee and Snyder (2006)

An example of the use of the VSM notation is shown in Figure 3.18.

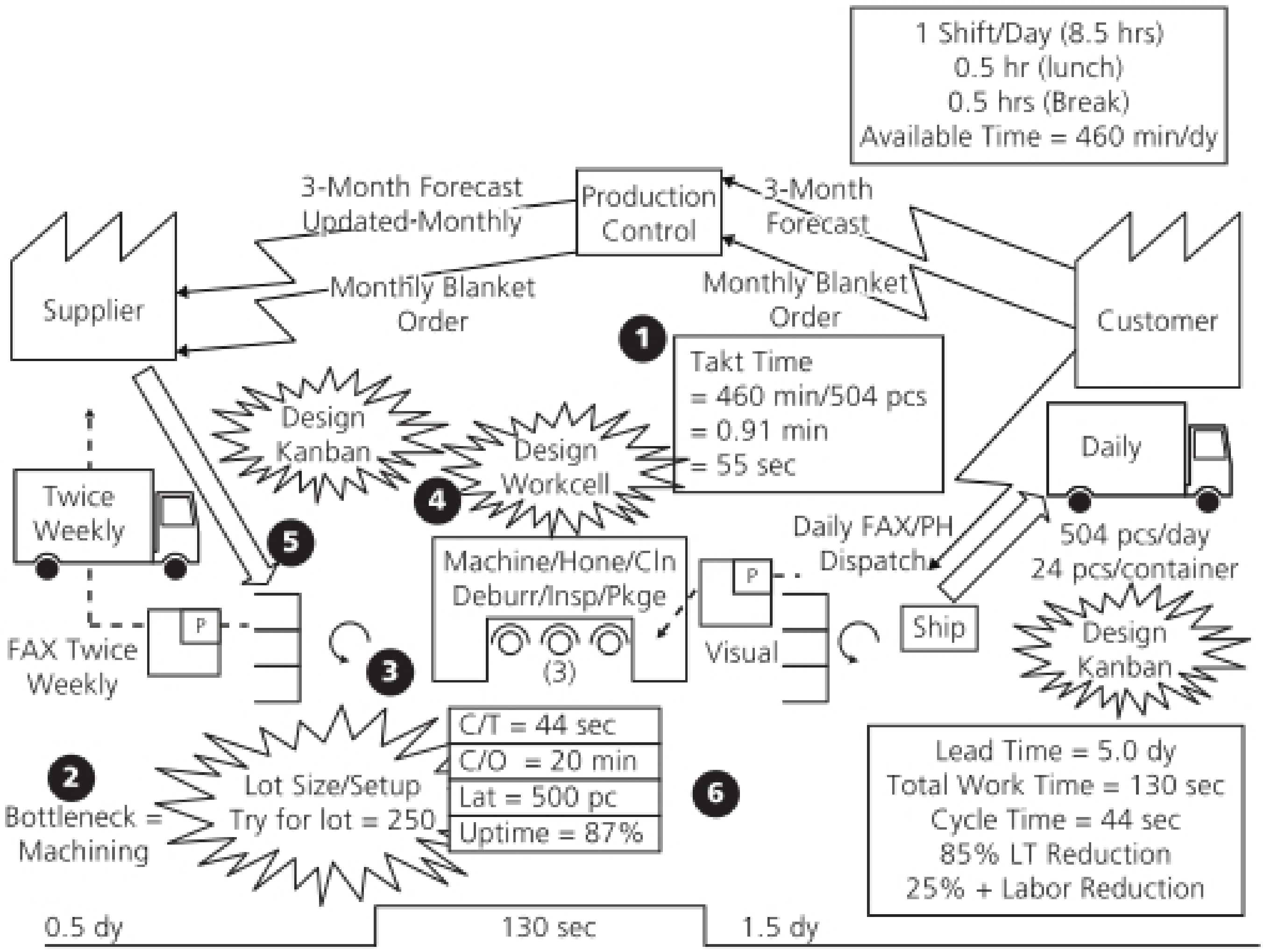


Figure 3.18: Example of the use of VSM
Source: Strategos (2009)

VSM diagrams are often drawn on paper as a part of a process analysis project. However, various types of software support the creation of VSM diagrams, e.g. iGrafx FlowCharter, ProPlanner, and Visio (add-on).

Which Diagram to use?

The choice of which diagram type to use depends on the particular context, such as user prerequisites, user preferences, process complexity, process type, etc. Therefore, it is not possible to give a general recommendation of a specific diagram. However, it is a good idea to limit the use of different diagram languages in order to avoid the confusion that multiple process languages can create.

Although the best choice of diagram type may be context-specific, there are some basic differences between the presented diagrams. Compared to DFDs, BPDs have the advantage that more information can be contained in a single diagram because of the use of pools and swim lanes. In many cases, this makes BPDs the better choice. Since pools and swim lanes can be used together with the ISO language, this approach is also a solid alternative. VSM is the least formal notation and thus the one that includes the greatest chance of language-related misunderstandings. Also, VSM is a less compact notation than BPDs and ISO flowcharts, and VSM is rarely included in standard drawing and diagramming software. On the other hand, in some cases, VSM may be easier to learn since some may find that it has more intuitively understood symbols and because it lets users invent their own symbols. However, for documentation of the business processes of a company for communication purposes, it is of major importance that the notation used is clearly defined and the diagrams are easy to read.

Discussion Questions

1. Describe the three basic types of DFDs.
2. How are DFD child diagrams numbered?
3. What are the four types of symbols of ISO flowchart diagrams?
4. Describe the four basic categories of elements in BPDs.
5. In BPDs, what are the difference between sequence flows and message flows?
6. In BPDs, what are the different ways of using data objects and the association relation?
7. What is a VSM diagram?
8. What are the dangers of letting users themselves invent symbols, rather than using predefined ones?
9. What are the advantages of being able to make compact diagrams?
10. In which situations do you think each diagram may be best suited?

CHAPTER 4

Business Data Management

Introduction

> We're entering a new world in which data may be more important than software. (Tim O'Reilly)

The data of the company is the area which most often needs attention in relation to business process analysis. In the business processes, data constitute the basis for most actions made. Thus, if the data used in the business processes are not of adequate quality the business processes will not be efficient. Before getting further into the discussion of data quality and approaches to ensure data quality, first the distinction between data, information and knowledge is discussed. Subsequently, the nature of business data, which is the focus of this book, is defined. Thirdly, the importance of data quality is demonstrated. To get an even more detailed understanding of the issue, the concept of data quality is unfolded in the subsequent section. Finally, the chapter explains how to evaluate data quality and how to ensure high data quality.

Data, Information and Knowledge

Data is the lowest level of abstraction from which information and knowledge are derived. Although there is general agreement on the meaning of data, different definitions are found, such as:

> [Data are] a set of discrete, objective facts about events. (Davenport and Prusak, 1998)

> Data represent observations or facts out of context, and therefore not directly meaningful. (Zack, 1999)

Often the terms 'data' and information are used interchangeably, but to be strict, there is a difference that relates to the meaning associated with information in contrast to data. As for data, there is general agreement on the meaning of the term 'information', but different formulations of its definitions, such as:

> [Information is] a message, usually in the form of a document or an audible or visible communication,
> Information is meant to change the way the receiver perceives something, to have an impact on his judgment or behavior. (Davenport and Prusak, 1998)

> Information is a flow of messages. (Nonaka and Takeuchi, 1995)

The transformation of data into information has been defined as:

> Information results from placing data within some meaningful context, often in the form of a message (Zack, 1999)

> [The transformation from data to information is when] data are presented in a particular way in relation to a particular context of action (Newell et al., 2002)

In contrast to the terms 'data' and 'information', the meaning of the term 'knowledge' has been much debated and still is. A popular definition of knowledge is provided by Davenport and Prusak:

> Knowledge is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. It originates and is applied in the minds of knowers. In organizations, it often becomes embedded not only in the documents or repositories but also in organizational routines, processes, practices, and norms. (Davenport and Prusak, 1998)

In management literature, many draw on Plato's definition of knowledge as "justified true beliefs" (Newell et al., 2002). For example, this is seen in Nonaka et al. (2001) who apply this traditional definition, but with an emphasis on the 'justified' rather than 'true' as they find the truthfulness aspect too absolute, static and non-human to address the dynamic, humanistic and relative dimensions of knowledge. Thus, they work with a definition of knowledge as a dynamic process of justifying personal belief towards the 'truth'. In the other end of the scale, the perspective on knowledge is found to be less externalized and related to personal action. Tsoukas and Vladimirou (2001) provide a definition with such a focus:

> Knowledge is the individual ability to draw distinctions within a collective domain of action, based on an appreciation of context or theory, or both.

Figure 4.1 illustrates the relationship between data, information and knowledge. As seen, when data are placed in a context and are given meaning they become information. The definition of knowledge used in the figure is something personal and related to action. The consequence of Figure 4.1 is that if the data of a company are of poor quality so will the information be, and in the end, the knowledge of a company. Especially in knowledge-intensive companies, this causality can be extremely unfortunate, and thus an extra focus on data quality is called for.

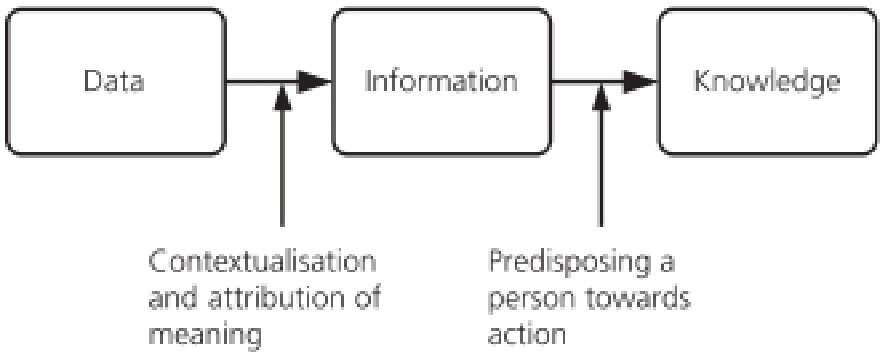


Figure 4.1: The Relationship between Data, Information, and Knowledge

Business Data

There are many types of data that are relevant in different contexts. In this chapter, the main focus is on 'business data'. The two most relevant types of business data are master data and transaction data. Master data are the basic characteristics of instances of business entities, such as customers, products and suppliers. Typically, master data are created once, used many times and do not change frequently. Master data is for example customer number, customer name, employee ID, supplier address, etc. Transaction data describe relevant events in a company, and each transaction record has a time dimension, a value and references to other data. These events may be: a purchase order arrives, monthly salary is paid to an employee, an invoice is sent to a customer, etc.

Business data can be seen on two abstraction levels, 'data models' and 'data values'. A data model is a definition of entities (classes), their attributes (properties), and relationships. An example of an entity is 'employee', which could hold the attributes 'ID', 'name', 'date of birth', 'address', etc. The employee could have a relationship to the entity 'ERP project', implying that the employee is involved in this project. The data value for the employee attribute 'ID' could be '01-77-98'.

Figure 4.2 shows an example of a data model. As seen, for each attribute, the type of data is indicated (e.g. character (char)) or it is indicated if it is a foreign key, i.e. an attribute that belongs to another entity. Also the relationships between entities are shown. In the current example, one customer can have one-to-many orders, each order can have one customer and one-to-many order lines, each order line has one order and one item, and each item is related to zero-to-many order lines.

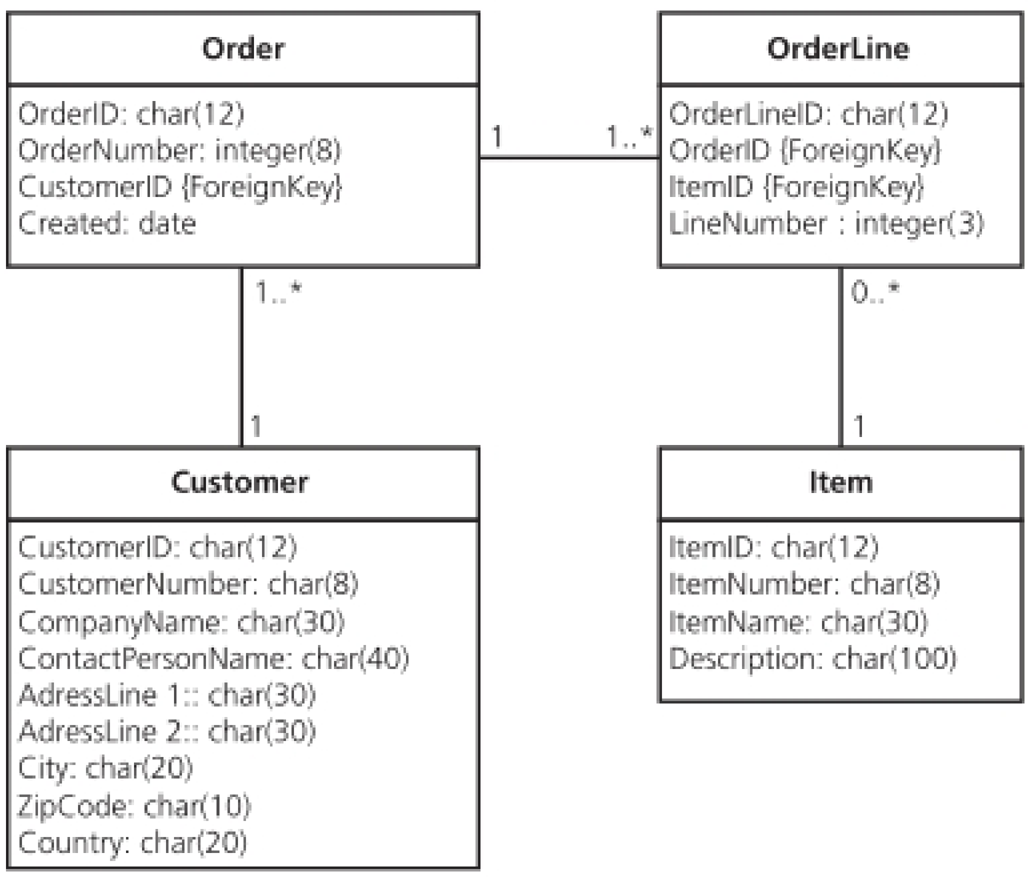


Figure 4.2: Example of a Data Model

When data values are stored, they become data records. Typically, records are stored in tables in a database. Figure 4.3 shows an example of a table for items. As seen, the table name is 'Item', and it has the columns 'ItemID', 'ItemNumber', 'ItemName', and 'Description'. Each time a new item is created, a new record is created with the relevant data.

Item			
ItemID	**ItemNumber**	**ItemName**	**Description**
A0000001	45	45mm Screw	
A0000002	46	50mm Screw	
A0000003	47	55mm Screw	
A0000004	48	56mm Screw	

Records

Figure 4.3: Example of Data Records in a Table

The data stored may be of a more debatable nature than the data of the example in Figure 4.3, i.e. item numbers and names. Data can for example also describe operation times, customer ratings and the like, which are data of a less exact nature. Although such data are based on observations of reality, they may still be more or less in correspondence with reality. Figure 4.4 illustrates this possible mismatch between the real world (RW) and what can be inferred from information system data. As seen, data are represented in an information system based on the user's perceptions of the real world. Such perceptions may differ, and different aspects may be found relevant and thus, included. When the data of an information system are interpreted, the user gets a view of the real world based on what the data say. But because of the different interpretations of the real world, the perspective on the real world inferred from the information system may not correspond to the specific user's view on the real world, and a mismatch occurs. Thus, when using such data, this should be done in a critical manner instead of blind faith in all data necessarily giving an accurate picture of reality.

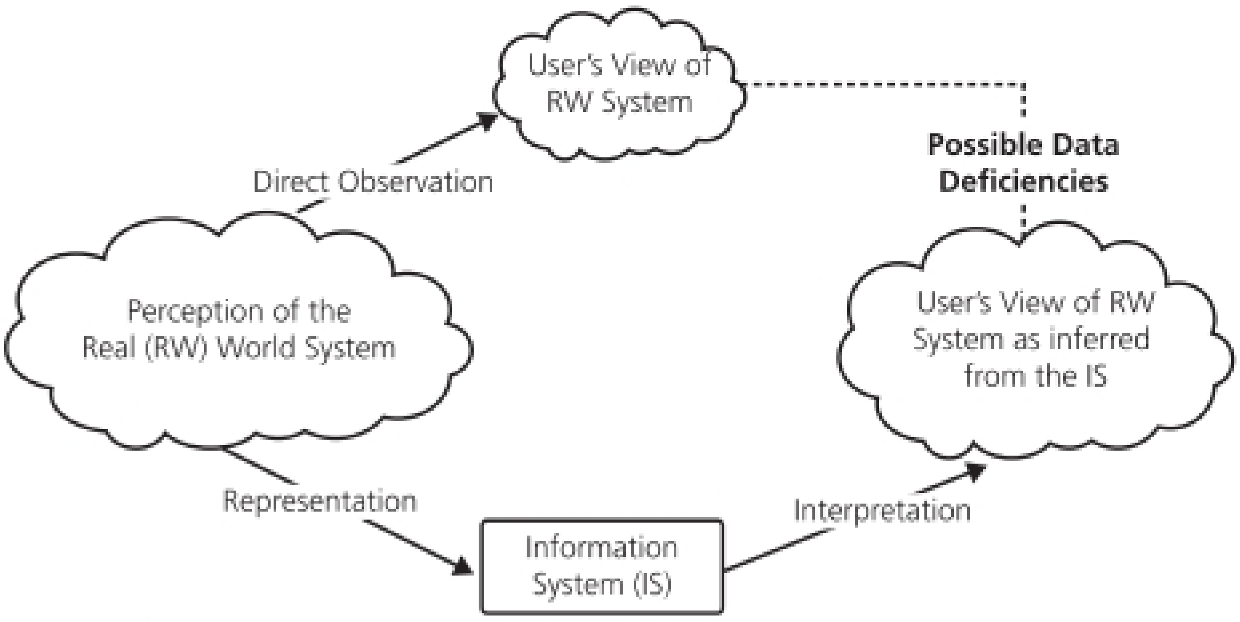


Figure 4.4: Possible Data Deficiencies
Source: Wand and Wang (1996)

The Importance of Data Quality

Data are created and used in all daily operations, data are critical inputs in relation to almost all decisions, and data implicitly define common terms in an enterprise. In other words, data are used at all levels of a company. IBM has made a model to illustrate this, the so-called 'business information maturity model'. The model defines five levels of data management, and it can be used for support of activities aimed at better use of company data. The model is shown in Figure 4.5. As seen, the focus of data at the lowest level is from an operational perspective. At the next level, the data/information is used to manage the company, i.e. play a greater strategic role. At the next level, the data/information become a strategic asset, i.e. something of value for the competiveness of the company. At the next level, the data/information enable innovation, i.e. a form of special expertise. Finally, at the top level, the data/information are what give the company a competitive advantage and therefore often need to be protected against external actors.

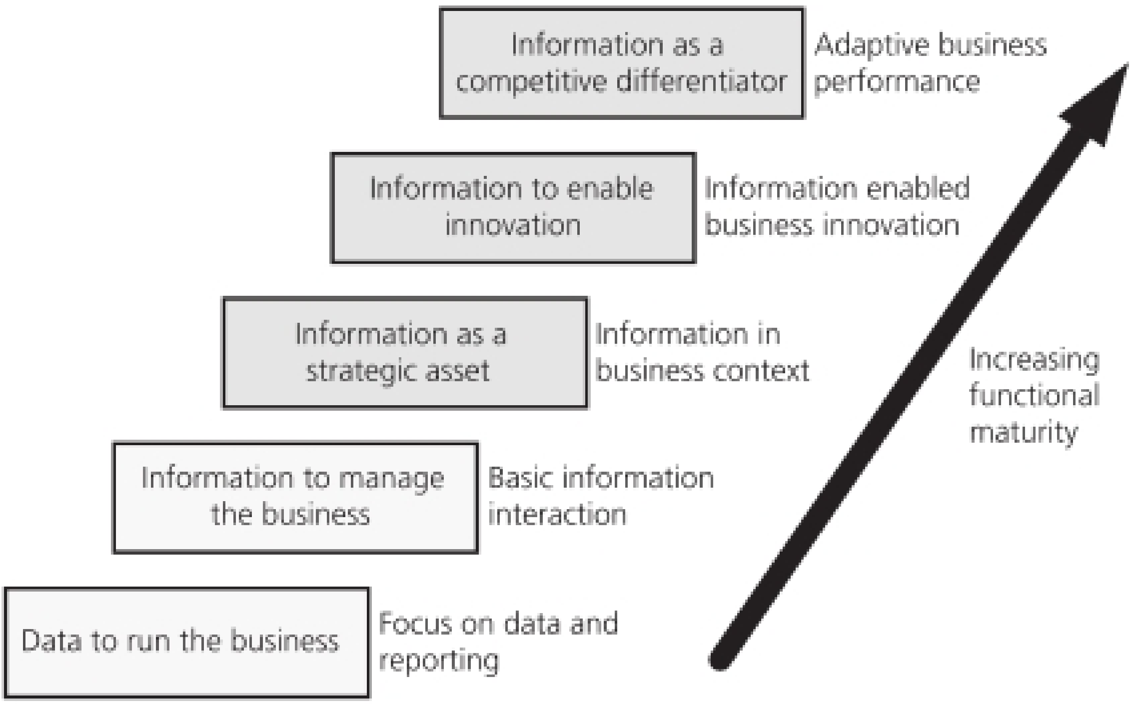


Figure 4.5: Data Maturity Levels
Source: Based on Vayghan et al. (2007)

Since data are used in almost all processes of a company, poor quality data (e.g. inaccurate or incorrect) obviously have a significantly negative impact on the performance of a company. There are multiple types of negative consequences of poor master data, such as (Redman, 1998; Kahn et al., 2002):

- Less customer satisfaction
- Increased running costs
- Inefficient decision-making processes
- Lower performance
- Reduced employee job satisfaction
- Resources spent on detecting and correcting errors.

Because of the extensive use of data in almost all processes, data constitute a significant contributor to the organization culture. Poor-quality data imply that it becomes impossible to build trust or confidence in the data which again implies a lack of user acceptance of any initiatives based on such data.

Industry experts like Gartner Group, Price Waterhouse Coopers and The Data Warehousing Institute have made surveys of data quality in companies. Based on this, they claim to identify a crisis in data quality management and reluctance among senior decision-makers to do enough about it (March, 2005). March (2005) summarizes the findings from such surveys as:

- "88% of all data integration projects either fail completely or significantly over-run their budgets"
- "75% of organizations have identified costs stemming from dirty data"
- "33% of organizations have delayed or cancelled new IT systems because of poor data"
- "$611bn per year is lost in the US in poorly targeted mailings and staff overheads alone"
- "According to Gartner, bad data is the number one cause of CRM system failure"
- "Less than 50% of companies claim to be very confident in the quality of their data"
- "Business intelligence (BI) projects often fail due to dirty data, so it is imperative that BI-based business decisions are based on clean data"
- "Only 15% of companies are very confident in the quality of external data supplied to them"
- "Customer data typically degenerates at 2% per month or 25% annually"
- "Organizations typically overestimate the quality of their data and underestimate the cost of errors"
- "Business processes, customer expectations, source systems and compliance rules are constantly changing. Data quality management systems must reflect this"
- "Vast amounts of time and money are spent on custom coding and traditional methods – usually firefighting to dampen an immediate crisis rather than dealing with the long-term problem".

Table 4.1: Findings from Surveys on Data Quality

Perspectives on Data Quality

Data quality refers to more than data being correct or not, but is to be seen from multiple perspectives. Generally, data quality can be divided into two main perspectives, namely intrinsic and extrinsic data qualities which are described in the following sections.

Intrinsic Data Quality

Intrinsic data quality refers to internal properties of the data. Intrinsic data quality can be divided into four dimensions (Wand and Wang, 1996):

- Completeness
- Unambiguousness
- Meaningfulness
- Correctness.

A *complete* dataset means that all relevant aspects of the real world are described in the relevant information system. Figure 4.6 illustrates the completeness dimension. To the left, all real world aspects are represented by at least one information system element, while to the right, a relevant real world aspect is not represented in the information system which therefore includes an incomplete representation.

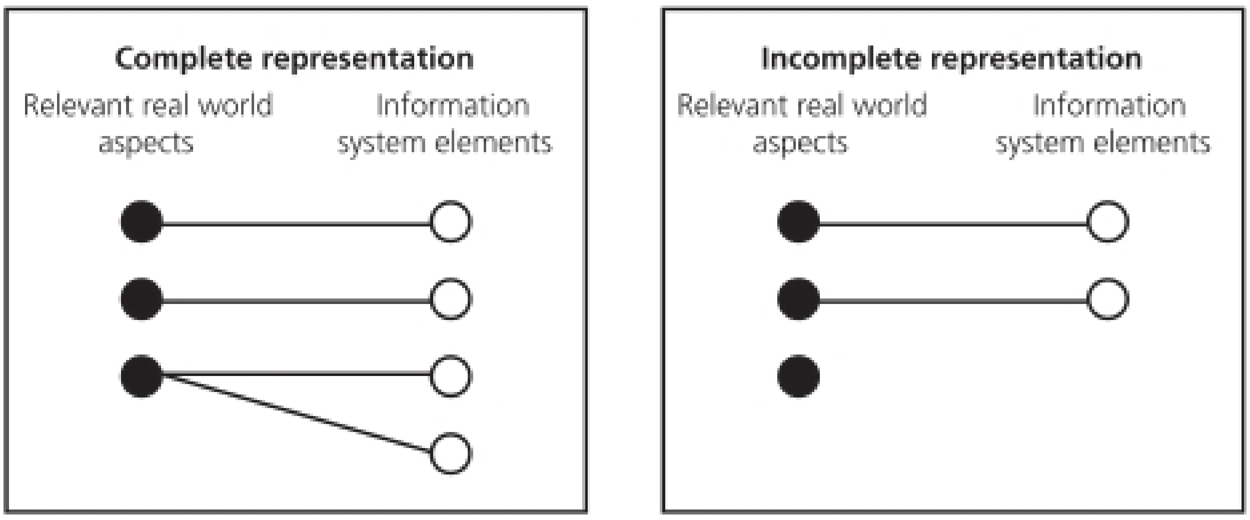


Figure 4.6: Data Completeness
Source: Based on Wang and Wand (1996)

An *unambiguous* dataset means that it is clear to what each element in an information system refers. Figure 4.7 illustrates the unambiguousness dimension. As seen in the illustration to the right, it is unclear to what the second information system element refers. This could for instance be one record that refers to two different items which among other things implies that it becomes impossible to see how many pieces of each item are sold.

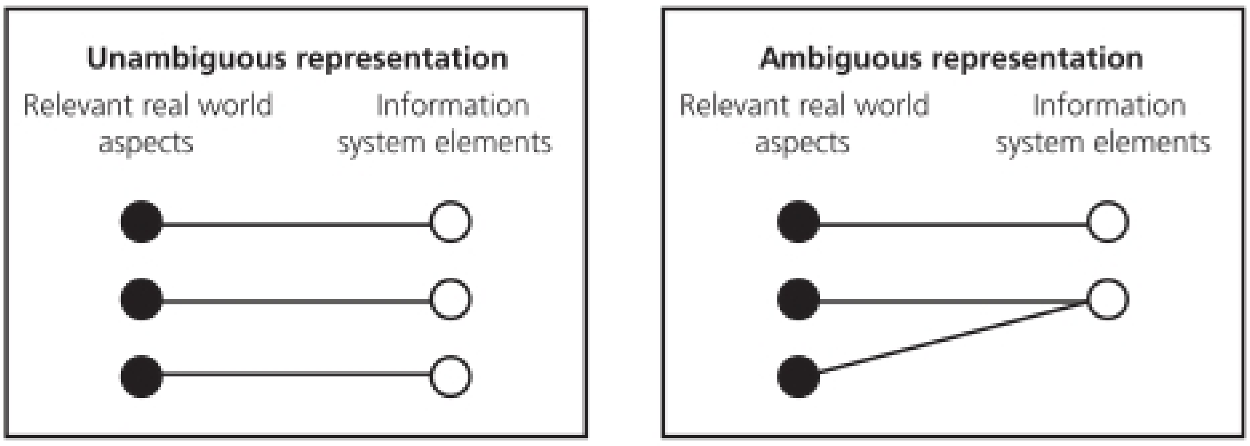


Figure 4.7: Data Unambiguousness
Source: Based on Wang and Wand (1996)

A *meaningful* dataset means that all elements represented in an information system have some information of value. Figure 4.8 illustrates the meaningfulness dimension. As seen in the illustration to the right, the third information system element does not refer to anything. This could for instance be a record of an item that does not exist and has been created by mistake, but not deleted.

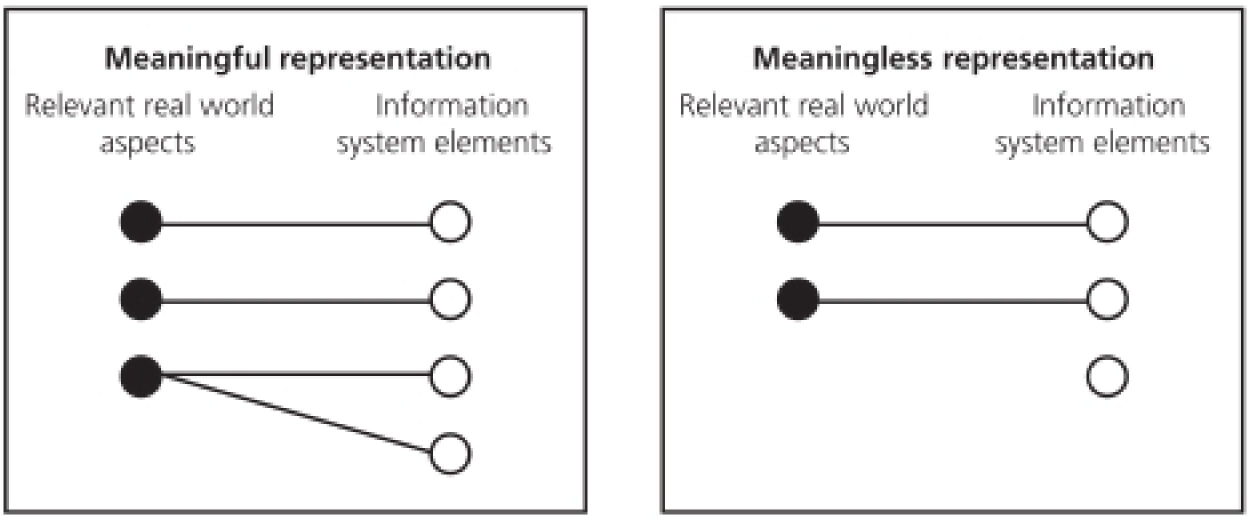


Figure 4.8: Data Meaningfulness
Source: Based on Wang and Wand (1996)

Finally, the *correctness* of data defines how well it is in accordance with the aspect of the real world that it is intended to describe. Some elements in the information systems are expected to be completely correct (e.g. item number, customer address and employee salary), while other information system data are merely estimates (e.g. operation times and customer rating), and thus some inaccuracy is accepted. Minor inaccuracies, such as misspelling in an item description, may not necessarily have consequences, but may have in some cases. The consequences of incorrect quality data vary depending on what it describes. Figure 4.9 illustrates the correctness dimension where the real world aspect 3 is not represented correctly in the information system.

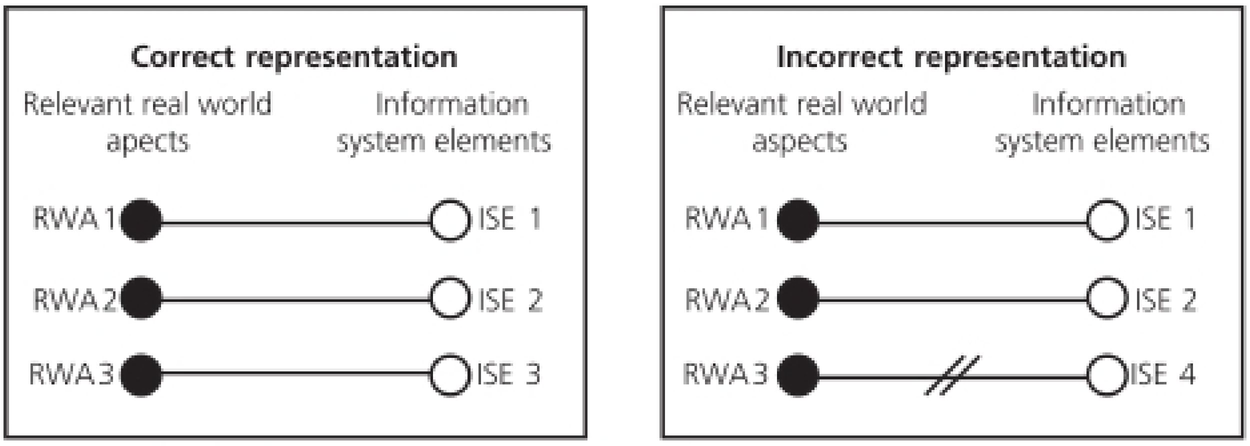


Figure 4.9: Data Correctness

Extrinsic Data Quality

Extrinsic data quality refers to contextual aspects of data. For example, just because some of the data are correct, it does not mean that they are useful in a particular context. Therefore, it makes good sense to view data quality from an extrinsic aspect besides the intrinsic aspect. There are many different definitions of extrinsic data quality. One suggestion is to divide the extrinsic qualities into two categories: accessibility and usefulness (Haug et al., 2009).

Data accessibility dimensions include access rights, storage issues, interpretability, understandability, etc. Therefore, although the relevant data exist,, the data cannot be utilized if the data cannot be accessed. Data usefulness dimensions include relevancy, value-adding, timeliness, level of detail, etc. Therefore, data usefulness dimensions relate to context, i.e. what may be useful in one context may not be useful in another.

Evaluation of Data Quality

Data quality can be evaluated in different dimensions. One alternative is to use the data quality dimensions: intrinsic, accessibility and usefulness (Haug et al., 2009). Typically, the first two data quality categories (intrinsic and accessibility) are easier to measure and/or observe than the third (usefulness), which to a higher degree is based on subjective beliefs. Even more importantly, generally, the first two categories are also more critical than the usefulness category. Poor data accessibility and intrinsic data quality are factors that make some of the daily operations impossible or imply costly errors. On the other hand, to a large extent, data of little usefulness can be ignored. Thus, a combination of intrinsic and accessibility data qualities provide a good basis for evaluation of some of the data of a company. Figure 4.10 shows this in matrix form. Here, it should be noted that since companies cannot expect to achieve perfect data quality, it is generally satisfactory that a small part of data is of poor quality with regard to intrinsic and accessibility dimensions. Thus, in square 1 both the intrinsic data quality and the data accessibility are unsatisfactory. In square 2, only the data accessibility is unsatisfactory, while in square 3 only the intrinsic data quality is unsatisfactory. Square 4 represents what should be the goal of any company, namely satisfactory intrinsic data quality and data accessibility.

Figure 4.10: Intrinsic and Accessibility Data Quality
Source: Haug et al. (2009)

Different levels of quality are perceived as satisfactory in different companies and data areas within companies. Also, some areas are easier to evaluate than others. Thus, it is not possible to generalize on what is a satisfactory level.

The intrinsic data quality can also be seen in relation to the usefulness of the data. In this case, there is a typical pattern of the relation between these two dimensions, which is shown in Figure 4.11. The argument for the exponential growth of the usefulness when the intrinsic data quality increases is that unless a big part of the data are of high intrinsic quality, users would often encounter problems caused by poor quality data and thus be reluctant to use such data. However, when the data quality reaches a certain level, the usefulness will rapidly increase. On the other hand, if the data quality drops from a high level in both dimensions, it would have to drop to a certain point before implying frequently encountered data quality problems. But when this happens, the users will soon begin to question the data validity (Haug et al., 2009).

Figure 4.11: Intrinsic Data Quality and Usefulness
Source: Haug et al. (2009)

When combining the data accessibility dimension with the usefulness dimension, three typical paths would often be encountered in relation to an increase of data accessibility (Haug et al., 2009). The three paths are illustrated in Figure 4.12 as 'a', 'b' and 'c'. Path 'a' may occur in a situation where it is decided to begin to register a new type of data, which, as it turns out, is not used for anything, after all. Thus, more non-useful data is found in the system, for which reason a bigger fraction of the data is not useful. Path 'b' may occur in a situation where new data are registered in a system or where existing data in some way are made accessible to users, while the increased amount of data does not make existing data more valuable and where the additional data hold a similar fraction of non-useful data. Path 'c' occurs when the usefulness of existing data increases because new data are made accessible. This may for instance occur in a situation where the existing sales data are not found useful for making sales statistics because they are incomplete. But when making the missing sales data accessible, the existing sales data become useful for making sales statistics.

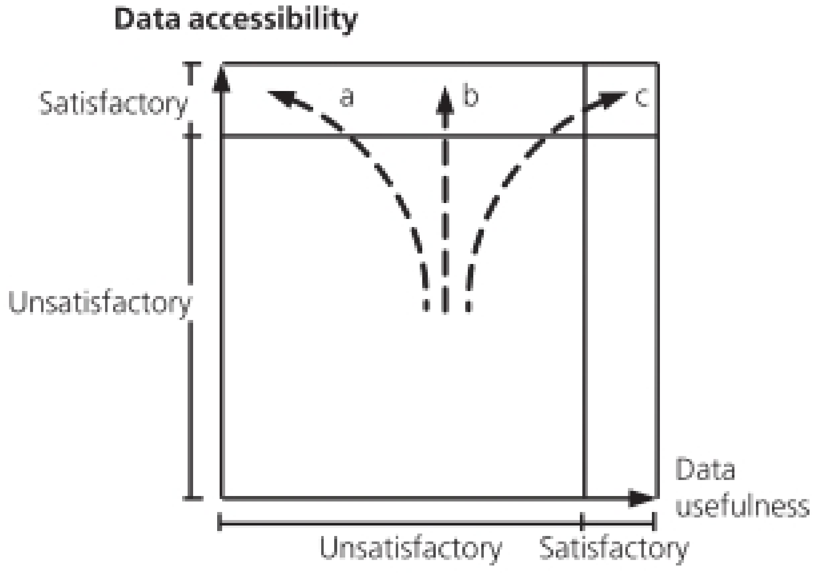


Figure 4.12: Data Accessibility and Usefulness
Source: Haug et al. (2009)

How to Ensure High Data Quality

Having demonstrated the great importance of having adequate data quality, the next question is how to achieve this? There are four basic approaches to improve and maintain high data quality:

- Error detection and correction
- Data strategies
- Data process improvement
- Data policies.

These four approaches may be combined which in fact, in many cases, is necessary in order to achieve the data quality goals. The four approaches will be described in the following sections.

Data Error Detection and Correction

An approach often applied to improve data quality is cleaning up existing data. There are different approaches to data error detection and correction (Redman, 1995). The simplest approach is to inspect all relevant data and make corrections if needed. However, this approach is time-consuming and therefore expensive. Another technique that can be applied if the same data are stored in multiple databases, is comparing databases. In all cases where the data are identical, it is assumed that these are correct, and in the cases where the data differ, the data are investigated and corrected. In many cases, this database comparison approach may not be applicable. Instead, a third approach can be applied, namely 'data editing'. Data editing implies computerized checking of data against constraints on the data. Such constraints can be:

- Single field: Checks that data are part of a particular domain, e.g. that item prices are defined or whether customer phone numbers contain letters.
- Multiple fields: Checks data across fields, e.g. that the same customer is not registered multiple times.
- Probability: Checks against unlikely data, e.g. that a quantity of more than 200 of a particular item on a particular stock location is unrealistic.

However, relying on data clean-up as a means of improving data quality is usually not the most useful approach, as the next subsection discusses.

Data Strategies

The problem of relying on data clean-up alone is that it can be a costly process and it often does not get to the root of the problem. Therefore, as an alternative to the continuous clean-up of data, three overall strategies for improving data quality can be defined (Redman, 1995):

1. Identify where the data problems are.
2. Treat data as an asset (both the data and the processes in which data are created and used).
3. Implement data quality systems (process management).

The advantages of these three strategies compared to data clean-up are illustrated in Table 4.2. As seen, although data clean-up in the short term produces better results, in the long run the three strategies are much more efficient. Furthermore, the costs associated with data clean-up are significantly higher than implementing the three strategies.

	Data Cleanup	Three Strategies
Improvement		
Short term	Medium (initiating such programs takes time)	Low
Long term	None (gains are lost as bad data replaces good)	High
Cost to Implement		
Short term	High	Low
Long term	High	Low

Table 4.2: Costs and Benefits of Database Clean-up Compared to the Three Strategies
Source: Redman (1995)

Data Process Improvement

A way of preventing data errors, rather than accepting to correct these continuously, is to analyze and redesign the processes in which the erroneous data are created. Such a data-oriented process redesign can be done in seven steps (Redman, 1995):

1. Define process management responsibilities
2. Define process and identify data customer requirements
3. Define and establish measures
4. Establish statistical control of data
5. Analyze the process in order to identify possible improvements
6. Rank improvement opportunities and define objectives
7. Improve process quality.

Besides process change, data policies can also be an important means of preventing data quality problems.

Data Policies

A data policy can be defined as a set of broad, high-level principles that form the guiding framework in which data management operates. In practice, the form of the data policy should depend on the characteristics of the company in which it is implemented. However, at a general level, a data policy can be defined in relation to three types of activities (Redman, 1995):

- **Data Creation**
  - Establish a clear understanding of which persons are using the data and for which purpose in order to ensure that their needs are fulfilled
  - Implement measures of data quality to ensure that the requirements of the users are fulfilled
  - Define process for control, assessment and possible improvement of data quality.
- **Data Storing/Processing**
  - Develop data architectures and databases that minimize data redundancy
  - Protect data against unwanted access
  - Ensure that data are readily accessible to relevant people
  - Ensure design of IT solutions that promote data quality.
- **Data Use**
  - Develop clear data requirements for data creators
  - Provide feedback to data creators
  - Ensure that data are interpreted correctly
  - Ensure that data are only used for legitimate purposes
  - Respect customers', suppliers' and employees' right to privacy.

Defining a data policy that addresses these issues would put a company on the right track to avoid extensive data problems.

A Danish manufacturer of printing equipment experienced great data quality problems in relation to the implementation of a new ERP system. They took their new ERP system into use after an approximately 9 months long implementation phase, but it took about 2½ years before the system was fully running in all areas and the project ended up costing more than twice as much as defined in the original budget. One of the major problems was too high ambitions for what to register in the system, i.e. down to 'screw-level'. This approach implied that it became very time-consuming to create new items and therefore, many employees took shortcuts resulting in poor-quality ERP data. The problems related to the fact that master data (such as item numbers and names) were sometimes registered multiple times, while at other times, all required fields were not filled out. This, for example, made it impossible to make useful statistics based on these data. Also, because of the tediousness of registering data, erroneous data occurred. To solve the data problems the company decided to:

- Use many resources on training employees in proper use of the ERP system
- Decide to leave out items at such a detailed level in the ERP system
- Initiate a data cleaning project.

These initiatives have significantly increased the data quality. Additionally, the company is considering allowing only centrally placed people to create item master data. However, the concern is that this may imply waiting times when creating purchases and sales orders.

Table 4.3: Master Data Quality Problems at a Danish Company
Source: Haug et al. (2009)

Discussion Questions

1. What is the difference between data, information and knowledge?
2. What is a data model?
3. Provide examples of data/information of different strategic importance.
4. What are the four defined types of intrinsic data quality?
5. Describe the three categories of data quality, defined by Haug et al. (2009).
6. Describe the relationships between these three categories of data quality.
7. What are the approaches for data error detection and correction?
8. Compare the consequences of data clean-up to the use of data strategies.
9. Which steps are included in data process improvement?
10. Which activities are relevant in relation to data policies?

CHAPTER 5

Performance Management

Introduction

> What counts can't always be measured. And what can be measured doesn't always count. (Albert Einstein)

"Difficult and boring – my favorite combination". According to Likierman (2009), this is not a rare comment from senior executives about the task of improving the company's performance measurement system. Many managers find it onerous and even threatening. As a consequence they leave it to people who may not be natural judges of performance, but are fluent in the language of spreadsheets. As Likierman (2009) addresses it, such a practice inevitably leads to a mass of numbers and comparisons providing little insight into the company's true performance. It may also lead to decisions that harm the company.

This introduction highlights why performance management and performance measurement are important in an organization. The topic area is very important in relation to business process optimization. In order to optimize. one must know where one came from. Otherwise, improvement efforts will be like shooting after a moving target. Thus, measures of a performance level before optimizations start by providing a base line for the optimization efforts. This makes it possible to track the improvements of future performances back to when they were initiated. However, like the opening quotation by Albert Einstein, performance measurement is perhaps not relevant in all areas. Typically, many companies have much data and many performance measures. Often, however, it is the wrong data and measurements, meaning 'what really counts is not measured'. On the other hand, we are also witnesses to measures of something that might not be measurable. It has been the practice, for example, in several Danish municipalities to measure care assistants' time consumption of elderly care. This might quite fast turn into a political discussion of whether it makes sense to measure such work. Thus, performance measurement has an element of inherent conflict by its nature. This chapter has set out to present performance management and performance measurement. In order to fulfill this purpose, the chapter is further organized into six main sections. In the following section, a distinction between performance management and performance measurement is made. Then follows a section that provides an overview of the need for performance measurement. In the subsequent section, three types of performance measurement are described. Then follows a section in which two performance measurement frameworks are discussed. Next follows a section that provides information about how to develop performance measures. The final section contains so-called deadly sins of performance measures.

Performance Management and Measures

Over the years, many contributions have been developed about what performance is and how it should be measured. In line with this, new terminologies have emerged that may create confusion about what performance actually is and what it is not. Performance is not only concerned with the past, but is also related to the future. According to Aguinis (2009, p. 2), performance management is a continuous process of identifying, measuring, and developing the performance of individuals and teams and aligning performance with the strategic goals of the organization. According to Lebas (1995), performance is about deploying and managing the components of the causal model(s) that lead(s) to the timely attainment of stated objectives within constraints specific to the form and to the situation. Lebas (1995) distinguishes between performance management and performance measurement (see Figure 5.1).

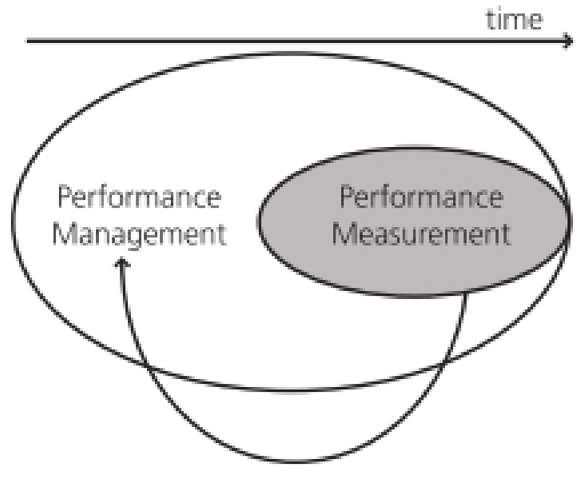


Figure 5.1: Performance Management vs. Performance Measures
Source: Lebas (1995)

Performance measures are closely related to performance management as shown in Figure 5.1. Performance management can be viewed as a philosophy that is supported by performance measurement. Performance management provides the foundation for the performance measures. The performance measures also influence the performance management indicated with the arrow in Figure 5.1

by providing data about the past and current situation. Table 5.1 lists characteristics of both performance management and performance measures.

Performance Management	Performance Measures
Training	
Team work	
Dialogue	Measures based on key success factors
Management style	Measures for detection of deviations
Attitudes	Measures to track past achievements
Shared vision	Measures to describe the status potential
Statistical Process Control	Measures of output
Employee Involvement	Measures of input
Multi-competence	
Total Quality Control	
Incentives, rewards	

Table 5.1: Performance Management and Performance Measures
Source: Lebas (1995)

As can be seen from Table 5.1, the elements listed under performance management all contain events and skills required to establish and practice performance management. The elements listed under performance measures are much more specific and relate to where measures can take place.

The Need for Performance Measures

In practice, every day much consumption takes place. Furthermore, companies engage in many different forms of relationships where services are being exchanged. In order to check whether the company is on the right track service-wise, i.e. whether it consumes costs at an appropriate level and people perform their jobs with the right productivity, measures are needed. Some basic requirements for performance measures exist. Lea and Parker (1989) suggest that they must be simple to understand, have visual impact such as graphs, and be visible to all. Monitoring too many facets of the practice should be avoided since most measures will have importance for only a short period of time, whilst there is a focus on improving them. When improvements have been made, the attention should be turned to a different facet.

According to Globerson (1985), performance criteria must share a number of characteristics:

- They must be derived from the company's objective.
- They should make it possible to compare with organizations in the same business.
- They must have a clear purpose.
- They must be based on reliable data and calculation methods.

- They should be under control of the evaluated organizational unit.
- They should be selected through discussions with the people involved (e.g. customers, employees and managers).
- They should prefer objectivity instead of subjectivity.

Performance measures are being implemented to fulfill several purposes. Figure 5.2 portrays seven purposes.

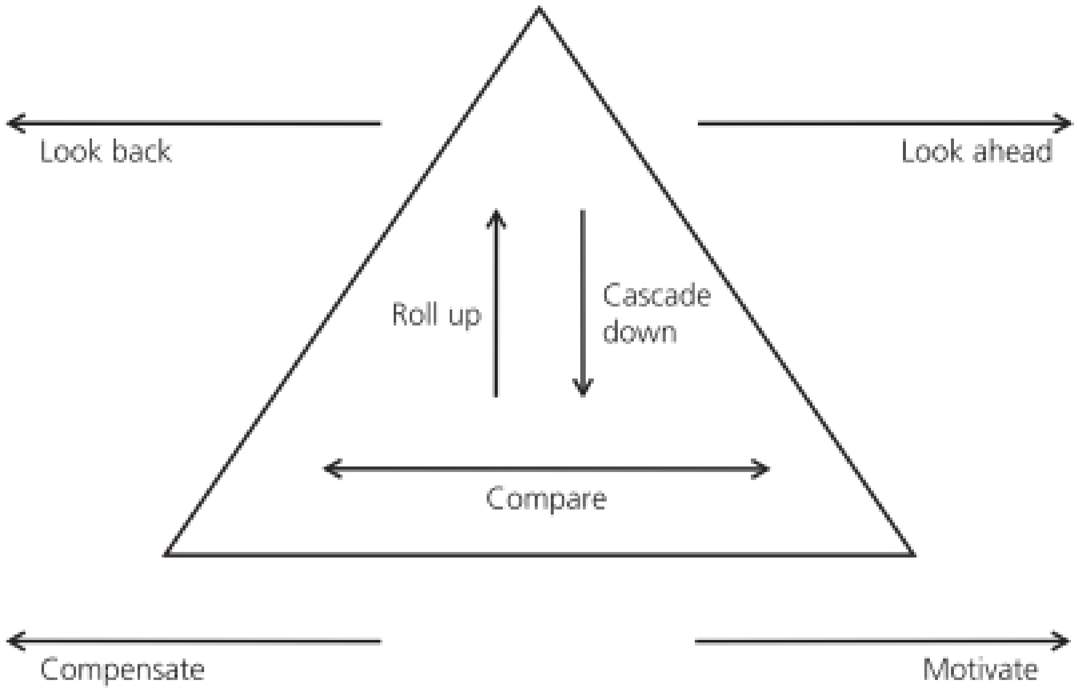


Figure 5.2: Seven Purposes of Performance Measurement

As shown in Figure 5.2, one purpose of performance measures is to look back (where have we been). Such measures can support the company's reward system. Rewards can be based on the past, not on the likelihood of future success. A second purpose is to make a status of where we are now (e.g. be comparing past results with budgets for the future). In other words, what is the actual status of the processes operated in the organization and what is their potential for achievement in the future? A third purpose of measures is to define where we want to go (to look ahead). Such measures support the overall objectives and targets and provide input to concrete action plans. A fourth purpose of measures is to provide input on how we are going to reach company objectives (e.g. to motivate). In other words, the measures must support the budgeting and planning activities, and also support continuous improvement. A fifth purpose of measures is to provide information about how we will know whether the objectives are reached or not (e.g. to make compensation). Thus, measures may not be separated from the feedback loops about whether or not objectives or targets have been reached. They need to be linked the reward system. A sixth purpose of measures is that it makes it possible to roll up performance measures to an overall perspective. A board, for example, needs information about the company's performance in general, which can be based on reports from the different business units within the group. Finally, a seventh purpose of measures is the opposite of the previously mentioned purpose since this purpose is to cascade down measures from e.g. a group level to an individual business unit. It could, for example, be how much the individual unit is expected to cover of the overall performance target of the group. Other purposes of performance measures can be summarized as follows:

- To ensure customer requirements have been met
- To be able to set sensible objectives and comply with them
- To provide standards for establishing comparisons
- To provide visibility and provide a 'scoreboard' for people to monitor their own performance levels
- To highlight quality problems and determine which areas require priority attention
- To give an indication of the costs of poor quality
- To justify the use of resources
- To provide feedback for driving the improvement
- To communicate with customers and suppliers
- To pay performance-related bonuses.

Types of Performance Measures

This section focuses on a description of different types of performance measures that a company can choose to implement. In practice, there are many different terminologies in use and often this takes place in an inconsistent manner. Firstly, a clarification will be made of the concepts of key result indicators, performance indicators and key performance indicators. Next, a presentation of some of the main areas of key figures follows. Finally, the concepts of financial and non-financial measures are subjected to deeper clarification.

Key Result Indicators, Performance Indicators and Key Performance Indicators

According to Parmenter (2007), many companies are working with wrong measures and with measures of which a high proportion mistakenly have been named key performance indicators. Actually, he claims that very few companies really monitor their true key performance indicators. One reason for this might be that there is a lack of understanding of the different terminologies. Therefore, Parmenter (2007) makes an explicit distinction between three types of performance measures, as shown in Figure 5.3: 1) Key result indicators (KRIs), 2) performance indicators (PIs) and 3) key performance indicators (KPIs).

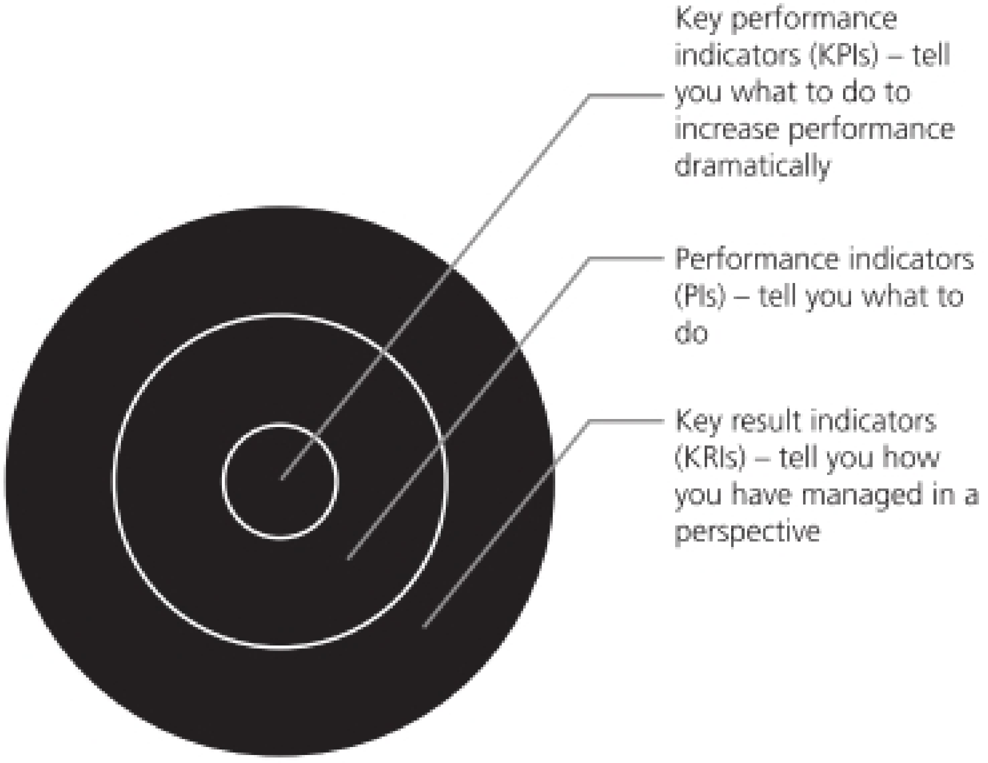


Figure 5.3: Three Types of Performance Measures
Source: Parmenter (2007, p. 2).

KRIs are represented as the outer layers (like an onion) in Figure 5.3. KRIs are the result of many actions. They give information on whether the company is on the right track or not. They do not say what to do in order to change the performance. In this way, they are ideal for board meetings. They simply state the facts and what to do about it. Typically, KRIs are reviewed within a monthly/quarterly cycle. KRIs are appropriate for a governance report (consisting of up to 10 measures, providing high level KRIs). A performance indicator (PI) is a measure of the performance. It tells you what to do. A number of such performance indicators are candidates for being key performance indicators (KPIs) which are a set of measures focusing on the aspects of organizational performance that are most critical for the current and future success of the organization. It is only a *Key* when it is of fundamental importance to gain competitive advantages and if it is a make-or-break component in the success or failure of the enterprise. It only relates to *Performance* when it can be clearly measured, quantified and easily influenced by the organization. Finally, it is only an *Indicator* if it provides leading information on future performance. With this classification of three types of performance measures, Parmenter (2007) presents a 10/80/10 rule. This rule expresses that, as a guideline, a company should develop about 10 KRIs, 80 PIs and 10 KPIs. Basically, many companies operate with too many KPIs and KRIs. Thus, the rule stresses the importance of linking KPIs to the company's corporate strategy in order to give information on what has to be done to increase performance drastically.

Key Figures/Ratios

Key figures or ratios contain information that briefly presents the status of a given practice. From finance, we know of several categories of ratios. Such ratios are:

- Leverage ratios that show the extent of debt used in the capital structure of a company.
- Liquidity ratios that provide a picture of the short-term financial situation or solvency of a company.
- Operational/efficiency ratios that apply turnover measures to portray the efficiency in the operations of a company and use of its assets.
- Profitability ratios which use margin analysis in order to show the return on sales and capital employed.
- Solvency ratios which are dedicated to picture the ability of a company to generate cash flow and settle financial obligations.
- Market ratios that measure the response of the investors to owning a company stock and the costs of issuing stocks.

Liquidity Ratios

This category of ratio expresses a company's availability of cash to pay debts. In the following, two of such ratios are listed.

$$\text{Current ratio} = \frac{\text{Current assets}}{\text{Current liabilities}}$$

This ratio expresses whether or not a company has enough resources to pay its debts over the next 12 months. It compares the current assets of a company to its current liabilities

$$\text{Operation cash flow ratio} = \frac{\text{Operation cash flow}}{\text{Total debts}}$$

This ratio refers to the amount of cash that a company generates from the money it brings in.

Operational/Efficiency Ratios

This category of ratio measures the effectiveness of the company's use of resources. In the following, two examples of such ratios are listed.

$$\text{Asset turnover} = \frac{\text{Net sales}}{\text{Total assets}}$$

This ratio measures the efficiency of a company's use of its assets in generating sales revenue or sales income to the company.

$$\text{Stock turnover ratio} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

These ratio measures show how many times a company's inventory is sold and replaced over a period of time. The days in the time period can then be divided by the above formula in order to calculate the number of days it takes to sell the inventory on hand or 'inventory turnover days'.

Profitability Ratios

This set of ratio measures the company's use of its assets and control of its expenses to generate an acceptable rate of return. Three examples of this category of ratio are listed below.

$$\text{Stock turnover ratio} = \frac{\text{Cost of goods sold}}{\text{Average inventory}}$$

$$\text{Return on investment (ROI)} = \frac{\text{Net income}}{\text{Average owners' equity}}$$

$$\text{Return on assets (ROA)} = \frac{\text{Net income}}{\text{Total assets}}$$

Solvency Ratios

These ratios measure the company's ability to repay debts. In other words, it expresses its creditworthiness.

$$\text{Debt ratio} = \frac{\text{Total liabilities}}{\text{Total assets}}$$

$$\text{Long-term debt to equity} = \frac{\text{Long-term debt}}{\text{Total assets}}$$

Market Ratios

These ratios measure the investors' responses to owning a company stock and the cost of issuing stocks.

$$\text{Earnings per share (EPS)} = \frac{\text{Net earnings}}{\text{Number of shares}}$$

EPS express the portion of a company's profit that is allocated to each outstanding share of common stock.

The ratio expresses a valuation ratio of a company's current share price compared to its per-share earnings.

$$\text{Price/earnings ratio} = \frac{\text{Market value per share}}{\text{Earnings per share}}$$

Financial and Non-Financial Measures

During the last decades, solely relying on financial performance measures has shifted to also applying non-financial measures. According to Neely (1999), some of the reasons for this shift are that the companies encourage short-termism, they lack strategic focus and fail to provide data on quality, responsiveness and flexibility, they encourage local optimization, for example 'manufacturing' inventory to keep people and machines busy, they encourage managers to minimize the variances from standard rather than seeking to improve continually and they fail to provide information on what customers want and how. Financial indicators are performance indicators that are typically characterized by lagging indicators. This means that financial indicators are produced via historical data. Such indicators are the traditional indicators of performance that companies use in order to get a feel of the current direction in which they are heading. Examples of such financial indicators are Return on Investment (ROI), Economic Value Added (EVA) and contribution margins. In contrast to this are the non-financial indicators (see examples in Table 5.2).

Performance Indicator	Indicator for?
Number of days that employees have attended courses	Learning potential
Employee satisfaction in percentage	HR department performance
Customer loyalty in percentage	Strength of brand
Waste in terms of scrapped products	Production department performance
Total lead time	Production department performance
Number of new patents	R&D department performance
Total resources invested in new product development	Product development potential
Total market share	Sales potential
Number of product defects	Quality assurance performance
Service error rate	Customer satisfaction
Revenue per employee	Individual employee performance
Delivery time	Customer satisfaction

Table 5.2: Examples of Non-Financial Performance Indicators

With the advent of the Balanced Scorecard (BSC), managers have realized that financial indicators alone are seldom enough. The reason for this should be found in the fact that companies have closer relations with their suppliers and customers in order to be effective and innovative. Such collaboration often consists in exchanges of knowledge. Here, the problem with traditional financial indicators is that it is not possible to put a precise value on them, i.e. show exactly how much the knowledge residing in organizations is worth. As a result, companies need to be able to track the progress and performance that they are making in terms of their non-financially related activities. An example of this could be how effective the organization is in innovating new products or supply chain related innovations. Another example could be how well the company's brand is performing. Has the company recently invested so much in its brand that customers are buying more products? This is difficult to measure with traditional performance indicators.

Performance Measurement Frameworks

This section describes three well-known performance measurement frameworks. In theory as well as in practice, other such frameworks exist. However, the three presented here are believed to be the most widely accepted and applied. The three performance measurement frameworks are the EFQM (European Foundation for Quality Management)Excellence Model, the Balanced Scorecard and the Performance Prism. In the following, these frameworks will be unfolded in detail.

The EFQM Excellence Model

In 1988, the EFQM was founded by a number of European countries. The first quality award was appointed in 1992. The award is given to a European company that demonstrates excellence in the management of quality as their fundamental process for continuous improvement (Shergold and Reed, 1996). The EFQM Excellence Model:

- Is a structure for the organization's management system
- Can be used as part of a self-assessment
- Provides a framework for comparison with other organizations
- Helps to identify areas for improvement.

The purpose of the EFQM Excellence Model is to provide a system perspective for understanding performance management. The excellence model is a non-prescriptive framework based on nine criteria reflecting validated, leading-edge management practices, as shown in Figure 5.4.

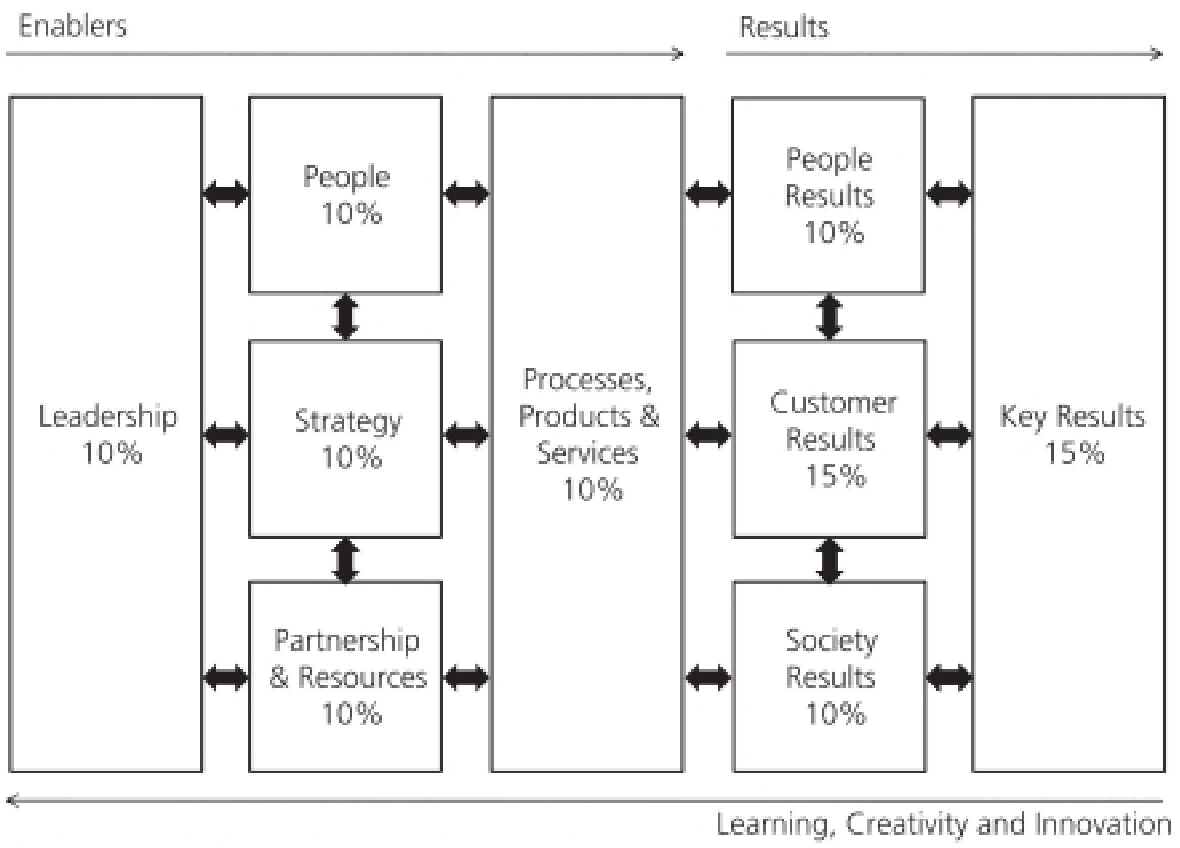


Figure 5.4: The EFQM Excellence Model

Five of the criteria in Figure 5.4 are 'enablers' and four are 'results'. The 'enabler' criteria are: leadership, strategy, people, partnerships and resources, and processes, products and services. These criteria cover what an organization does and how well it is done. The 'results' criteria cover people results, customer results, society results and key results. They portray what an organization actually achieves. Company 'results' are caused by 'enablers'. The 'enablers' are improved using feedback from 'results'. These measures provide the basis for continuous learning, creativity and innovation.

The Balanced Scorecard

The Balanced Scorecard was developed by Kaplan and Norton in 1992. The Balanced Scorecard provides an overview of financial and non-financial performance metrics by building bridges between the company's visions, strategies and operational tasks. Kaplan and Norton (1992) use the following metaphor from an airplane to explain the need for the Balanced Scorecard:

> Think of the balanced scorecard as the dials and indicators in an airplane cockpit. For the complex task of navigating and flying a plane, pilots need detailed information about many aspects of the flight. They need information on fuel, airspeed, altitude, bearing, destination, and other indicators that summarize the current and predicted environment. Reliance on one instrument can be fa-

> tal. Similarly, the complexity of managing an organization today requires that managers be able to view performance in several areas at once. (Kaplan and Norton, 1992)

Instead of focusing only on financial metrics, the Balanced Scorecard also includes metrics about customers, internal processes and innovation and learning. Thus, the Balanced Scorecard has moved away from a traditional management accounting and towards a more balanced view of the company. Basically, the purpose with the Balanced Scorecard is to provide answers to the following main questions:

1. How do the customers look at the company? (the customer perspective)
2. How does the company excel in performance? (the internal business perspective)
3. How does the company continue with improvements and create value? (the innovation and learning perspective)
4. How do the shareholders view the company? (the financial perspective)

The four perspectives in the Balanced Scorecard are shown in Figure 5.5.

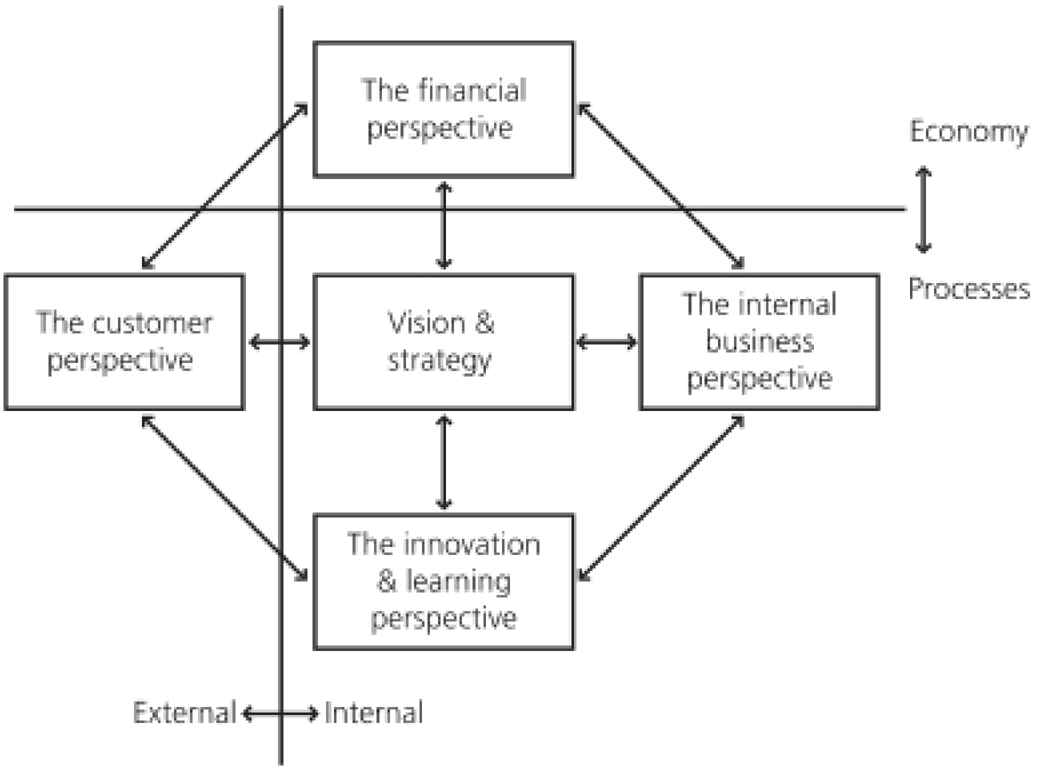


Figure 5.5: The Balanced Scorecard
Source: Based on Kaplan and Norton (1992)

As shown in Figure 5.5, the financial perspective has an economic focus whereas the other three perspectives are related to a process focus. Furthermore, the customer perspective is pointed at external relationships whereas the others have an internal company focus. The Balanced Scorecard has evolved from its early use as a simple performance measurement framework to a full strategic planning and management system. Recent versions of the Balanced Scorecard are focusing on transforming an organization's strategic plan from an attractive, but passive document into active daily decisions in companies (see e.g. Kaplan and Norton, 2004). It provides a framework that not only provides performance measurement, but helps planners identify what should be done and measured. It enables managers to link strategies to operational levels and vice versa.

The Customer Perspective

This perspective draws attention to the importance of customer focus and customer satisfaction. Customers' concerns tend to fall into four categories: time, quality, performance and service, and cost. Thus, if customers are not satisfied with the company's ability to fulfill their expectations within these areas, they will perhaps initiate a process to find another supplier.

The Internal Business Perspective

This perspective is concerned with the company's internal business processes. Performance measures within this perspective allow managers to know how well their business is running, and whether its products and services conform to customer requirements. The performance measures should originate in the business processes with the greatest impact on customer satisfaction (e.g. factors that affect cycle time, quality, employee skills, and productivity). Companies are advised to analyze which processes and competences they really excel in and then develop measures to track their performances within them.

The Innovation & Learning Perspective

This perspective includes employee training and corporate cultural attitudes related to both individual and corporate self-improvement. In a knowledge economy, the brainware is the key source of competitive advantages. Information technology has been under huge development over the last decades with global track-and-trace systems. The concept of 'Big Brother Is Watching You' is a true phenomenon in many business settings. This rapid development in technologies creates a demand for continuous learning cycles in companies. The perspective helps managers to be aware of the development of performance measures that focus on learning and innovation so that the company's products and business processes can remain competitive.

The Financial Perspective

The last perspective in the Balanced Scorecard focuses on the traditional financial measures. Timely and accurate cashflow-related data will always be of high priority to managers.

The Performance Prism

In 2002, Neely et al. (2002) introduced the performance framework Performance Prism. The concept of prism is borrowed from optics where a prism is a transparent optical element with flat, polished surfaces that refract light. A triangular prism with rectangular sides is a traditional geometrical shape for a prism. They are typically made out of glass, but can be made from any material that is transparent to the wavelengths for which they are designed. The framework by Neely et al. (2002) consists of five interrelated facets as shown in Figure 5.6: Stakeholder satisfaction, strategies, processes, capabilities and stakeholder contribution. According to Neely and Powel (2004), the Performance Prism is different from the two above-mentioned frameworks among others in the way that this framework includes a much broader stakeholder view. The Performance Prism deliberately distinguishes between stakeholder satisfaction and stakeholder contribution (e.g. a customer requires satisfaction from an organization and an organization seeks contribution from the customer in the form of loyalty and profitability.

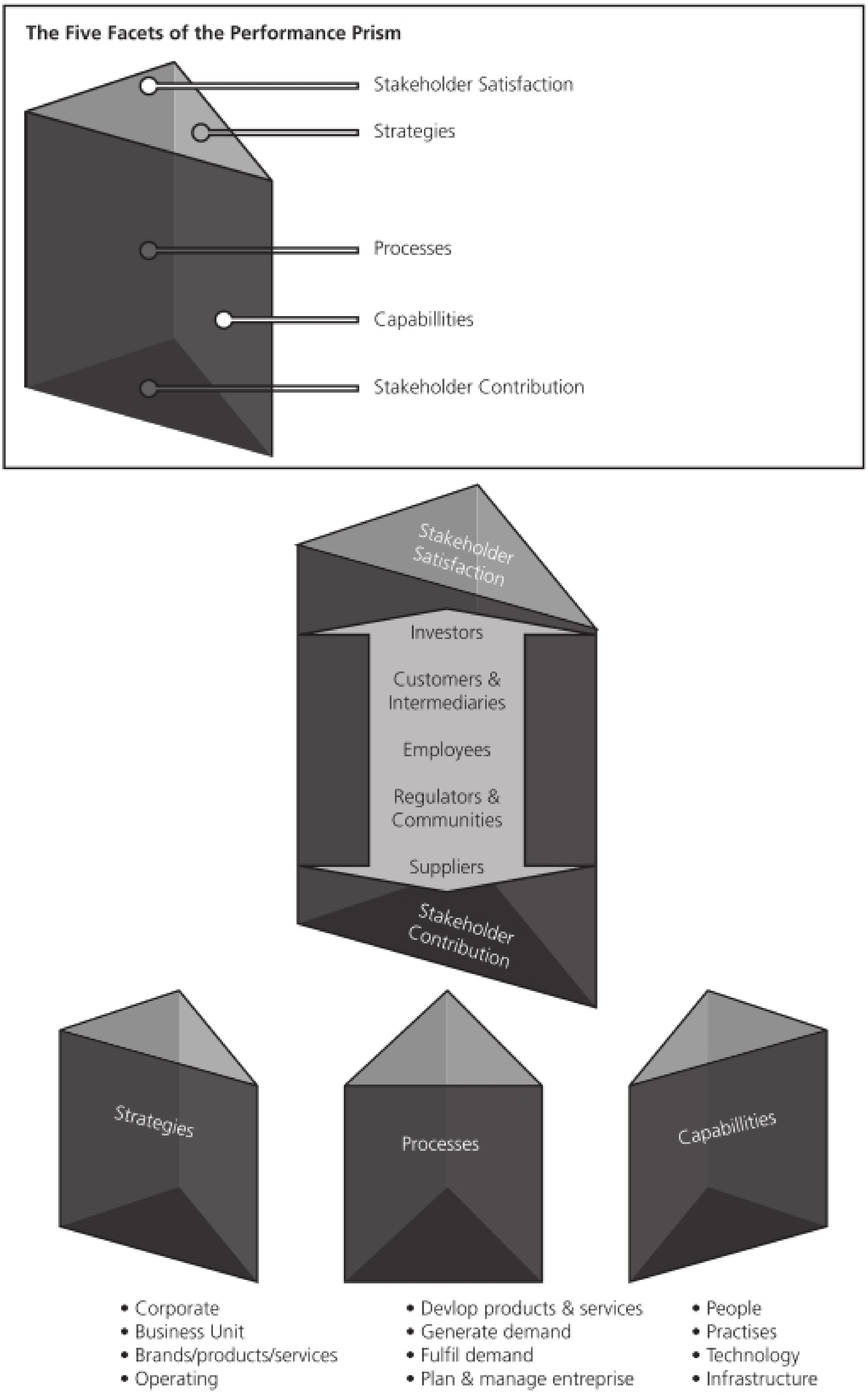


Figure 5.6: The Performance Prism

Source: Neely et al. (2002, p. 180)

Each of the above five interrelated facets in Figure 5.6 represents a key area that determines success. The weight given to each will depend on the particular strategic objectives (e.g. quality improvement, cost reduction or joint research and development). There are five basic questions that a company must ask in relation to the five facets:

1. Who are the key stakeholders and what do they want and need? (stakeholder satisfaction)
2. Which strategies do we need to put in place to satisfy the needs of our stakeholders while at the same time satisfying our own requirements? (strategies)
3. Which processes do we need to put in place to allow us to execute our strategies? (processes)
4. Which capabilities do we need to put in place to allow us to operate and improve our processes? (capabilities)
5. Which contributions do we require from our stakeholders if we are to maintain and develop these capabilities? (stakeholder contribution)

According to Neely et al. (2002), organizations that obtain long-term success have a quite clear picture of who their key stakeholders are and what they want. These companies have defined which strategies they will pursue to ensure that value is delivered to these stakeholders. They understand which processes the enterprise requires if these strategies are to be delivered and they have defined which capabilities they need to execute these processes. In other words, they have a clear business model and an explicit understanding of what constitutes and drives good performance.

Development of Performance Measures

The development of performance measures may not be viewed as an easy and fast going task. The development of sound and useful measures often requires a considerable amount of time. Poorly defined measures not only provide a wrong picture of reality; they probably also only have a limited life. In practice, we often see that companies have a high number of measures that are available in a high number of different reports. A good exercise is to ask the company how many employees actually use the reports and really understand the measures. Often the answer is ‘Few’! An almost hidden factory is occupied by gathering data for the figures and developing the reports. In order to avoid poorly defined measures and thus also to waste resources, the development of the measures can benefit from following the requirements as shown in Table 5.3.

Name of measure	Write the name of the measure here
Purpose	In this field, the purpose of the measure is described. In other words, why is the measure included?
Definition	The measure has to be defined precisely. All elements must be explained. The calculation methods must be explained (e.g. showing the numerator and denominator in a fraction).
Reporting	Here, one has to describe how the measure is reported. It contains information about the form of reporting (e.g. in a pie chart or a bar chart), the specific content (result of the measure) and frequency of the measure.
Assumptions	This part refers to identifying the data basis needed to accomplish the measure. It may clarify which data should be available and the quality level of the data.
Responsibility	In this field, the responsibility for the development and maintenance of the measure is specified. Several people may be involved in this so it is important to be precise in this description.
Scope of the measure	This element is concerned with how wide the measure is. Does it, for example, cover the whole organization or does it only concern a specific department? Is it for all products or only for some products? Etc.
Information	This field explains who should be informed about the result of the measure and where the measures can be seen (e.g. at the company's intranet, at information boards in the factory or in the canteen or in a staff magazine).
Possibility to influence	In this field, one has to list actions that may influence the measure (e.g. better planning can reduce the load of overtime work).
Current level	If the current performance level of the measure is known it should be listed in this field. It serves the function as a fix point for measure making it possible to track progress.
Other comments	Specific comments about, for example, the definition or the use of the measure can be described in this last field.

Table 5.3: Template to Describe a Measure
Source: Based on Neely et al. (1997)

Table 5.3 contains eleven descriptive elements to document a measure. An explanation of the elements is placed right beside each of the elements. In Table 5.4, a concrete practical example of a description of measure is provided.

Name of measure	Extent of overtime work
Purpose	The purpose of the measure is to illustrate the development of the overtime work by the hourly-paid workers in order handling, warehouse and maintenance. The development is shown in total and also divided into the different shifts.
Definition	Each month a report is developed based on the registered number of overtime hours. The consumption is assessed both in total and per area and shifts.
Reporting	The overtime hours are illustrated in bar charts per month (both in total and divided in function areas and shifts).
Assumptions	The data basis is the reported pay slips for the hourly-paid workers.
Responsibility	Data for the measure come from the salary system. The Finance Manager, Per Stentoft Nielsen, is responsible for delivering these data. Human Resource Manager Ole Stentoft Nielsen is responsible for updating the measure.
Scope of the measure	The measure is valid for the workforce in order handling, warehouse and maintenance.
Information	The measure is published at the intranet and on the information board in the warehouse.
Possibility to influence	Increased efficiency can reduce the amount of overtime.
Current level	Not known.
Other comments	No further comments.

Table 5.4: Example of Described Measure

A few years ago, a Danish manufacturer experienced a vast number of challenges in their manufacturing unit. The observable outcome of their performance was a huge amount of work-in-progress, a high amount of re-planning of production orders, a high amount of overtime and much fire-fighting between the different workshops. The company was asked whether they could deliver some performance measures of their efforts. The answer was a bit hesitant, but a 'no'. The company was not able to give a description of whether they were under or above targets, because no performance measures existed. A process was initiated in order to change this situation. The company decided to begin with developing and implementing five performance measures (plan compliance, amount of work-in-progress, number of open production orders, internal ability to deliver, and development in overtime work). These measures were defined on the basis of Table 5.3. The company then began to communicate the measures on the intranet. Subsequently, the company has developed fifteen other measures that are being reported and communicated continuously. The company has also improved the communication part of the measures by applying some speedometer-like icons to make the measures more readable.

As a supplement to Table 5.3, the specification of a measure can also benefit from a simple test of the measures of SMARTness. According to Doran (1981), the establishment of objectives and the development of their respective action plans are the most critical steps in a company's management process. However, writing meaningful objectives is not a trivial task. Many objectives are not focused and difficult to measure. Doran (1981) therefore suggests that effective objectives should meet SMART which is an acronym for:

- Specific – target a specific area for improvement
- Measurable – quantify or at least suggest an indicator of progress
- Assignable – specify who will do it
- Realistic – state which results can be achieved realistically, given available resources
- Time-related – specify when the result(s) can be achieved.

In practice, there may be situations where objectives do not meet all five criteria. However, the closer one gets to these SMART criteria, the smarter the objective will be.

The Seven Deadly Sins of Performance Measurement

Hammer (2007) has elaborated on his experience with companies and their practice of performance measurement systems in an article with the title of this section. Thus, he discusses seven deadly sins of performance measurement like the seven deadly sins of Catholicism. The sins of operational measurement is not just a measurement problem, but is also rooted in company cultures with a lack of emphasis to articulate what is really important for the success of a company. In many companies, there is a lack of structured approach to performance management and improvement. Poorly designed metrics cannot repair themselves. They have to be linked to corporate strategy. In the following, the seven sins will be briefly described.

Vanity

The first sin is to develop a performance measurement system due to vanity. The performance has to look good. 'Nobody wants a metric on which they do not score 95' could be a classic comment. Just because it looks good, it does not necessarily report the true story of the company's performance. This sin is often also reinforced by the fact that several managers have performance-related salaries linked to specific measures. This fact can hinder changes of performance measures taking place since some managers seem to be very satisfied with the ongoing metrics.

Provincialism

This sin takes place when organizational boundaries and concerns dictate performance metrics. There is no doubt that the single departments of a company would like to define their own performance metrics. They should of course be involved in such a process, but it needs to be aligned across the whole company in order to avoid sub-optimizations.

Narcissism

This sin takes place when a company's amount of performance measures have an overwhelming focus on internal performances instead of operating with performance measures that measures from the customer's perspective. It is often quite a different story when data from the customers are received compared to the self-generated data of the company (e.g. performance metrics about number of deliveries at the right time).

Laziness

This sin is about poor performance measures due to inadequate thought processes and efforts to define the measure. One assumes, for example, that another part knows what is important, but fails to provide the measure that documents the facts.

Pettiness

When a company only measures a fraction of what really matters, the sin of pettiness takes place. It may be that a company has many measures within a certain area. However, it does not help the company if it is the wrong measures – e.g. if they do not cover what really counts for the company.

Inanity

Inanity takes place when a company implements metrics without any prior thoughts on the consequences of these metrics on human behavior and on the enterprise performance. What gets measured gets done. What gets done gets rewarded. People are hunting the performance metrics even if they are characterized by inanity. A fast-food chain decided to reduce waste in order to improve the financial performance. The waste reduction was concerned with the chicken that had been cooked, but unsold at the end of the day and thus had to be scrapped. The practice was changed so that the chicken was not cooked before the orders were delivered. However, this practice initiated to drive out waste resulted in a transformation of the fast-food chain to a slow-food chain.

Frivolity

The worst sin is perhaps the sin of frivolity that expresses a behavior where performance measurement is not taken seriously enough. Practice might be that there is a flow of excuses of poor performance instead of tracking the root causes of the poor performance or by blaming others rather than taking the responsibility for the improvement. Remember, each time you point the finger at others there are three fingers pointing back at yourself.

In order to overcome the above-mentioned deadly sins of performance measurement, Hammer (2007) suggests companies to take four steps to calibrate their performance measures:

1. Decide what to measure (what is most important for the company?)
2. Measure the right way (there must be a balance of precision, accuracy, overhead and robustness)
3. Use metrics systematically (the metrics must be embedded in systematical processes)
4. Create a measurement-friendly culture (see measures as a positive thing; a foundation for improvement and continuous learning).

Likierman (2009) also reports on the problem areas of performance measurement. Many senior executives find performance measurement difficult (literally threatening) and they are hesitant to engage in it in a meaningful way. The results of such a behavior is that they fall into five traps: 1) They use themselves rather than competitors as benchmarks, 2) they look to much backwards by focusing on past indicators of success, 3) they overvalue numbers at the expense of qualitative measures, 4) they set easy-to-game metrics and 5) rely on outdated measures.

Discussion Questions

1. Why is performance management relevant in process optimization?
2. What is the difference between performance management and performance measurement?
3. Explain the concepts of Key Result Indicators, Performance Indicators and Key Performance Indicators.
4. Explain different purposes of performance measurements.
5. What is the difference between financial and non-financial measures? (give some examples of each type)
6. Explain the major components of the Performance Prism framework.
7. Explain the enablers and results of the measures in the EFQM Excellence model.
8. Explain the four perspectives in the Balanced Scorecard.
9. What is a SMART objective?
10. What are the seven 'deadly' sins of performance measurement?

PART 2: DESIGN

CHAPTER 6

Strategies for Process Improvements

Introduction

> Excellent firms don't believe in excellence – only in constant improvement and constant change. (Tom Peters)

As shown in this textbook so far, there is a potential in many companies for making process improvements. These process improvements may lead to increased performance in terms of, for example, reduced cost consumption, reduced time consumption in business processes or improved quality during the processes and thus also in the output (in the physical product or in a service). As has been demonstrated in the previous chapters, awareness of such a potential can be initiated based on mapping exercises of both business processes and IT systems. Such mapping processes can lead to shocking results. The visualization of the existing situation should be based on facts and portray how processes are actually performed. The mapping process may, for example, document how inefficient processes are with e.g. unnecessary feed-back loops, waiting times and bottlenecks. In the previous chapters, we have also learned what process management is about and how performance can be measured. We now need to learn at what speed the business improvements have to be carried out. This chapter is dedicated to different ways of making process improvements. How can such business improvements be implemented and when does one decide to make small-scale incremental improvement strategies and when does one choose radical improvements? This chapter discusses these issues. In order to fulfill this purpose, the chapter is further organized into four subsections. In the next section, the deliberateness and emergence of strategy formation is described. Then follows as section that presents two diametrically opposed approaches to business improvement (Kaizen vs. business process reengineering). The next section describes four different system implementation strategies. The final section is concerned with critical success factors in system implementation.

Deliberate vs. Emergent Strategy Formation

Within the strategy literature, a tension or a paradox exists of how strategy formation takes place. The debate is concerned with whether strategy formation processes are deliberate or emergent (Mintzberg and Waters, 1985). Some strategists think that companies should strive to make strategies in a highly deliberate manner. This type is called planned strategy. Intentions are formulated as precisely as possible and managers are then striving to implement these intensions with as little distortion as possible. Thus, managers must first articulate their intensions in the form of a plan, in order to minimize confusion, and then transform this plan into action points as detailed as possible. Other strategists argue that most new strategies emerge over time. In this perspective, the strategy process is not concerned with defining the final strategy in advance, but is merely concerned with navigating during the process. Making strategy involves sense-making, reflection, learning, visioning, experimenting and changing the company which is not able to plan and program (de Wit and Meyer, 1998, p. 154). The difference in strategy formation processes between deliberate and emergent strategies is outlined in Figure 6.1.

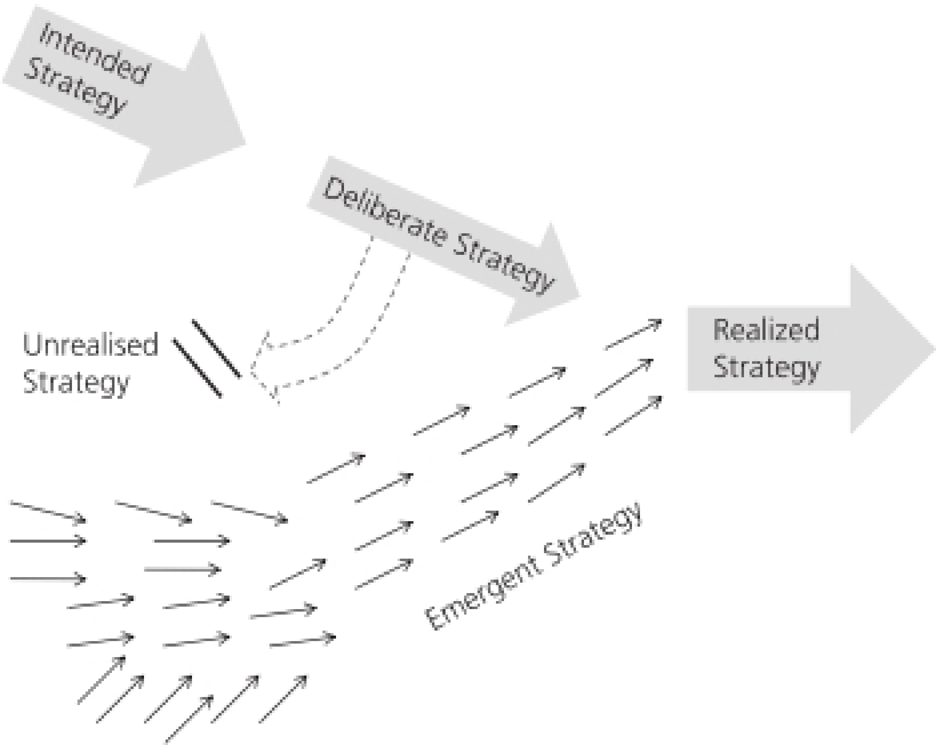


Figure 6.1: Forms of Strategy
Source: de Wit and Meyer (1998, p. 151)

Table 6.1 summarizes the differences between planning and emergent strategy perspectives along with a series of descriptive dimensions. In line with Figure 6.1, one can see that the planning perspective operates with a strategic preparedness where strategies are planned in advance in hierarchical decision-making processes. In contrast, the emergent strategy perspective is gradually shaped in unstructured and fragmented processes. The decision process is often much more political in such emergent processes. In Table 6.1, the planning and the emergent strategy perspectives is contrasted in a number of different dimensions.

	Planning Perspective	**Emergent Perspective**
Emphasis on	Deliberateness over emergence	Emergence over deliberateness
Nature of Strategy	Intentionally designed	Gradually shaped
Nature of Strategy Formation	Figuring out	Finding out
Formation Process	Formally structured and comprehensive	Unstructured and fragmented
Formation Process Steps	First think, then act	Thinking and acting intertwined
Focus on Strategy as a	Pattern of decisions (plan)	Pattern of actions (behavior)
Decision-Making	Hierarchical	Political
Decision-Making Focus	Optimal resource allocation and coordination	Experimentation and parallel initiatives
View of Future Developments	Forecast and anticipate	Partially unknown and unpredictable
Posture Towards the Future	Make commitments, prepare for the future	Postpone commitments, remain flexible
Implementation Focused On	Programming (organizational efficiency)	Learning (organizational development)
Strategic Change	Implemented top-down	Requires broad cultural and cognitive shifts

Table 6.1: Planning vs. Emergent Strategy Perspectives
Source: de Wit and Meyer (1998, p. 158)

The dualism of strategy perspectives shown in Table 6.1 can indicate when one perspective is to be preferred over the other. In stable environments, the planned perspectives may be preferred whereas the emergent strategy perspectives are suitable for dynamic environments in particular. In practice, it is not a question about either-or. A part of a company's strategy may, for example, be driven by a planning perspective whereas other parts are driven by emergent perspectives.

Kaizen vs. Business Process Reengineering

Business improvement in companies can take place in different ways. Imai (1986) distinguishes between Kaizen and innovation. Kaizen means to carry out ongoing improvements involving everyone, i.e. including both managers and workers. Kaizen signifies small improvements made in the status quo as a result of ongoing efforts. Innovation involves a drastic improvement in the status quo as a result of a large investment in new technology and/or equipment. The term reengineering is used here instead of 'innovation', as in the original source by Imai (1986). Table 6.2 contrasts the two different approaches to process improvement.

	Kaizen	**Reengineering**
Effect	Long-term and long-lasting, but undramatic	Short-term, but dramatic
Pace	Small steps	Big steps
Time-frame	Continuous and incremental	Intermittent and non-incremental
Change	Gradual and constant	Abrupt and volatile
Involvement	Everybody	Select few champions
Approach	Collectivism, group efforts, systems approach	Rugged individualism, individual ideas and efforts
Mode	Maintenance and improvement	Scrap and rebuild
Spark	Conventional know-how and state-of-the-art	Technological break-throughs, new inventions, new theories
Practical requirements	Requires little investment, but great effort to maintain it	Requires large investment, but little effort to maintain it
Effort orientation	People	Technology
Evaluation criteria	Process and efforts for better results	Results and profits
Advantage	Works well in slow-growth economy	Better suited for fast-growth economy

Table 6.2: Features of Kaizen and Reengineering
Source: Imai (1986, p. 24)

In the next two subsections, we dig deeper into the content of Kaizen and business process re-engineering.

Kaizen

Kaizen is a central concept in Japanese management practice. Kaizen means improvement, more specifically ongoing improvement involving everyone, i.e. top management, managers and workers (Imai, 1986, p. xxix). Kaizen solves problems by establishing a corporate improvement culture in which everyone can admit these problems freely. Kaizen is thus about continuous improvement. According to Imai (1986), Kaizen is the key to Japan's competitive success. Also according to Imai (1986), Western companies do not focus on continuous improvement. In Figure 6.2, Kaizen and Western perceptions on job function are contrasted.

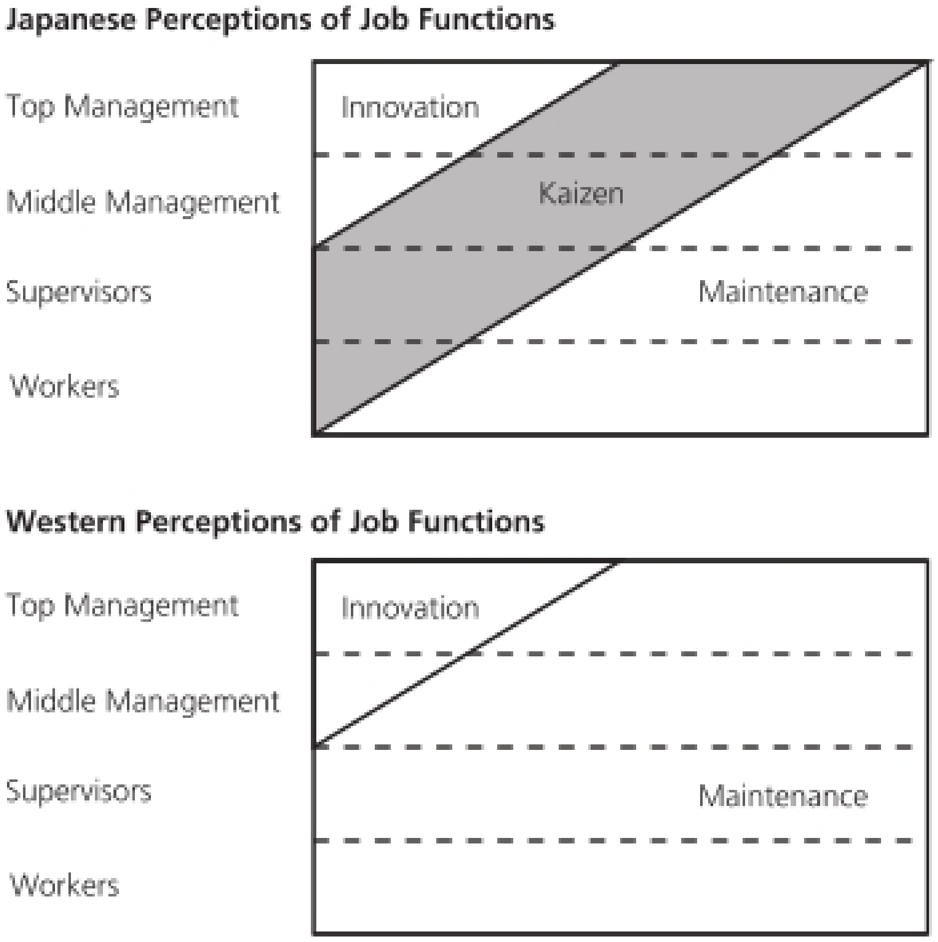


Figure 6.2: Japanese and Western Perceptions of Job Functions
Source: Imai (1986, p. 7)

As shown in the top of Figure 6.2, all job functions in Japanese companies are concerned with continuous improvements that should lead to better company performance. In the bottom of Figure 6.2, the Western perception of job functions is shown. There seems to be the same level of innovation, but no focus on Kaizen. Recently, it has been questioned how much employee involvement there really is in Japan. There is a cultural difference between Japanese and Western companies. In many, often consultant-developed textbooks about Japanese manufacturing practice (which in these days are named 'lean'), this practice is almost idolized without any critical comments. Thus, it is almost taken for granted that their practice can be implemented in a Western culture without any modifications. Especially in Western consulting literature, the concept of Kaizen has been marketed as a concept in which the individual blue-collar worker is truly involved in making improvements. In a Western context, we see the practice, of the original father of continuous improvement W. Edwards Deming in terms of the 'Deming Cycle' with the continuous improvements steps of Plan-Do-Check-Act. What is interesting is that W. Edwards Deming was an American statistician who was invited to Japan to teach the Japanese statistical quality control. His original work later appeared in connection with the Japanese work 'Kaizen' – which is probably more exotic to many consultants. However, in Western countries, there seems to have been an over-interpretation of the actual involvement of the Japanese work force in these Kaizen initiatives. According to professor Christian Berggren, Kaizen is not a matter for the ordinary worker, but an activity that takes place between the workers' foremen and their closest workers (the team leaders and instructors) (Nielsen, 2010). According to Christian Berggren, one should be careful not to interpret Kaizen too literally since the normal assembly line worker at Toyota is recommended to suggest improvement initiatives, but normally this applies to only very small improvements that has no real influence on the production. In relation to the blue-collar workers, Kaizen is basically used to keep working moral high. In this way, Kaizen is only ideological. The reality for the individual worker is still monotonous and standardized work routines.

Business Process Reengineering

Hammer and Champy (1993) are the "fathers' of the management concept of Business Process Reengineering (BPR). They define BPR as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed". Three keywords are essential in this definition: 1) Radical, 2) Redesign, and 3) Processes. BPR requires that enterprises take a comprehensive review of their entire ongoing operations and try to redesign these processes in order for them to serve customers better. BPR is based on a process approach. This allows for a process design approach to the problem situation, where important system elements such as categories of stakeholders (e.g. customers), technologies available or attainable, and the current context of the business situation, provides a much richer picture of what is available and what is possible (Arlbjørn et al., 2007). According to Hammer and Champy (1993), common elements for BRP projects are:

1. Several jobs are combined into one.
2. Workers make decisions.
3. Steps in the process are performed in a natural order.
4. Processes have multiple versions.
5. Work is performed where it makes most sense.
6. Checks and controls are reduced.
7. Reconciliation is minimized.
8. Hybrid centralized/decentralized operations are prevalent

Obstacles for reengineering projects are according to Bashein et al. (1994):

1. *Lack of sustained management commitment and leadership*. Management commitment must be sustained throughout the project. Leadership must focus on empowering employees because, ultimately, they are the source of dramatic improvements.
2. *Unrealistic scope and expectations.* Misperceptions and misunderstandings about BPR are allegedly common. Senior executives' expectations may not be realistic. They may want concrete evidence of success within a few months, for example, when the design and implementation of a project may take 18 to 24 months.
3. *Resistance to change.* BPR is said to cause great resistance everywhere in the organization. Most resistance is reported to come from middle managers, because major layoffs are occurring in middle management ranks.

Klein (1994) has provided an overview of different techniques and methods that can be used in order to create a higher possibility for success with a BPR project. First, Klein (1994) groups BPR tools into six categories: 1) Project Management (with planning, scheduling, budgeting, reporting and tracking tools), 2) Coordination (with tools to distribute plans and to communicate updated details of projects), 3) Modeling (with tools to model something in order to understand its structure and functions), 4) Business Process Analysis (with tools to analyze the company's business processes), 5) Human Resources Analysis and Design (with tools used to design and establish the human or social part of reengineered processes, and 6) Systems Development (with tools used to automate the reengineered business processes). Klein (1994) introduces a five-stage BPR methodology in which certain tools are of special relevance (see Figure 6.3).

Figure 6.3: BPR Methodology's Stages and Tasks
Source: Klein (1994)

Figure 6.3 illustrates in 54 tasks included across the above-mentioned five stages:

1. Preparation: Mobilize, organize, and energize the people who are to perform the reengineered project.
2. Identification: Develop a customer-oriented process model of the business.
3. Vision: Select the processes to reengineer and formulate redesign options capable of achieving breakthrough performance.
4. Solution: Define the technical and social requirements for the new processes and develop detailed implementation plans.
5. Transformation: Implement the reengineering plans.

Strategic Alignment

Alignment is a concept concerned with adjusting an object in relation to other objects. According to Lockamy III and Smith (1997), a reengineering program must be designed and implemented within the context of a company's strategy. A strategic alignment between a company's strategy, processes and customers is essential to ensure that:

1. Strategic objectives are driven by customer needs and expectations.
2. Processes selected for reengineering have a strategic impact on the creation of customer value.
3. Processes are reengineered in a manner that supports strategy achievement.

Information technology is often the enabler to link the strategy, the processes and the customers together. Lockamy III and Smith (1997) have developed three principles for the effective deployment of reengineering programs that facilitate strategic benefits and customer satisfaction and delight within four areas: 1) Strategic alignment, 2) Performance measurement, 3) Information technology, and 4) Reengineering methodology. The principles are portrayed in Table 6.3.

Strategic Alignment	**Performance Measurement**	**Information Technology**	**Reengineering Methodology**
Principle 1: Processes selected for reengineering must have a strategic impact on the company.	Principle 1: Performance measures are needed to evaluate the potential impact of a reengineering program on competitiveness and customer satisfaction.	Principle 1: Information technology must be used to facilitate easy access to process information across functional boundaries.	Principle 1: Business process reengineering programs should adopt a pilot implementation approach to minimize risk.
Principle 2: Processes selected for reengineering must have a significant impact on customer satisfaction and delight.	Principle 2: Process measures are needed to assess current performance and reveal future improvement opportunities.	Principle 2: The assessment of information technology for use in a business process reengineering program must be conducted within the context of the company's information technology strategy.	Principle 2: Business process reengineering programs should utilize a project management approach to control cost, performance, and timeliness objectives.
Principle 3: The strategic direction of the company must be driven by customer requirements for effective business process reengineering.	Principle 3: The performance measurement system must provide a mechanism for determining if the current strategies and processes are sufficient relative to a particular customer base.	Principle 3: The deployment of information technology for use in a business process engineering program should not occur until the selected processes have been successfully redesigned.	Principle 3: Business process reengineering programs must evaluate alternative approaches to process redesign to promote creativity and innovation.

Table 6.3: Reengineering Programs: Principles for Success
Source: Lockamy III and Smith (1997)

The principles shown in Table 6.3 can be used to increase the likelihood of the success of a reengineering program. Thus, the strategic alignment principles draw one's attention to the fact that the processes that are to be reengineered must really have a strategic impact; they must be of high importance for delivering customer satisfaction and the process must be driven by customer requirements. Performance management is needed in order to measure the potential impact on competitiveness and customer satisfaction; track any improvement; and evaluate whether the current strategies are appropriate to fulfill customer requirements. The principles under information technology say that: IT should be used to make it easier to process information across organizational boundaries; IT used in connection with the BPR project must underpin the company's overall IT strategy; and IT should be taken into use before the new business processes have been finally approved. Finally, the principles related to the reengineering methodology argue for a pilot approach to be carried out in order to minimize the risk; a project to be based on a solid project management approach; and one to question current practice by testing other approaches to stimulate creativity and innovation.

BPM Maturity Stages

Business Process Management (BPM) does not mean the same to all companies. We can distinguish between different stages of maturity to work with business process management, as shown in Figure 6.4.

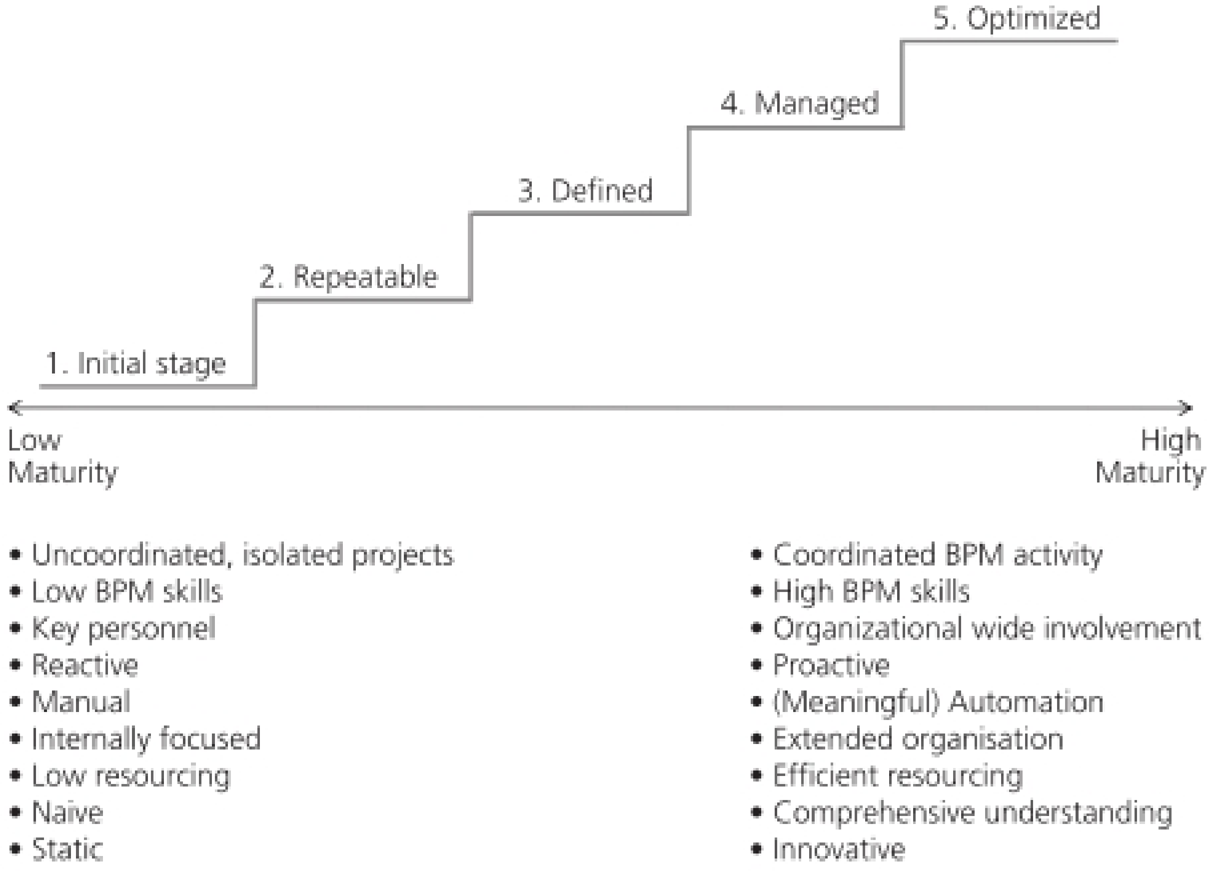


Figure 6.4: BPM Maturity Stages
Source: Based on Jeston and Nelis (2006, p. 301)

In the following, the five stages in Figure 6.4 will be commented in detail. The section relies greatly on the work of Jeston and Nelis (2006, pp. 299-315).

Stage 1: Initial stage
A company that operates on an initial BPM maturity stage often has both an uncoordinated and unstructured approach to BPM. Basically, the concept of business processes is less understood in such a company. The following elements are typically found in a company with such a BPM maturity stage:

- Ad hoc approaches to business improvement
- Non-synchronized approaches and improvement efforts
- Minimal involvement of employees from the business processes fire points
- Low reliance on external BPM consultants
- High amount of manual work interventions.

Stage 2: Repeatable
A company that reaches this BPM maturity level has moved beyond the first main obstacles of defining and implementing business process improvements. At this stage, a company is conscious of the importance and relevance of business process management for its competitiveness. Thus, at this stage the company begins to build on its process capabilities. Further descriptive elements characterizing a company at this stage might include:

- Capability to document the first business processes
- Top management awareness and involvement of BPM
- Use of business process modeling techniques
- A beginning use of a structured methodology and standards for business process descriptions
- An increased appliance of external BPM consultants.

Stage 3: Defined
At this mid-level stage of BMP maturity, the company has now reached a level on which the processes have been defined in the company. The BPM capabilities are growing in the company in line with the number of people who are aware of business processes and their relevance for competitiveness. At this stage, companies typically share some of the following characteristics:

- Dedicated focus on the early phases on the process life-cycles
- Appliance of a wide range of tools in a common BPM tool-box
- Use of wider range of technology for delivery and communication of BPM
- Implemented formalized BPM training sessions
- Some reliance on external BPM consultants.

Stage 4: Managed

A managed BPM maturity stage signals that the company benefits from having BPM implemented in the company. At this stage, the business processes are under control and typically, the following characteristics are found among the companies:

- A PBM centre of excellence is in operation (maintaining business standards)
- Operated with widely accepted methods and techniques
- Process orientation as a mandatory project component
- Relies on external expertise to a minimal extent
- Views IT and business elements as twin objectives in process optimization.

Stage 5: Optimized

This maturity stage is dedicated to the companies that have BPM deeply anchored in both the strategic and operational part of their business. A company at this BPM stage will share some of the following elements:

- Process management is an integrated part of the managers' activities, accountabilities and performance measurement.
- The company operates with a wide set of accepted methods and technologies.
- The company operates with one organization-wide approach to business process management.
- Business process life-cycle management is implemented.
- The need for BPC Centre of Excellence shrinks as BPM is deeply rooted in the way business is done.

Four IT Implementation Strategies

IT system implementation may take place based on different strategies. Such strategies differ with respect to the implementation speed, complexity and require different levels of maturity. This section about implementation strategies draws heavily on Hassan (2005). The four strategies are: 1) Big Bang Implementation, 2) Concurrent Implementation, 3) Phased Implementation, and 4) Pilot-Ramp-Up. Table 6.4 outlines the advantages and disadvantages of each of the four strategies.

Big Bang Implementation		**Concurrent Implementation**	
Advantages	Disadvantages	Advantages	Disadvantages
• Projects start quickly. • Learning curve is short if processes are similar. • Time to deploy is shorter. • Results are seen more quickly and may inspire further improvements and changes. • Solution is implemented in "one go".	• High risk, could lead to chaos if not managed properly. • Implementation may not be proven or validated. • No time to make mistakes and learn, with little time for corrections and fine-tuning. • Focus is on breadth of implementation and not necessarily on depth.	• Projects are consistent. • More projects get started. • Risk is mitigated and is spread across projects/the business. • Success is more likely and balanced out with projects that may not work as well. • Is an excellent way of determining the robustness of the implementation in different business environments.	• Requires more effort up front, and is a drain on resources and time. • Complexity of the implementation increases. • No time to make mistakes and learn, with little time for corrections and fine-tuning. • Is sometimes difficult to maintain the momentum, especially when conflicts and disagreements arise.

Phased Implementation		**Pilot-Ramp-Up Implementation**	
Advantages	Disadvantages	Advantages	Disadvantages
• The changes can be embedded over time through familiarization. • Tools and processes can be well-defined and rolled out. • Implementation projects can be overseen by the team. • The team members ultimately become functional owners. • Experience builds up and can be shared. • Changes are gradual and buy-in is easier to gain.	• Is implemented on a project-by-project basis. • Is slow and detailed; overall results and impact will not be seen immediately. • Is difficult to maintain the momentum of the team and instill a sense of urgency.	• Low complexity/low risk. • Learning curves are fast and the ROI is seen immediately in some cases. • Quick-wins approach gives a higher rate of success. • Shorter introduction (readiness) step. • Faster implementation; refinement happens as you implement. • The period for review and refinement is shorter. • Momentum is easier to maintain since results and successes can be seen quickly and build confidence in individuals.	• Wrong pilot may be chosen. • Momentum is difficult to maintain if pilot is not successful. • Too many pilots increase complexity. • Requires intense focus from participants. • Requires buy-in from the earliest point of implementation; lack of buy-in could lead to the implementation failing to be accepted once completed. This holds implications for the project's long-term sustainability.

Table 6.4: Advantages and Disadvantages of Four Implementation Strategies
Source: Hassan (2005)

The *Big Bang approach* is characterized by a group ERP system, for example, being implemented across several sites at the same time. However, the interpretation of Big Bang must also be understood in the specific context. A Big Bang implementation can also be used for single company implementation, but denotes here that all ERP modules are implemented at the same time. Mostly, the term Big Bang is used when a company implements ERP modules across different sites (e.g. at manufacturing plants and sales offices). The Big Bang approach is the most effort-demanding approach since it requires much planning and coordination. The approach is most effective when processes are similar across the sites and when a large share of the system elements is the same. The major advantage of this approach is that the implementation is done all at once, whereas a major disadvantage is that there is limited room for learning, correction and fine-tuning.

The *Concurrent approach* means that the old IT system is maintained under the implementation of the new system. Thus, there are two systems operating at the same time (the old one and the new one). The approach can be used in situations where risks must be avoided (e.g. operating with sensitive data or the company cannot afford a system break-down where customer orders are lost). The approach is therefore costly since two systems should be operated at the same time (in a predetermined period) until the new processes in the new system is well-understood. When this practice occurs, the company can cut the old system. Further advantages and disadvantages with this approach can be found in Table 6.4.

The *Phased approach* is the most common among the four implementation approaches. In general, companies do not have much experience with process changes since, typically, it is a major activity that takes place only at 5-7 years' intervals (radical changes). The entire implementation is broken down into sub-implementations (phases). As such, this approach is less risky. An example of a phased ERP implementation may be that a company begins the core ERP applications such as the item master, bill of materials, resources, customers, suppliers and the chart of accounts. Later, they can make phase-based implementations of, for example, a CRM module, HRM module and a Shop Floor Control module in manufacturing.

The *Pilot-Ramp-Up approach* is applicable if a company first needs to demonstrate that the new system works or if there is resistance to change, resulting in the company needing to show that the system works with the planned benefits. In such a pilot approach, system design and functionalities can be tested and refined before being rolled out on a larger scale. In a pilot approach, it is important to demonstrate quick-wins because there is much attention on the pilot project. Advantages and disadvantages of this approach are further listed in Table 6.4.

Critical Success Factors

The concept of critical success factors (CSF) connotes the key areas that must be present for a project to become a success (Pollard and Cater-Steel, 2009). If these CFSs are not managed and performed well, it will be difficult for a company to reach its mission and the goals of a project. Table 6.5 provides a list of CSFs. The list is based on comprehensive studies of IT implementation, BPR and project management literature (Pollard and Cater-Steel, 2009).

Rank	Critical Success Factor	Rank	Critical Success Factor
1	Top management support	12	Dedicated resources
2	Project team competence	13	Use of steering committee
3	Interdepartmental cooperation	14	User training on software
4	Clear goals and objectives	15	Education on new business processes
5	Project management	16	Business process reengineering
6	Interdepartmental communications	17	Minimal customization
7	Management of expectations	18	Architecture choices
8	Project champion	19	Change management
9	Vendor support	20	Partnership with vendor
10	Careful package selection	21	Use of vendors' tools
11	Data analysis and conversion	22	Use of consultants.

Table 6.5: Critical Success Factors in ERP Implementations
Source: Pollard and Cater-Steel (2009)

In the following, each of the twenty-two critical success factors in Table 6.5 is commented briefly.

Top Management Support. All major initiatives in a company, no matter which type it is, will have difficulties surviving if there is no top management support. Therefore, one will always read about the importance of top management support in connection with implementation of a management concept (such as balanced score cards), a new project model or a new ERP system. Support from top management provides the initiative with the right light – a precondition for growth.

Project Team Competence. If the company does not have the right competences in the project the project runs the risk of failing. The competences may vary from project to project. The competences are related to both in-depth knowledge about the existing practice and more general project management skills.

Interdepartmental Cooperation. Projects are rarely only silo projects (projects within one function). Most projects have a cross-functional impact. It is crucial for a company that the different functions of the company cooperate in such a project. Such cooperation could, for example, be to release some important resources to the project or be adaptive to changed practice due to new technology.

Clear Goals and Objectives. As examined in chapter 5, it is difficult to succeed without goals and objectives. This is also true for IT implementation projects. To have clear goals and objectives is a CSF because CSFs clarify what is needed at which time, at which cost and with how much resource consumption. Clear goals and objectives also make it easier to measure the projects performance and thus provide the foundation for paying bonuses.

Project Management. A company is in a bad way if it has a number of brilliant specialists in the project, but no resources to manage the project. In particular, project management is very important in ERP implementation projects. Project management is concerned with a wide range of activities related to the project such as planning, economy, resource allocation, follow-up and communication. We will return to the project management element later in chapter 9.

Interdepartmental Communication. The cross-functional nature of most IT implementations requires that there is communication across the various functions of the company. Such communication can be the input to process development and communication of new functionalities, when the project is expected to go live, and to the plans for education. Too often, the communication element is underestimated which can lead to resistance to change.

Management of Expectations. This is a CSF since an IT implementation involves a wide range of different staff both in the development, implementation and operation phase. Many people will be impacted by the project. During communication before and during the implementation, expectations are being set that at this point of the operation phase the new changes shall demonstrate their robustness. Thus, there is a need for organizational talent that is continuously aware of the different stakeholders in the company and their expectations to the new system.

Project champion. This CSF is similar to project management. However, project management is more concerned with the discipline of project management in general. The concept of project champion is related to those few passionate employees that often carry the project through.

Vendor Support. Today, very few projects are implemented without any support from the system vendor. Vendor support is a prerequisite in IT implementations. Vendors should provide the person who has the in-depth knowledge of the system's functionality and thus is able to judge what is possible to do with the system and what is not.

Careful Package Selection. When the IT project has provided an overview of the existing processes (cf. AS-IS description), they need to design the new process (TO-BE). In such a design process, one often has to take into consideration the functionality of the new system. There is always a balance between using standard functionality vs. making costly adjustments to the standard system (by programming). In an IT project, it is therefore important to carefully select which application is needed.

Data Analysis and Conversion. An often underestimated activity in IT projects is validating the current quality of the master data. In many companies, there is no specific responsibility for the master data. Without any responsibility, there is no incentive to improve the master data. A CSF in an IT implementation project is therefore not to overlook the tasks related to secure valid master data and then to plan how to convert the data from one system to the new system. Different tools exist that can be used when flushing data from one system to another. Within this CSF is also the development of new data types that the new functionality provides.

Dedicated Resources. This CSF is concerned with a fixed amount of resources that is dedicated to work in the project. Thus, if one department, for example, assigns full-time employees to the project it is important that the persons are named and that their competences match the requirements of the project. It makes it difficult if different resources participate in the project. The project needs stability. It also has to build its own project culture (in terms of working methods, communication and joint planning).

Use of Steering Committee. In the project organization, i.e. a temporary organization that is dissolved when the objectives are met, the steering group plays an important role. The steering committee makes decisions based on proposals developed by the project group. A CSF is therefore that the project group is continually using the steering group both to test proposals and to promote the project to the stakeholders in the company. We return to this later in chapter 9.

User Training on Software. In IT projects, it is not uncommon that the project is delayed and/or is more costly than planned. The project can be tempted to rely on the job training by some internal super users. Sometimes, we also see that the planned education activities are pruned down due to budget problems. However, if the company is to really take the full advantage of their IT investment, it is of crucial importance that the staff also understand using the new software. Otherwise, the company runs the risk that the staff develop their own sub-systems in order to bypass the new processes.

Education on New Business Processes. This CSF is closely related to the above-mentioned section about training in the new software. This CSF is related to business processes – the understanding of how the businesses will operate. The staff needs necessary education to understand these new processes and also to perform them.

Business Process Reengineering. As has been described earlier in this chapter, this CSF is concerned with making radical redesigns of business processes which are often required in order to obtain noticeable improvements.

Minimal Customization. Software customization is costly. The costs associated with customization are programming costs, testing costs, and training and education costs. Many IT projects begin with the mantra "instead of changing the system, we need to change the organization". In other words, change the business processes so that they fit the work structure in the new system. In spite of starting out with such a mantra, many projects must admit that customization is necessary within certain areas.

Architecture Choices. When IT systems are implemented it is often not the IT software alone that is implemented. Typically, there will also be questions related to hardware, Wireless Area Network, Local Area Network, firewalls etc. There is a need for a strategic view of the company's entire IT architecture so that the company makes sure that all the system elements can play together.

Change Management. IT system implementation creates new ways of working in business processes by using new functionalities in the new IT system. These changes need to be managed. They call for change management. Change management is concerned with different ways to manage people's behavior before, during and after an implementation of a change. In chapter 10, we discuss the concept of change management thoroughly.

Partnership with Vendor. A good relationship with the system vendor is of major importance. The IT project is often very costly for the company and the performance of the company cannot avoid being influenced during the implementation. It is of special importance that the vendor and the company view such a project as a common project. In spite of system experience, the vendor is often also faced with new challenges in the project that develop their skills. Such elements are important to be discussed during the project in an open and trustful manner.

Use of Vendor's Tools. This CSF is related to the different tools, methods and techniques that are often required to be used in an IT project. Instead of developing own tools, why not rely on the vendor's tools which are tested and documented in applicability? From a resource consumption perspective, it is more economical to rely on the vendor's tools.

Use of Consultants. In some companies, there is a fear of using external consultants. This is often for no reason. Consultants can bring in experience from other similar projects. They often have an in-depth knowledge of the system's functionality and will be a necessary sparring partner in establishing user requirement specifications and solution design. Project management consultants can also be hired if the company does not have such competences in house.

Discussion Questions

1. What are the differences between a planned and an emergent strategy perspective?
2. What are the differences between incremental and radical business improvement strategies?

3. Explain the advantages and disadvantages of the big bang implementation approach.
4. Explain the advantages and disadvantages of the concurrent implementation approach.
5. Explain the advantages and disadvantages of the phased implementation approach.
6. Explain the advantages and disadvantages of the pilot-ramp-up implementation approach.
7. Explain different BPM maturity stages.
8. Explain the meaning of strategic alignment.
9. What is a critical success factor in an ERP implementation?
10. Give examples of critical success factors in an ERP implementation.

CHAPTER 7

Information Technology

Introduction

> I think there is a world market for maybe five computers. (Chairman of IBM, 1943)

In the context of process analysis and redesign, it is important to be aware of the distinction between manual and automated activities. Before the use of software, business processes were completely manual and mostly paper-driven. Nowadays, many activities are automated in most companies. However, in most companies the potential of using IT is far from reached. There are a lot of good reasons for considering the use of IT when planning business process improvements, such as:

- IT is one of the most important means for managers to make the business processes of a company more efficient.
- Companies that invest wisely in IT experience better productivity and efficiency.
- IT makes it possible to realize new business opportunities in relation to markets, products and services.
- IT makes it possible for companies to differentiate themselves from competitors.
- IT makes it possible for companies to gain a strategic advantage over rivals.

Process improvement with the use of IT can be done in different perspectives ranging from automation of a task which a single person carries out, to breaking down organizational borders and redefining the value chain. The range of different perspectives on the use of IT is illustrated in Figure 7.1. At the bottom, the purpose of IT is to automate a business function. A level higher, the purpose is to automate several functions. One level above, IT also links functions via a corporate database. At the next level, IT integrates business processes within a company. One level higher, IT transcends organizational borders, implying that processes are integrated with the processes of business partners. At the top level, the organizational boundaries become blurred and the value chain redefined.

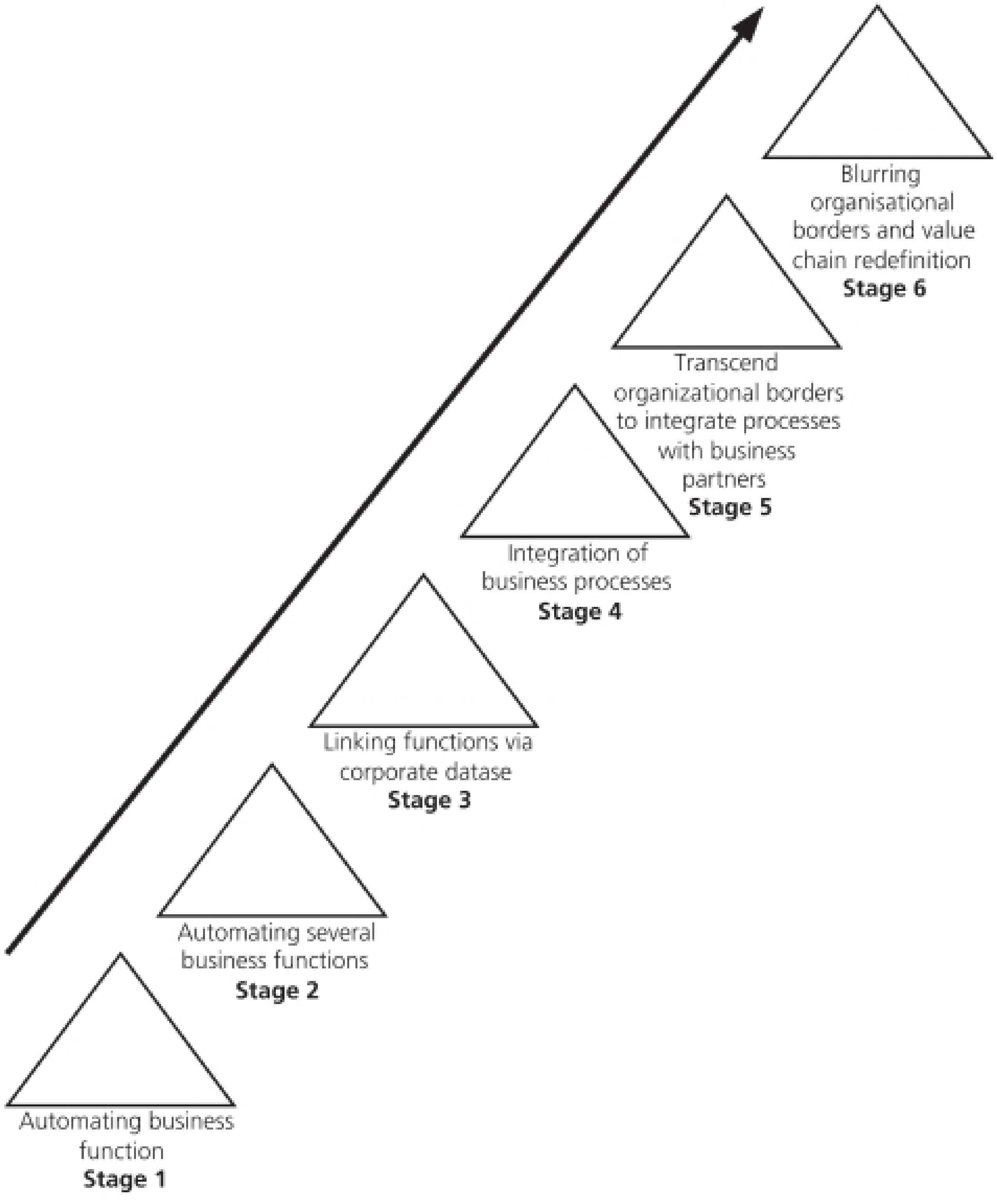


Figure 7.1: IT Implementation on Different Levels
Source: Based on Boddy et al. (2008, p. 131)

This chapter aims at providing a brief overview of some of the most common technologies which can be implemented in order to optimize business processes. To achieve this, the remainder of this chapter starts with a brief overview of the development of IT from mainframes and mini computers to the concept of cloud computing. The subsequent sections describe 'the automation pyramid' and the technologies that it includes, i.e. PLC, SCADA, MES, ERP systems and business intelligence. The next sections describe the technologies: knowledge management systems, technologies to control movements of items, and e-commerce.

The Development of IT

To begin with, the difference between three terms needs to be understood: 1) Information Technology (IT), 2) Information and Communication Technology (ICT), and 3): Information System (IS). IT refers to the hardware and software created to collect, store, process and create outputs of digital content. ICT is a term often used synonymously with IT. The use of the term ICT often serves to emphasize the communication aspect, i.e. technologies such as broadcasting (radio, microphone, camera, etc.) and wireless telecommunication. An information system, on the other hand, does not necessarily have anything to do with IT, although it often does. An information system refers to the interaction between people, processes, data and technology. It can be described as a set of interrelated elements which gather data/information inputs, process inputs, and deliver data/information outputs.

The way in which IT is used has gone through a big development since the first computers were made in the early 1940s. Figure 7.2 shows how IT infrastructure has evolved. To begin with, IT infrastructure was created by the use of mainframes and mini computers. A mainframe computer is a large computer which is capable of supporting hundreds or even thousands of users simultaneously and can process very high volume input. To avoid overheating, mainframe computers are normally placed in special air-conditioned rooms. Mainframe computers are still used to a large extent and it has been estimated that more than half of the data in the world are placed in mainframes. A mini computer can perform the same types of functions as a mainframe, but is smaller physically and in processing power. Later, personal computers (PC) emerged. A PC is a computer which is built around a microprocessor and is to be used by an individual. A few years later, the client server architecture emerged. Client server architecture means that the user's PC (the client) is the requesting machine, while the server is the supplying machine. Client and servers are connected via a local area network (LAN) or wide area network (WAN). Later enterprise internet architecture emerged because of the problems that the client/server model posed, i.e. that many large firms found it difficult to integrate LANs in a single and coherent corporate computing environment. As the internet evolved and became a trusted communications environment in the mid-1990s, companies seriously began to use the internet to tie their disparate networks together. More recently, the concept of 'cloud computing' emerged. Cloud computing means internet-based development and use of computer technology where the term 'cloud' is used as a metaphor for the internet. Cloud computing, among other things, implies that software solutions, data servers and operating systems can be accessed on external servers via the internet instead of being installed locally. Google Apps which include web applications with functionality similar to traditional office programs is an example of this technology.

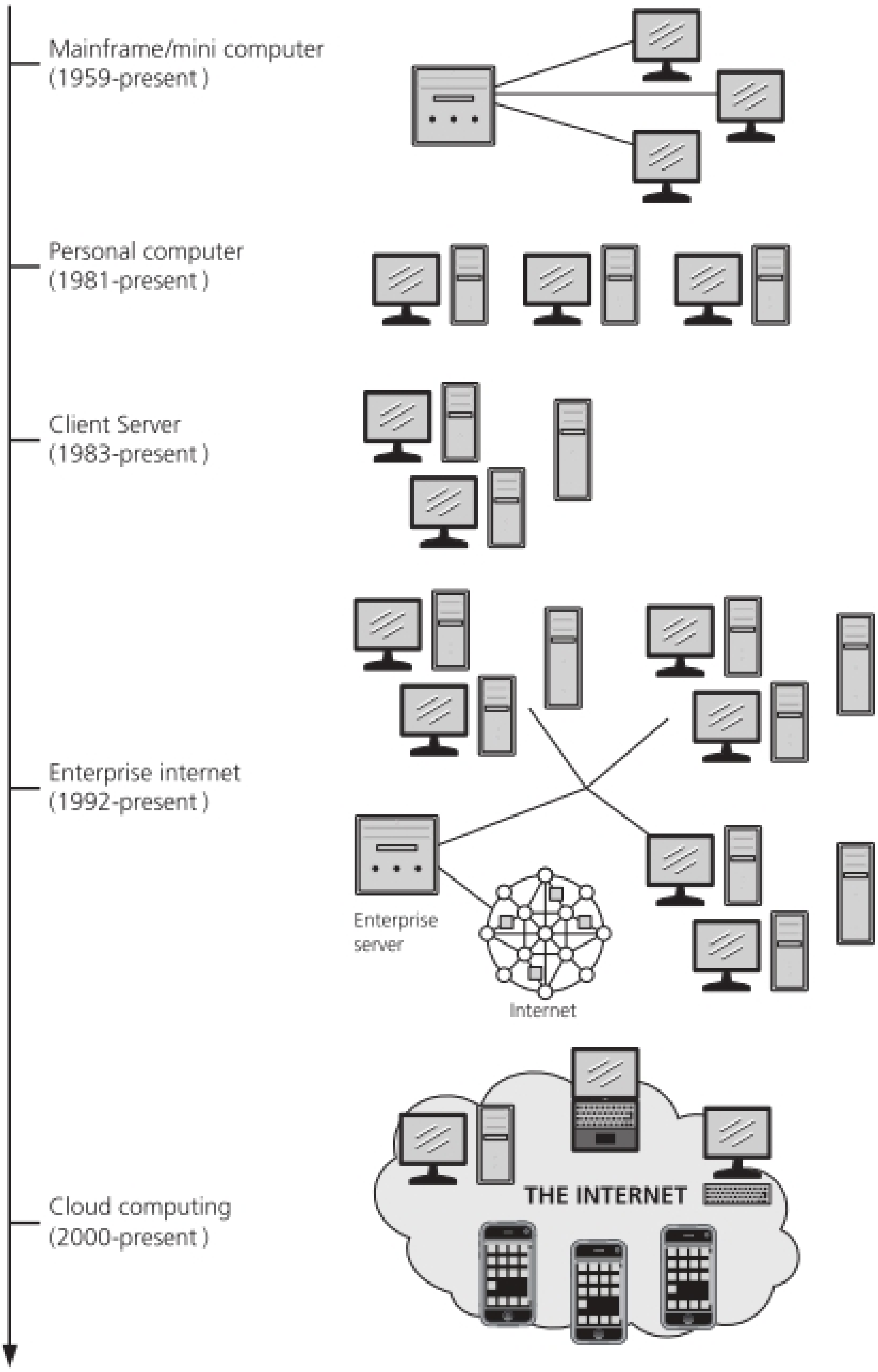


Figure 7.2: Stages of IT Infrastructure Evolution
Source: Pictures and information from Laudon and Laudon (2009, p. 193)

The Automation Pyramid

In general, the purpose of IT is to automate an activity to make it more efficient. IT solutions work at different levels, as illustrated by Figure 7.3. The levels can be understood as moving up from an operational level to an increasing strategic level.

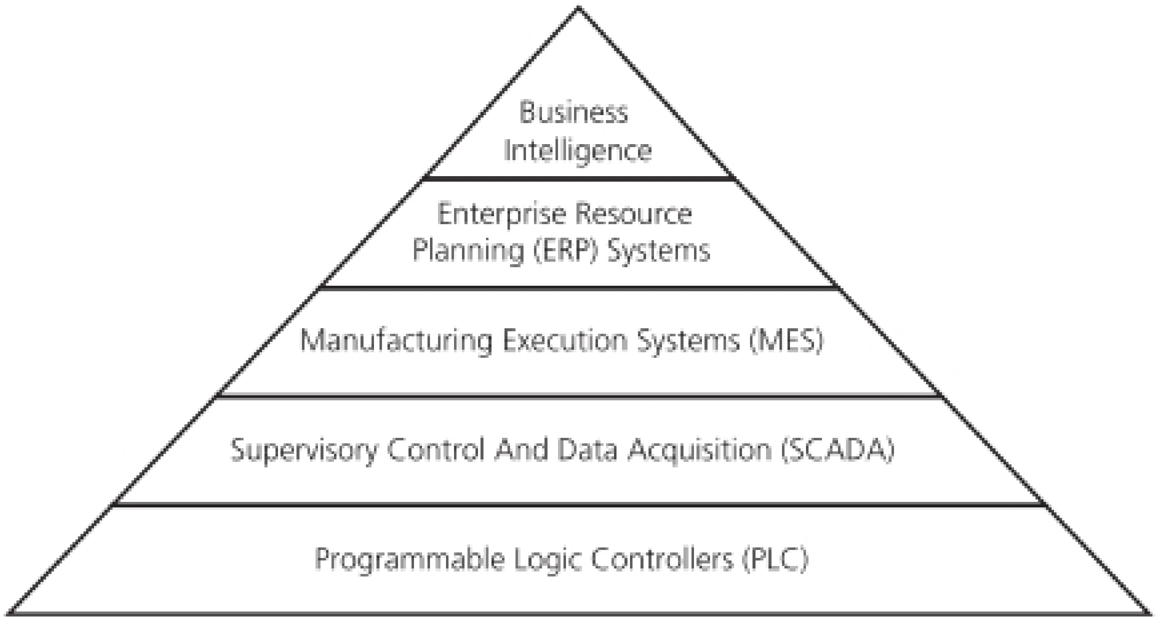


Figure 7.3: The Automation Pyramid
Source: Arlbjørn (2006, p. 126)

In the following sections, each level of the pyramid is described, starting from the bottom and up. Subsequently, other types of information technologies that are not included in the pyramid, are described.

PLC

A programmable logic controller (PLC) is a small computer that automates electromechanical processes, such as controlling factory assembly lines or machines. Before PLCs, factories needed many individual relays and CAM (Computer Aided Manufacturing) timers. In some cases, thousands of relays and timers can be replaced by a single PLC.

PLCs have a programmable microprocessor, which converts programmed instructions into action. Typically, the programs for PLCs are written on regular computers and then downloaded to a PLC. The PLC continually cycles the program in its memory, so that when it detects changes in a signal it monitors, it reacts based on the programmed logic and produces an output signal. These output signals can be in the form of instructions to a manufacturing machine, ventilation system, transport system, etc. PLCs can monitor multiple sensor inputs, such as motor starters, lights, valves and displays. PLCs have a wide range of functionalities, such as relay control, motion control, process control, and complex networking. PLCs are designed to be more resistant than normal computers and to withstand extended temperature ranges, noise, vibration and impacts.

SCADA

The term SCADA (Supervisory Control And Data Acquisition) generally refers to an industrial control system where a computer system monitors and controls processes. A SCADA system can control a number of PLCs from which the SCADA system receives information and to which it sends instructions. An example of the relationship between SCADA systems and PLCs could be a PLC that controls the flow of cooling water in an industrial process, while the SCADA system allows operators to configure the flow and define alarm conditions, e.g. low flows or high temperatures.

SCADA systems typically include:

- A man-machine interface: process data to a human operator who can monitor and control a process
- A computer-based supervision system: receives data from the process and sends commands to the process
- Remote terminal units: connects to the sensors in the process where sensor signals are converted into data to the supervision system
- PLCs: used as 'field devices'.

Typically, SCADA systems are centralized systems that monitor and control entire sites or even systems spread out over large areas (even across countries). SCADA systems have a range of applications. Most critical industrial infrastructures and processes are for instance managed remotely from central control rooms using SCADA technology. Other examples of the use of SCADA technology include control of the flow of gas and oil through pipes, refining processes, water distribution, management of the electricity grid, signal network for railways, electrical power transmission and distribution, management of large communication systems, control of ventilation systems, etc.

MES

Manufacturing Execution Systems (MES) constitute one of the key components in information systems for manufacturing support. MES are control systems that monitor and manage work-in-process on a factory floor. This can relate to production resources, such as machines, tools, labor resources, materials and supporting equipment. MES used to be stand-alone systems, but are increasingly being integrated with ERP software suites. The great advantage of integrating a MES with ERP software is that factory managers can be proactive about ensuring the delivery of quality products in a timely and cost-effective manner. However, MES are generally very complex systems that must be built and customized for a specific application.

MES monitor the production activities in a continuous way and feed operators with enough information for corrective actions to be taken. MES register manufacturing information in real time by receiving data instantly from robots, machine monitors and employees. Therefore, MES allow companies to track and monitor almost all aspects of manufacturing processes, while tying it all together for detailed analysis of each process.

Furthermore, MES can control the sequence in which orders are processed by considering the chain of properties and all possible changes that can occur after the job is begun. The use of MES can reduce the setup time of machines by considering aspects like colors, shapes, formulas, mechanical processes and equivalent components in order to calculate the most efficient mixes of operations. Also, MES can perform activities related to planning and scheduling of preventive maintenance and trigger corrective maintenance jobs in alarm situations.

MES can be seen as being in the system layer between the ERP systems and plant floor control systems, such as SCADA systems and PLCs that control individual machines or production lines. The relationship between ERP systems, MES and SCADA/PLCs is shown in Figure 7.4.

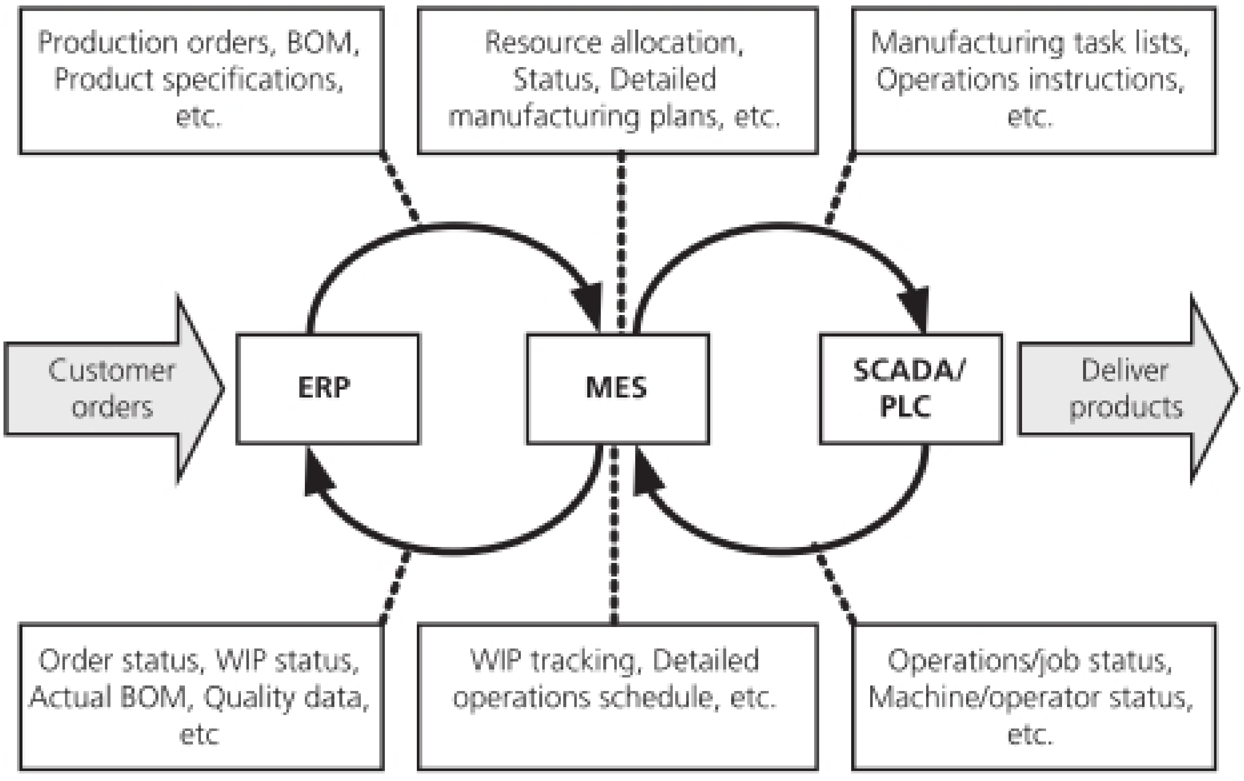


Figure 7.4: The Role of MES
Source: Based on Zhou et al. (2005)

ERP Systems

ERP (Enterprise Resource Planning) systems are computer-based systems used for managing internal and external resources. An ERP system includes software architecture with the purpose of facilitating flows of information between all business functions inside the organization and to outside stakeholders. ERP systems integrate many facets of the business, such as purchase, sales, manufacturing, human resources, etc. Typically, an ERP system is integrated with a relational database system.

ERP systems emerged as an answer to the problems that emerged from companies having multiple loosely interfaced IT systems. The many disparate IT systems for instance implied that combining information about sales and manufacturing with accounting data was difficult and error-prone. Thus, throughout the 1980s and 1990s, software entrepreneurs were developing integrated software packages in which multiple functional applications shared a common database. ERP systems emerged both from the administrative (financial and human resources) side of the business (e.g. SAP and Peoplesoft) and from material resource planning in manufacturing (e.g. Baan). The term 'ERP' is derived from its more narrowly focused predecessors on the manufacturing side, i.e. 'manufacturing resource planning' (MRP II) which followed 'material requirement planning' (MRP).

In the 1990s, ERP packages got a huge boost as companies began to realize the potential impact of the Year 2000 (Y2K) problem. Thus, many companies took this opportunity to replace several existing systems with an ERP system.

Figure 7.5 illustrates how the central database of an ERP system connects different functional areas which are used by or control different areas of the company and form the basis of communication with external actors.

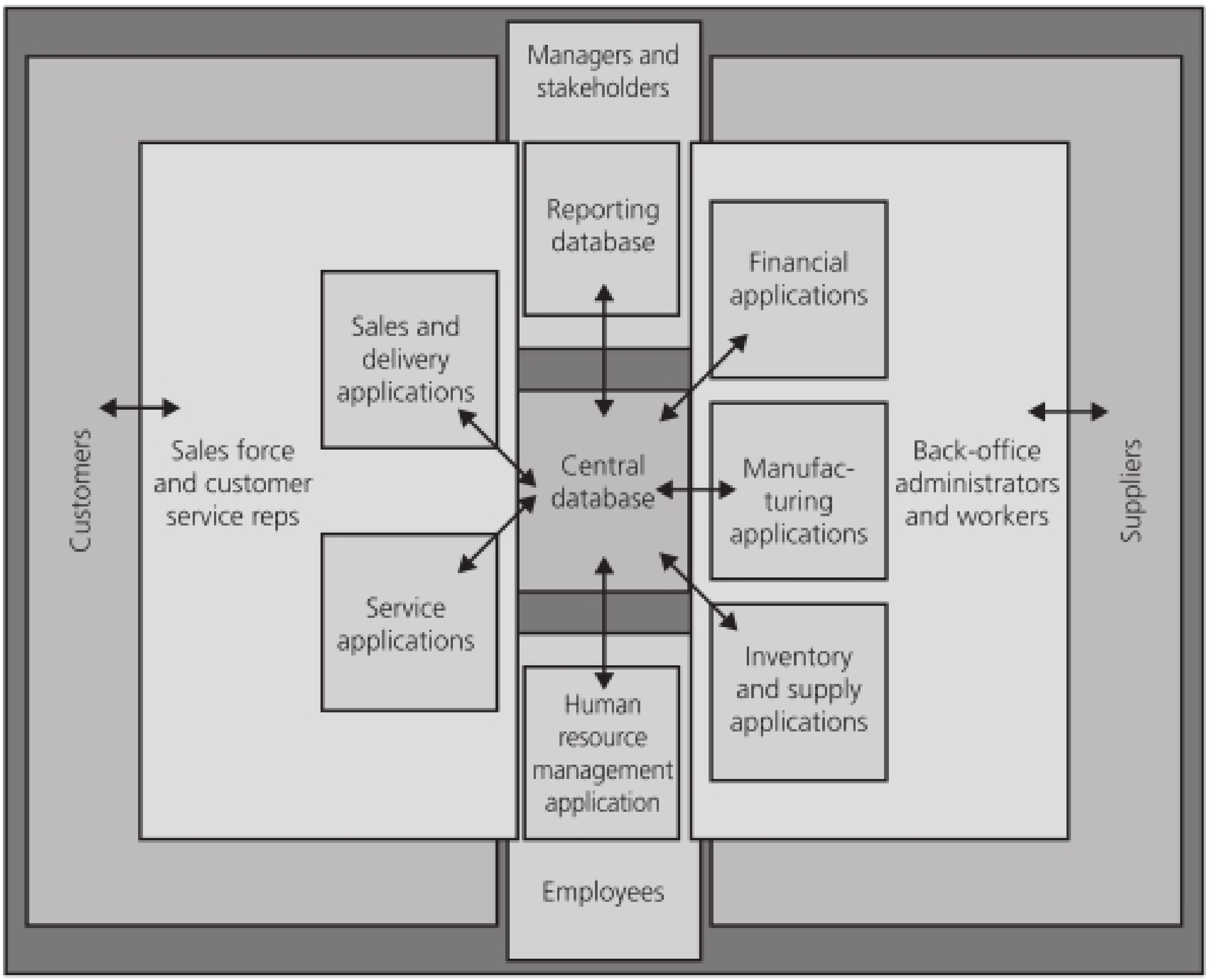


Figure 7.5: ERP System Components
Source: Davenport (1998)

ERP systems cover many functional areas. Some of the typical functions supported by an ERP system are (Dillon, 1999):

- **Financials**
  - Accounts receivable and payable
  - Asset accounting
  - Cash management and forecasting
  - Cost-element and cost-centre accounting
  - Executive information system
  - Financial consolidation
  - General ledger
  - Product-cost accounting
  - Profitability analysis
  - Profit-centre accounting
  - Standard and period-related costing
- **Human resources**
  - Human resource accounting
  - Payroll
  - Personal planning

  - Travel expenses
- **Operations and Logistics**
  - Inventory management
  - Materials management
  - Plant management
  - Production planning
  - Project management
  - Purchasing
  - Quality management
  - Routing management
  - Shipping
  - Vendor evaluation
- **Sales and Marketing**
  - Order management
  - Pricing
  - Sales management
  - Sales planning

Many companies have engaged in the use of ERP systems as a means of improving their competitiveness. The popularity of ERP systems can be attributed to their promise of improving operational efficiency and business efficiency. In many cases, ERP projects have also led to substantial tangible benefits (e.g. inventory reduction, less personnel needed, and reduced IT costs) and intangible improvements (e.g. improved internal processes, better customer service, strategic enhancements) in different areas of organizations (Davenport, 2000; Al-Mashari et al., 2003). However, achieving the expected benefits of the ERP system is by no means a guarantee in an ERP project. In fact, there are many examples of organizations that have not been successful in obtaining the intended benefits in spite of their large investments in ERP projects (Davenport, 2000; Markus and Tanis, 2000). Some researchers even argue that ERP implementation projects commonly do not fulfill their initial objectives and operations often suffer from ERP-related problems (Häkkinen and Hilmola, 2008; Liang et al., 2007). However, in spite of it not fulfilling its initial goals, an ERP project may still be profitable from an overall perspective.

The problems of ERP systems revolve around the numerous technical and organizational challenges, such as the required standardization of work processes, norms, skills, and outputs. As formulated by Davenport (1998):

> An enterprise system, by its very nature, imposes its own logic on a company's strategy, organization, and culture.

In the last decade, there has been increased focus on making ERP systems more adaptable to the individual organization. Thus, most ERP systems are configurable to a varying extent. The perspectives for the future of ERP systems may be captured in the term 'ERP II'. The term 'ERP II' was coined in the early 2000s to describe what will be the next generation of ERP software. The ideas in this direction include a new generation of ERP software which is web-based and allows both employees and external actors (such as suppliers and customers) real-time access to the system's data.

Related to ERP systems, and often included as modules in ERP systems, are CRM (Customer Relationship Management) systems and SCM (Supply Chain Management) systems.

CRM systems support companies in managing customer relationships in an organized way. This can be both sales and service-related. CRM technologies include:

- Sales Force Automation: The basis of such systems is typically a contact management system for tracking every stage in the sales process for each prospective customer, from initial contact to final disposition. Furthermore, such systems may include functionalities, such as opportunity management, sales forecasting, workflow automation, etc.
- Customer Service: The central area is call centre management, which includes phone routing to the correct service person and computer telephone integration to an easy analysis of calls. Customer service systems may also be in the form of self-service web-based applications.
- Marketing: Systems which help companies identify their best customers and generate leads for the sales team. Key functionalities include management of multi-channel campaigns (e-mails, social media, and direct mail) and marketing automation (support for managing customer loyalty, internal marketing resources, collateral, etc.).

SCM systems (and SCM modules of ERP systems) help companies to:

- Fast communication of orders to suppliers
- Track order statuses
- Check inventory levels
- Decide needed purchase orders
- Track shipments
- Fast communication of changes in product design
- Decide what and when to produce
- Decide what, when and where to store items.

SCM systems are inter-organizational systems because they automate flows of information across organizations. Overall, the functionality of SCM systems can be divided into three types:

- Planning systems: Can generate forecasts for a product (demand analysis) and support the development of plans for sourcing and production.
- Management systems: Can automate and support information flows between a company and its supply chain partners.
- Execution systems: Can control the flow of a product through distribution centers and warehouses to ensure that products are delivered to the right locations in the most efficient manner.

Business Intelligence

Business Intelligence (BI) is a term that covers a broad range of technologies for gathering, storing, analyzing, and providing access to data in order to help companies make better business decisions. There are several definitions of which technologies are included in BI. Some of the most commonly included technologies in BI definitions are:

- Reporting and querying
- OLAP (OnLine Analytical Processing)
- Data mining
- Decision support.

Figure 7.6 illustrates the general complexity of the first three technologies. Decision support systems, on the other hand, are not directly comparable, since they normally do more than operate on existing data.

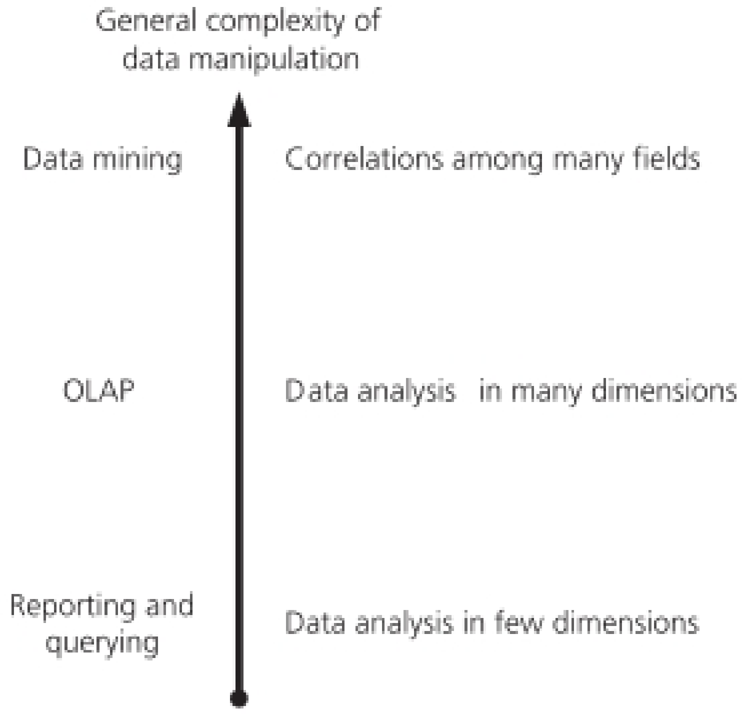


Figure 7.6: The General Complexity of BI Technologies

The four mentioned BI technologies are described in the next sections.

Reporting and Querying

Reporting and querying software are tools with the purpose of collecting information, categorizing the information, making summaries of the information and presenting the chosen information in a desired format. Such operations are generally based on large amounts of data in digital form which are often found in a data warehouse (a central repository for significant parts of the data of a company which various business systems collect).

OLAP

OLAP (OnLine Analytical Processing) is a technology that supports multidimensional data analysis. If a company for example needs to find out how many items of a particular product type has been sold during the last month, this is straightforward and can be done by the creation of a simple report or query. On the other hand, if the information needed is how many items of the particular product has been sold in each sales region and how this compares to the projected sales, OLAP can support this. In OLAP software, each aspect of information is represented in a different dimension, e.g. product type, product group, pricing, cost, region, time periods, etc. These dimensions can be combined in different ways to provide the required information.

Data Mining

Roughly speaking, data mining is the process of analyzing data from different perspectives and summarizing it in useful information. Such information can be used in an attempt to increase revenue or cut costs. Data mining software allows users to analyze data from different perspectives, categorize them, and summarize the relationships identified. From a technical perspective, data mining can be described as the process of finding correlations among dozens of fields in large relational databases. Data mining differs from OLAP by allowing users to find hidden patterns and relationships in large databases. Examples of the use of data mining are Blockbuster Entertainment who mines its video rental history database to recommend rentals to individual customers and American Express who can suggest products to its cardholders based on an analysis of their monthly expenditures.

Decision Support

Decision-making is crucial for any company and decisions are often irreversible and have far-reaching consequences. In effect, it may be claimed that decision-making is synonymous with management. There are three main types of decisions:

- Structured: repetition and routine oriented, and can often be formulated in rules
- Unstructured: requires judgment, evaluation and knowledge to solve the problem
- Semi-structured: a part of the problem is structured and a part of the problem is unstructured.

Systems for decision support operate on the data of transaction processing systems (TPS). Transaction processing systems (TPS) became popular in the 1950s, as many organizations began to utilize their functionality. TPS are systems that gather and store information about transactions and control some aspects of these transactions. TPS are designed to deal with routine-oriented transaction processes and they are often linked to or integrated in other systems (e.g. ERP systems). TPS deliver data which (mostly in processed form) constitute the basis for management decisions on higher levels. Examples of TPS include billing systems, payroll systems, purchase systems, stock management systems, and EPOS (Electronic Point Of Sale) systems.

IT systems that support decision-making can be divided into the following technologies (Laudon and Laudon, 2009, p. 483):

- Decision support systems (DSS)
- Management information systems (MIS)
- Executive information/support systems (EIS/ESS)

DSS emerged in the 1960s to assist decision-makers in dealing with semi-structured and structured problems. DSS can combine raw data, documents, personal knowledge or business models to solve problems and make decisions. A DSS may contain OLAP and data mining tools. Examples of DSS include: systems for medical diagnosis, systems for determining the optimal product mix for a specific market, systems for forecasting sales depending on various parameters (product cost, raw materials costs, etc.), etc.

MIS emerged in the 1960s with the development of database management systems as systems for collecting, organizing, storing and retrieving data. MIS can extract valuable management information by processing and summarizing massive amounts of transaction data and by allowing user-interactive queries. In contrast to DSS, MIS typically work on structured problems, such as: costing a product based on sales, define future financial needs, when to provide inventories to achieve just-in-time deliveries, etc.

EIS emerged in the mid-1980s to serve the information needs of executives. An EIS can provide timely and critical information in a filtered and compressed form for tracking and control purposes. EIS consolidate and summarize ongoing transactions within the organization, but also integrate external information. Often the terms 'Executive Support Systems' and 'Executive Information

Systems' are used interchangeably. However, some also use the term ESS to refer to systems with a broader set of capabilities than EIS. While EIS work on structured problems, ESS include broader decision support capabilities. Also the terms ESS and DSS are often used synonymously, but strictly speaking, these are not the same. In general, an ESS (and EIS) provides 'war-room style' graphical interfaces to overlook the entire enterprise, while a DSS typically has more of a spreadsheet style and often supports only one department or one product at a time. However, it should be noted that there are different definitions of what DSS, MIS, EIS and ESS are exactly.

Figure 7.7 shows how the described systems are placed in a hierarchy from the operational to the strategic level. The systems are typically used across different functional areas. As seen, EIS/ESS are found at the strategic level. MIS and DSS are found at management level. TPS are used at the operational level.

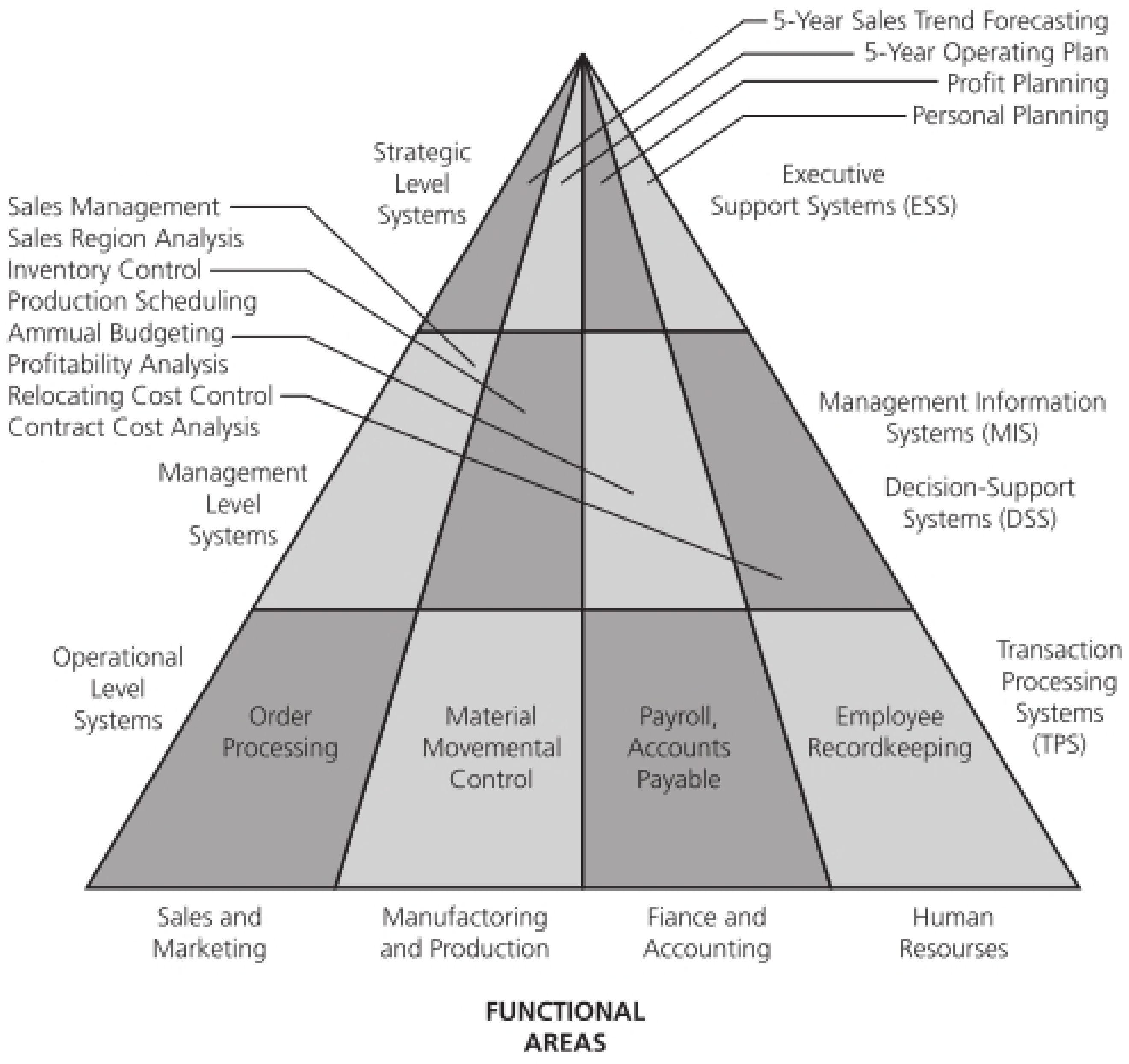


Figure 7.7: Decision Support Systems
Source: Laudon and Laudon (2006, p. 42)

Knowledge Management Systems

For many types of companies, knowledge is the main resource. However, managing business knowledge can be challenging. Thus, many companies invest in knowledge management systems (KMS). KMS enable companies to better manage their processes for capturing and applying knowledge and expertise. KMS collect all relevant knowledge and make it available to those who need it, wherever and whenever. KMS can also link a company to external sources of knowledge. There are different definitions and understandings of a KMS. In this book, the rather broad definition of the technology by Laudon and Laudon (2009, p. 446) is used. In this perspective, KMS can be divided into three major types:

- Enterprise knowledge management systems
- Knowledge work systems
- Intelligent techniques.

Enterprise Knowledge Management Systems

Enterprise knowledge management systems (EKMS) include capabilities for storing both structured and unstructured data. EKMS also include functionality for locating employee expertise and for obtaining information from key transaction systems. Furthermore, EKMS include supporting technologies, such as portals, search engines, and collaboration tools, such as e-mail, instant messaging, blogs, etc. EKMS can be divided into three categories: 1) Structured knowledge systems, 2) Semi-structured knowledge systems, and 3) Knowledge network systems. Structured knowledge systems are used to deal with structured information (information organized in a structured and consistent way, such as database fields in a predefined format). On the other hand, semi-structured knowledge systems can also handle unstructured information (information created individually and manually, such as natural language documents, speech, audio, images and video). Knowledge network systems support situations where focus is on the tacit knowledge residing in the heads of experts. Knowledge network systems provide a directory of corporate experts regarding their knowledge domains, in order to support employees in finding the appropriate expert in a company. The three types of systems are summarized in Table 7.1.

Type of knowledge	Knowledge content	Category of EKMS
Structured knowledge	Formal documents	Structured knowledge systems (SKS)
Semi-structured knowl-edge	E-mail, voice mail, memos, bro-chures, digital pictures, bulletin boards, and other unstructured documents	Semi-structured knowledge systems SSKS)
Network knowledge	Expertise of individuals	Knowledge network systems (KNS)

Table 7.1: Categories of Enterprise-Wide Knowledge Management Systems
Source: Based on Laudon and Laudon (2009, p. 447)

Knowledge Work Systems

Knowledge work systems are aimed at offering support for knowledge workers, i.e. researchers, designers, architects, scientists, engineers, etc. Knowledge work systems support the knowledge workers in their creation and documentation of knowledge. Three examples of knowledge work systems are shown in Table 7.2.

Knowledge Work System	Function in Organization
CAD/CAM (computer-aided design/computer-aided manufacturing)	Provides engineers, designers, and factory man-agers with precise control over industrial design and manufacturing
Virtual reality systems	Provide architects, engineers, and medical work-ers with precise, photorealistic simulations of objects
Investment workstations	High-end PCs used in financial sector to analyze trading situations and facilitate portfolio man-agement.

Table 7.2: Examples of Knowledge Work Systems
Source: Based on Laudon and Laudon (2009, p. 455)

The first type of system in Table 7.2, i.e. CAD/CAM systems, is used for the support of analysis, design and manufacturing of products. CAD systems are typically used for the creation of technical and engineering drawings, while CAM systems are used to control machinery in the manufacturing process, such as drilling holes in a medium with a CAD drawing as input. Virtual reality systems can simulate places in the real world and imaginary worlds and are often found in the form of 3D environments in which the user can move around. Investment workstations are high-end PCs specialized in accessing and manipulating large amounts of financial data in order to support the analysis of trading situations and portfolio management.

Intelligent Techniques

Intelligent techniques include artificial intelligence and database technology. Intelligent techniques allow companies to capture individual and collective knowledge and generate new knowledge from this basis. Intelligent techniques include (Laudon and Laudon, 2009, p. 446):

- Data mining (described in a previous section)
- Neural networks
- Expert systems
- Case-based reasoning
- Fuzzy logic
- Genetic algorithms
- Intelligent agents.

Expert systems, case-based reasoning and fuzzy logic support the creation of new knowledge based on facts, approximations, estimates and rules. For example, such systems are used for the automation of engineering knowledge in relation to the design of complex products. Data mining and neural networks focus on the discovery of knowledge based on finding patterns, categories and behavior of large datasets. Genetic algorithms can generate solutions to problems that are too large and complex for human beings to analyze on their own, such as finding the most efficient solution to logistic problems. Intelligent agents can be used for the automation of routine tasks by providing searches and filtering of information for use in electronic commerce, supply chain management, etc.

FLSmidth is a large Danish company that produces complete processing plants for cement manufacturing, supplies parts for processing plants and carries out the modification of existing cement plants. A complete cement plant typically costs about 150-200 million USD and the throughput time for construction is typically 2-3 years. Because of the great complexity of the product, FLSmidth faced some challenges related to the quotation phase. First, FLSmidth should be able to propose different solutions to the customer and provide a set of alternative setups (e.g. capacity, operating costs, price, and energy consumption). This information was needed as fast as possible in order to make binding quotations. However, given the complexity and uniqueness of each project, the company had to allocate great resources to the quotation process in order to meet this demand. The time consumption for this task was further increased by the fact that great correctness of calculations was needed, since one miscalculation could mean a huge loss for the company. To face some of these challenges, FLSmidth decided to implement a product configurator (a product-oriented type of expert system). The configurator was launched in 2000 and can, based on relevant design choices from a specific customer, generate a budget quotation which, among other things, includes:

- An outline of the content of the quotation, preconditions, and financing terms
- A cost estimate
- Project characteristics, e.g. operating time, capacity, emissions, etc.
- Flow charts (mass flow) of the entire cement plant
- Flow charts of plant departments, including mechanical descriptions
- Descriptions of the main machines
- A general description of electricity and control.

The benefits that have been achieved from the use of the configurator include:

- Reduction of resources for the elaboration of quotations by 50%.
- Sales representatives much more seldom need to burden engineering specialists with the elaboration of budget quotations.
- The period of elapsed time from a client request to the signing of the final contract has been considerably reduced.
- It is now possible to respond to all requests with a quotation, whereas before only half such requests could be answered..
- More homogeneous and better quality budget quotations.
- The difference between costs calculated in the budget quotation and the actual costs has been reduced.
- The configurator ensures that the sales person obtains all the necessary information before the budget quotation is made.
- Application of default values means that a quotation can be made at an early stage with very little customer input.
- Easier to simulate different solutions for the customer.

Table 7.3: Sales Process Redesign at FLSmidth
Source: Hvam (2006)

Enterprise Content Management Systems

Closely related to KMS (in particular EKMS) are enterprise content management systems (ECM). ECM technology has its roots in the innovations in network technologies which, in the 1990s, made it possible to store, organize and share information in new ways. On this basis, the field of web content management emerged in the mid-1990s to face the challenges of managing corporate web pages which increased in complexity and size. However, ECM should not be confused with web content management, but have a different and more extensive focus. ECM systems can be traced back to IT system concepts such as information resource management, knowledge management, and electronic document management (EDM). While EDM traditionally addresses the management of files, ECM goes beyond the idea of a file being just an object to be managed. Instead, ECM includes dealing with other technical and organizational challenges related to keeping track of the content together with its organizational production and use. ECM includes the management of all digital assets, i.e. documents, data, reports, web pages, etc. The term 'ECM' is widely used by software vendors and practitioners to refer to technologies used for managing the content of information media like documents, web sites, intranets, and extranets. However, the term ECM is in many ways still ambiguous.

Technologies to Movements of Items

Different technologies exist in relation to making the processes related to movements of items more efficient. Such technologies include:

- Bar codes
- Voice picking
- RFID.

Bar Codes

A bar code is a data representation, readable for machines. More specifically, bar codes can be read by optical scanners (bar code readers) and scanned from an image by different types of software. Bar code technology became really successful when the technology was used for the automation of supermarket checkout systems. Today, this use of the technology is almost universal. Besides the use of bar codes in relation to supermarkets, bar codes also have a wide range of other applications, such as: patient identification in hospitals; document identification in document management tools; item movements in relation to manufacturing and distribution; entertainment event tickets; and much more.

Based on information from GS1 Denmark, an example of a bar code is given in Figure 7.8. The first 2 or 3 digits indicate in which country the product is registered, which is not necessarily the same place as it was produced. The bar code starts with 57 which is the code for Denmark. The next digits (the number of digits may differ in different countries) indicate the manufacturer, importer, wholesaler or retailer who has registered the product. Except the last digit, which is a control number, the next numbers refer to the number of the product. The control number allows for analysis of errors in bar codes.

5 701598 025806

Figure 7.8: Example of EAN Bar Code

RFID

RFID (Radio Frequency Identification) is a common denominator for technologies that apply radio waves to identify objects and individuals. By some, RFID is referred to as the 'bar codes of the future'. The greatest difference between the two technologies is that a bar code needs physical contact with a scanner, whereas an RFID tag can be read without visual contact, but obviously within readable distance.

RFID technology includes three main components: an RFID tag (also named a transponder), an RFID reader and a backend server. The RFID tag is a small chip attached to the object which is to be controlled. The tag emits a unique bit string which serves as the object identity. Tags can be active or passive tags. Active tags are battery-powered, while passive tags get their energy from the reader. An RFID reader is a device that can read RFID tags, such as a PDA or a mobile phone. A reader must have a number of antennas that can send and receive radio waves. The information exchanged can be in various formats. However, in commercial RFID systems it is often just the ID of a product that is exchanged. By using the identity of the object as a pointer, an RFID reader can retrieve detailed information about the object from a backend server database. By using such a database, the need for information in the RFID tag itself can be minimized.

Today, RFID is used in many operation and supply chain management contexts to help keeping track of products (to avoid empty inventories, tracking of goods and reduction of theft). The use of RFID can help reduce waste, optimize storage position, improve the identification of goods, make bottlenecks visible, trace erroneous deliveries, and improve the handling of returned goods.

A main obstacle to the use of RFID instead of bar codes is the price. While bar-code labels can be as inexpensive to implement as $.005 for each bar code label, in its most simple form RFID tags typically costs at least ten times more to implement. More complex RFID tags cost much more.

Voice Technology

Voice technology is often applied to warehouses to manage the movement of goods. Voice-directed employee devices consist of a battery-powered unit and a headset with a microphone which via radio frequency connects to a warehouse management system. Voice-directed devices allow employees to perform their job functions 'hands free and eyes free'. A voice system can direct an operator to perform each pick by giving directions to each pick location, while the operator provides feedback on having done the action, product identification numbers, amounts and similar.

The use of voice technology became popular in the 1990s, especially in large distribution centers, such as the ones of Wal-Mart. Voice technology may provide advantages, such as fewer picking errors, increased productivity because of the elimination of unnecessary transport to the warehouse, less need for training of new employees and reduced use of resources (time and materials) to print picking lists. In fact, providers of voice-recognition technology claim that the effects of voice technology can increase accuracy in picking up to 99.99%, productivity up to 50% and reduction of training time by 50% (Berger and Ludwig, 2007).

E-Commerce

Normally, the term 'e-commerce' is used to refer to the conduction of business by the use of the Internet. However, more formally, the term includes all sorts of digitally enabled commercial transactions. Some 30 years ago, e-commerce normally referred to technologies such as Electronic Data Interchange (EDI) and Electronic Funds Transfer (EFT). These technologies were introduced in the late 1970s and allowed companies to send business documents (e.g. purchase orders and invoices) digitally. In the 1980s, the much increased use of credit cards and ATMs (automated teller machines) represented other forms of electronic commerce. In this decade, also airline reservation systems emerged. In the mid-1990s and until now, the use of online shopping has been through a dramatic growth. Although most purchases are still done through traditional channels, e-commerce continues to gain an increased share. According to Laudon and Laudon (2009, p. 403), the first wave of 'the new' e-commerce transformed the business related to books, music, and air travel, while the second wave includes eight new industries facing a similar transformation, namely telephones, movies, vision, jewellery, real estate, hotels, bill payments, and software.

The terms 'e-commerce' and 'e-business' are sometimes used interchangeably. However, these are different concepts. Roughly speaking, the difference is that while in e-commerce, information technology is used in business transactions across companies and/or consumers, the term e-business refers to the use of IT to enhance a business. More specifically, e-business includes any process done in a business context which an organization conducts over a computerenabled network. Thus, e-business is a broader concept including production processes, internal management processes and customer-focused processes, including e-commerce.

Laudon and Laudon (2009, p. 406) define seven unique features of e-commerce technology:

1. Ubiquity: Internet technology is available everywhere, for which reason the marketplace gets extended beyond traditional physical barriers.
2. Global Reach: The technology reaches across cultural and national boundaries worldwide.
3. Universal standards: One set of technical standards (i.e. internet standards) makes disparate computer systems able to communicate with each other.
4. Richness: The technology allows video, audio, and text messages to be integrated in marketing messages.
5. Interactivity: The technology allows interaction with the user making the customer a participant in the process of delivering goods to the market.
6. Information density: The technology reduces information costs dramatically and raises information quality.
7. Personalization: The technology allows personalized messages to be delivered to individuals.

Disintermediation and Re-Intermediation

E-commerce enables the strategies of disintermediation and re-intermediation. Disintermediation means that actors of a supply chain are passed. In Figure 7.9, two examples of disintermediation are shown. In the example to the left, the distributor is passing the retailer and approaching the consumer directly, while in the example to the right the manufacturer is passing both the distributor and the retailer. E-commerce is a means of making this possible because the use of internet-based sales can dramatically reduce transaction costs and make it easier to get in contact with potential customers. The business model of the company 'Dell' provides a good example of disintermediation, since Dell via sale through the internet directly to the customers skips the use of retailers.

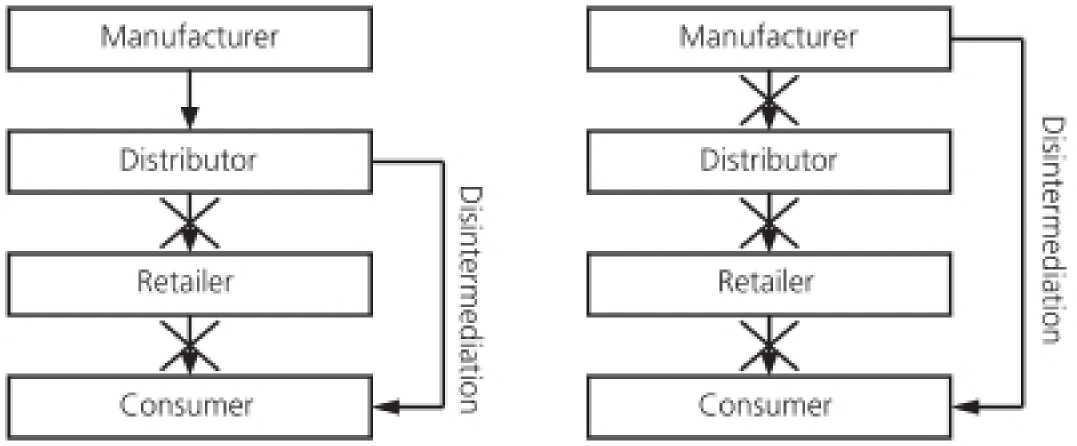


Figure 7.9: Disintermediation

The opposite of disintermediation is re-intermediation. Re-intermediation is the creation of new intermediaries between the customer and the suppliers. These are often in the forms of portals that can give customers an overall view of products and prices of different suppliers. An example of re-intermediation is the web pages which allow booking of travels, whereas normally, this was done through a travel agent.

Characteristics of E-Commerce

One needs to consider some basic characteristics of digital markets compared to traditional ones when considering a change in the sales channels of products. Table 7.4 summarizes some of these differences.

	Digital markets	**Traditional markets**
Information asymmetry	Asymmetry reduced	Asymmetry high
Search costs	Low	High
Transaction costs	Low (sometimes virtually nothing)	High (time, travel)
Delayed gratification	High (or lower in the case of a digital good)	Lower: purchase now
Menu costs	Low	High
Dynamic Pricing	Low cost, instant	High cost, delayed
Price discrimination	Low cost, instant	High cost, delayed
Market segmentation	Low cost, moderate precision	High cost, less precision
Switching costs	Higher/lower (depending on product characteristics)	High
Network effects	Strong	Weaker
Disintermediation	More possible/likely	Less possible/unlikely.

Table 7.4: Digital versus Traditional Markets
Source: Based on Laudon and Laudon (2009, p. 412)

As seen in Table 7.4, e-commerce provides a range of advantages compared to traditional markets. However, there are also some problems associated with this. Besides the consumer not being able to touch and feel the item bought, e-commerce also poses some security-related challenges that need careful consideration when rethinking business process in this manner. From the perspective of the customer, risks include: stolen credentials or passwords; dishonest merchants; disputes over transactions; and inappropriate use of transaction details. From the perspective of the merchants, the risks include: forged or copied instruments; disputed charges; insufficient funds in customer accounts; and unauthorized redistribution of purchased items.

Discussion Questions

1. What are the different levels of IT implementation?
2. Why should IT be considered when planning process improvements?
3. What is a PLC?
4. What is a SCADA system?
5. What is a MES?
6. What is an ERP system?
7. What is business intelligence?
8. What are knowledge management systems?
9. What are the technologies for managing item movements?
10. What is e-commerce?

CHAPTER 8

Design of Future Processes

Introduction

> The best way to predict the future is to invent it. (Alan Kay)

The purpose of the process design phase is to identify relevant business processes and redesign them in a way that improves the competitiveness of a company. It is essential to carry out the design phase in a formal manner instead of moving directly to implementation with preconceived assumptions of what the possible effects may be. Such an approach will inevitably lead to problems.

In the process design phase, a basis is taken in the process diagrams, performance measurements, company characteristics and other documentation created in the analysis phase. By analyzing such material, answers to the following questions can be established:

- What are the current problem areas in which changes are critical?
- Which other areas have room for improvements?
- What are the company constraints or limitations in relation to process change?
- What are the expected benefits of different future scenarios?
- Which process changes should be pursued first?

To provide more specific guidelines for answering these and related questions, the remainder of this chapter is organized in three main subsections concerning: 1) Evaluation of existing processes; 2) Defining the process redesign focus, and 3) Design of new processes.

Evaluation of Existing Processes

In many companies, there is much room for improvement of existing business processes. Often, some processes are carried out in an inefficient manner or are organized in a way that means that waiting for processes to finish so that others can begin takes up much of the time. However, identifying and evaluating problematic processes can be challenging. To support this task, a range of techniques exist. In the following subsections, the following techniques are resumed:

- Identification of evaluation aspects
- Process rating
- Problem matrix
- The brown paper method.

Identification of Relevant Evaluation Aspects

The redesign of a business process has to be done under consideration of internal and external variables which constitute the context of change. Internal variables include process purpose, process deliverables, resources, affected parts of the organization, etc. External variables are such as suppliers, competitors, customers and government regulations. By explicitly defining all the variables relevant for the process improvement project and organizing these in a form easy to overview, it can be avoided that relevant aspects are overlooked in the process design phase. An example of the formulation of internal and external variables is provided in Table 8.1.

Process: New Product Development	
Internal variables	**Explanation**
Main goal	Create new competitive products
Main deliverables	Product specification form, CAD drawings
Main resources needed	Product designers, engineers, AutoCAD
Main affected parts of the organization	Sales, Marketing, Manufacturing, Purchase
Etc.	
External variables	**Explanation**
Main competitors	Company A, B and C
Main customers	The graphic industry
Main suppliers	Company X, Y and Z
Government regulations	According to list Q
Etc.	

Table 8.1: Internal and External Variables

As seen in Table 8.1, for the process of developing new products the relevant internal variables for the process include goal, deliverables, needed resources and affected parts of the organization. The relevant external variables include competitors, customers, suppliers and government regulations. Obviously, if there is not a clear and common understanding of what such variables are, this may result in communication problems in the process design phase and/or in a poor process design.

Process Rating

Having described the relevant business processes, the next step is to evaluate these in order to determine which processes hold the potential for improvement. When conducting such evaluations, some of the important dimensions are:

- Process efficiency: Do errors occur? Are lead times satisfactory? Are tasks carried out redundantly?
- Process criticality: How important is the process for the company? This aspect can be divided into a short-term and long-term perspective.
- Process changeability: Are the involved employees ready for a change? Are there obvious ways of improving the process or would a change require great efforts?
- Risk of change: How risky is it to change the process?

Using the dimensions described above, in Table 8.2 and Table 8.3 examples of an evaluation of processes are shown. In the examples, the ratings are from 1 to 10, with 10 being highest.

Process: New Product Development		
Dimension	**Rating**	**Comments**
Efficiency	3	• Poor communication between product developers and engineers. • Long product development cycles.
Criticality (short-term)	3	• Currently there is not a great need for new products.
Criticality (long-term)	10	• New products within 5 years is necessary.
Changeability	9	• There seems to be great possibilities of change, e.g. better use of IT and change of work procedures.
Risk of change	1	• No significant risks have been identified.

Table 8.2: Process Evaluation: New Product Development

Process: Purchase		
Dimension	**Rating**	**Comments**
Efficiency	5	• Some errors occur. • Sometimes the promised delivery times are broken.

Criticality	10	• Purchases are essential for conducting the daily operations.
Changeability	8	• Strict policies towards suppliers can be employed. • Better software for order management can be used.
Risk of change	7	• Changes may lead to confusion and have a negative impact on supplier relationships.

Table 8.3: Process Evaluation: Purchase

The Problem Matrix

Another technique which can be used for identifying process problems, is the so-called 'problem matrix' (Johansen and Mitens, 1986, p. 34). The idea of a problem matrix is to identify the relations between problems. To do so, a matrix with the axes 'problem types' and 'areas/actors' is created. In the fields of the matrix, relevant problems are described. Next, the relations between these problems are shown by arrows. The method aims at getting to the root of the problem in order to avoid a superficial problem focus. If one does not understand a problem in depth, there is a chance that the implemented solution would not solve the problem. An example of the use of the problem matrix is shown in Figure 8.1.

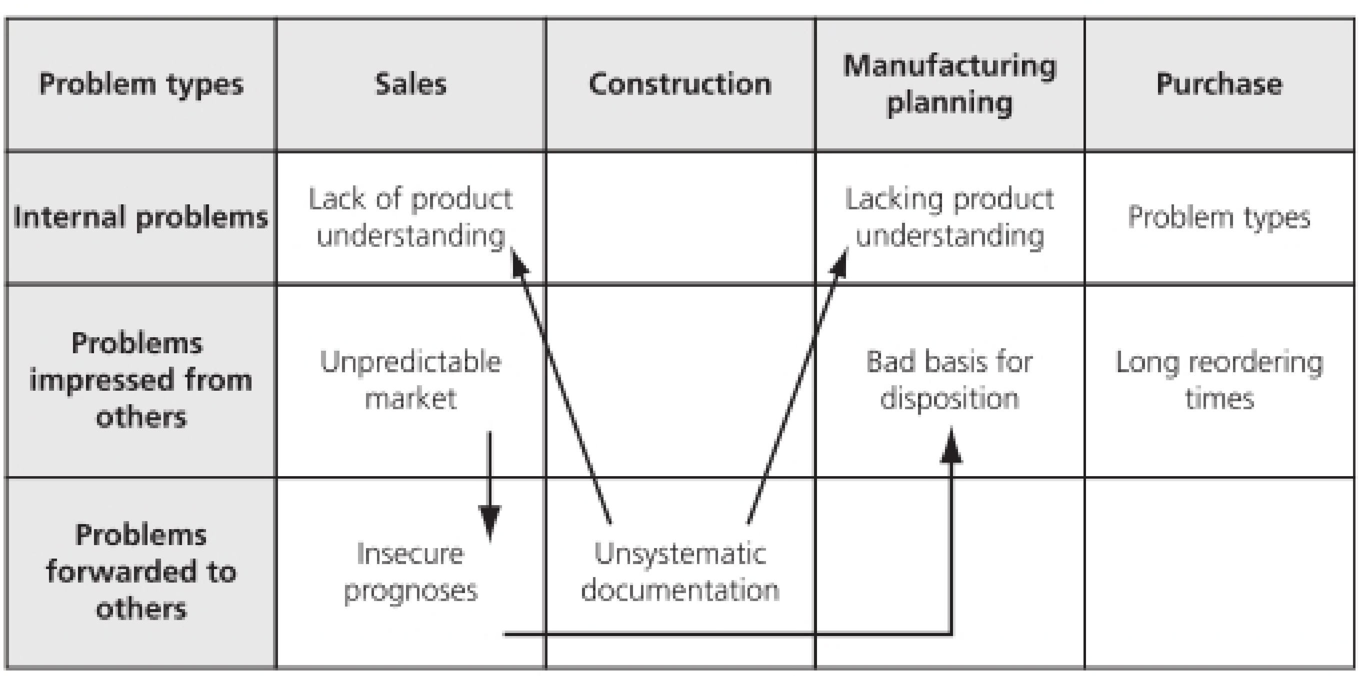


Figure 8.1: Problem Matrix
Source: Johansen and Mitens (1986, p. 34)

The Brown Paper Method

The brown paper method is a simple, but effective method to create a common overview of problem areas and proposals for solutions across functional units in a company. The brown paper method is easy to understand, interactive and dynamic. The method supports the identification of:

- Dead zones – places where work sits
- Lost time
- Rework loops
- Checkers checking the checkers
- Duplication of work
- Broken interfaces
- Value-added vs. non-value-added activities.

A brown paper session is typically organized into three main steps:

1. Identification of strengths and problem areas
2. Presentation of strengths and problem areas
3. Synthesizing and planning for the next steps.

As preparation for a brown paper session, the processes in focus should be mapped and portrayed on the brown paper (or what color of paper that is available). A brown paper session begins with each participant using about thirty minutes to reflect on the strengths and weaknesses of the relevant processes. Strengths are stated on for example green post-its and problem areas are written on for example red post-its. When all participants have done this part, they present each of their post-its and place them on the brown paper in the process flow where they are related. In this way, each participant has to argue why something is a strength or a problem area. When all have been through this process and discussions have taken place, the final step is summarizing the strengths and problem areas in headlines. The results of a brown paper session can then be presented to the company's management group. It should be noted that the idea is to get all involved to participate in order to gain a common understanding of current processes and potential improvement areas.

In Figure 8.2, a picture from a brown paper session is shown. In the example, the squares and triangles represent processes which are connected by arrows drawn on the brown paper.

Figure 8.2: An Example of an Ongoing Brown Paper Exercise

Defining Process Redesign Focus

When changing the business processes of a company, the capabilities of a company need to be evaluated in order to establish realistic goals for the future business processes. In the following subsections, the following aspects are discussed:

- Process change capabilities
- Goals for future processes
- Gap analysis.

Process Change Capabilities

The resources of a company determine the possibilities and limitations for a business process change. As a basis for defining process changes, an overview of the resources currently available provides an important input when defining the future business processes. The consequences of the availability of specific resources can be analyzed isolated as a start, but should eventually be analyzed in a more holistic picture, since they are interrelated in many ways. The resources available in an organization can be classified in the following areas which are subsequently discussed:

- Financial resources: capital, debtors, creditors, shareholders, etc.
- Physical resources: manufacturing machines, buildings, inventory, etc.
- Human resources: expertise and skills of employees
- Intellectual capital: brands, business systems, customer databases, reputation, supplier relationships, etc.

The financial resources often have a main focus, since they can compensate for the lack of human and physical resources in the form of investments. If financial resources are low in a company, it may be best to focus on low-risk projects with rapid payoffs. On the other hand, if there is room for some financial risk, focus may also be placed on more innovative ideas or long-term process improvements.

In many contexts, the physical resources limit the possibilities of altering processes. For example, the manufacturing machine resources limit how much can be produced in a day. Thus, when rethinking the processes, this may imply that the pool of physical resources needs to be changed as well.

In relation to the human resources, some process changes may require new skills of the employees. Often process improvement projects involve the implementation of IT systems which may pose some challenges in relation to employees not being familiar with the use of IT. Thus, less ambitious use of IT or training of employees may be necessary in order to implement the process changes.

The intellectual properties of a company have a great effect on business process changes with a business strategy perspective. This could for example be a project of implementing an e-shop where the existing customer awareness of the company plays a significant role in the success. Also, process changes may affect the intellectual properties. For example, the reputation of a company could be damaged if a dysfunctional e-shop solution is launched. Thus, both the possibilities that the intellectual capabilities provide and the possible effects on the intellectual properties need to be considered.

Goals for the New Processes

The understanding of the characteristics of the existing processes and the capabilities of the company provides a basis for defining the goals of the process redesign project. It varies from case to case which goals are relevant, depending on which processes are in focus. In the case of a process optimization project with a focus on manufacturing related processes, goals are often such as improved product quality, shorter lead times, fewer errors, faster communication, improved data quality, reduced labor costs, reduced use of materials, reduced use of other resources, environmental issues, etc. For other types of goals, see Chapter 5 on key performance indicators.

Gap Analysis

A ‘gap analysis’ is a simple technique for identifying the difference (the gap) between existing and desired performances. An example of a gap analysis is shown in Table 8.4. The ‘as-is’ column describes the existing state and the ‘to-be’ column describes the goal of the process optimization project.

Measures	As-Is	To-Be	Gap
Delivery times (avg.)	15 days	10 days	5 days
Delivery precision	80%	95%	15%
Defect end- products	0.5%	0.1%	0.4%
Use of machine capacity	78%	85%	7%

Table 8.4: Example of a Gap Analysis (1)

A main challenge of making a gap analysis is defining and selecting the relevant measures for the comparison of existing and desired processes. Also, it varies how such measures can be obtained. Some measurements can be done by measuring equipment (lead times, use of electricity, use of man-hours, etc.), some can be observed (number of errors, misunderstandings, missing data, etc.), and some need evaluation (employee happiness, quality of information, customer satisfaction, etc.).

Gap analyses can also be conducted continuously while implementing the process improvements. Hereby, the current distance to the goal can be established. An example of this is given in Table 8.5. In this example, the 'was' column states the status at the project start, the 'realized' column states the current status, and the 'to-be' column states the goal of the project.

Measures	Was	Realized	To-Be	Gap
Delivery times (avg.)	15 days	12 days	10 days	2 days
Delivery precision	80%	88%	95%	7%
Defect end- products	0.5%	0.3	0.1%	0.2%
Use of machine capacity	78%	87%	85%	-2%

Table 8.5: Example of a Gap Analysis (2)

By creating gap analyses, the level and scope of the change becomes clearer. This also helps demonstrate the benefits that can be generated by the implementation of the new processes. Such information can assist in managing resistance to change by making the purpose of such a project clear.

Design of the New Processes

Business process changes can impact a number of employees and may imply closer relations with suppliers, new types of customer interaction and the implementation of new IT systems. Thus, major process changes can be a challenging project with a great risk of failure associated. In order to increase the chances of success, a structured approach for business process redesign is needed. In the following subsections, the following aspects of design of new processes are discussed:

- Preparation
- Scenario planning and business cases
- Process redesign guidelines
- Process redesign principles
- Process diagrams of the future processes
- Implementation plan.

Preparation

Before initiating a process optimization project, a time plan for the project design phase should be elaborated. The key activities commonly carried out during the design phase are (ABPMP, 2009, pp. 88-89):

- Definition of the activities within the new process
- Definition of the rules that control the activities
- Definition of handovers in processes
- Gap analysis to compare with existing processes
- Definition of the physical design to support the processes
- Design of new IT infrastructure
- Creating an implementation plan.

During the design of the new processes, it is important to involve many people from the different functions that interact with the processes. This supports the ambition of utilizing the breadth of the experience and the knowledge of those closest to the process; the new processes reflects what the organization can accomplish; and getting the support of relevant personnel.

Business Cases

The creation of a business case has the purpose of capturing the reasoning for initiating a project. A business case builds on a clarification of the consumption of resources and the business needs the business case support. Business cases can capture both quantifiable and unquantifiable characteristics of a proposed project.

The formality and content of business cases vary. However, some of the information typically included is:

- Project background
- Project purpose
- Expected benefits
- Options considered (including arguments for rejecting/accepting options)
- Expected costs

- Expected risks
- Etc.

A process optimization project can be seen in four overall perspectives that determine the success of the project. This is illustrated in Figure 8.3.

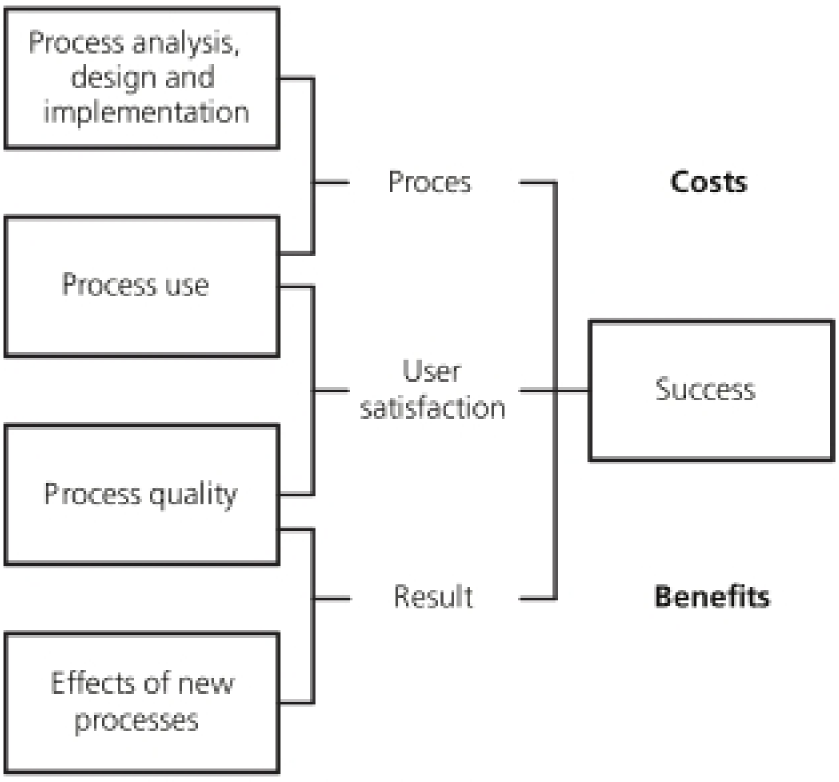


Figure 8.3: Overall Process Optimization Project Dimensions
Source: Inspired by Saarinen (1996)

To create a strong business case, establishing the costs and benefits of a project is a minimal requirement. The costs of a process optimization project can include:

- **Purchases of physical items:**
  - Inventory
  - Machines
  - Software
  - Hardware
  - Etc.
- **Use of internal employee resources (man-hours):**
  - Training
  - Planning
  - Management
  - Analysis
  - Etc.
- **Use of external consultants**
  - Education
  - Analysis
  - Support

- Project management
- Etc.

The tangible benefits of a process optimization project can be:

- Increased productivity
- Lower operation costs
- Lower man-hour consumption
- Fewer employees
- Reduced overhead costs
- Etc.

The possible intangible benefits include:

- Shorter lead times
- Fewer errors
- Increased delivery certainty
- Improved facility utilization
- Improved resource control
- Improved organizational planning
- Increased organizational flexibility
- More timely information
- Better information quality
- Increased employee satisfaction
- Improved basis for decision-making
- Improved customer satisfaction
- Improved company image
- Etc.

Process Redesign Guidelines

While defining the new business process design, some general guidelines should be kept in mind. ABPMP (2009, pp. 93-98) define the following 16 process design principles which, however, do not all apply to every process:

1. Design around customer interactions
2. Design around value-adding activities
3. Minimize handoffs
4. Perform work where it makes the most sense
5. Provide a single point of contact
6. Avoid that single processes should handle to much variation
7. Ensure a continuous flow
8. Reduce batch size
9. Bring downstream information needs upstream
10. Capture information once at the source and share it

11. Involve as few as possible
12. Redesign before automating
13. Ensure quality at the beginning
14. Standardize processes
15. Use co-located teams for complex issues
16. Consider outsourcing of business processes.

To 'design around customer interactions' means: To recognize that each customer interaction represents an opportunity to enhance the reputation of the organization. Thus, the total customer experience can be seen as the sum of the customer experiences from each contact point. Obviously, the better the total experience for the customer, the greater the chance that the customer will return and speak positively about the company.

To 'design around value-adding activities' means: To start out getting a clear understanding of what the (internal or external) customer of the process requires. On this basis, any step for which the customer is willing to pay can be seen as value-adding, while the ones not fulfilling this criterion may be eliminated, depending on the consequences in a more holistic picture.

To 'minimize handoffs' means: To simplify the handoffs and limit handoffs when possible. A 'handoff' is what occurs when the ownership of an activity or information is passed from one individual to another. The more transfers between groups, the more need for registration and the greater the chances of errors. Also, the more times information is transferred, the greater the risk of distortion of the information.

To 'perform work where it makes the most sense' means: To look beyond organizational limitations and instead design the processes in a more holistic manner. This can for example imply that some tasks are moved from one department to another.

To 'provide a single point of contact' means: To avoid issues such as multiple transfers of customer calls, staff not being directed to where they should obtain information and the like. Transforming multiple points of contact into a single point of contact can provide great improvements of customer satisfaction and internal efficiency. In this context, it should be noted that a point of contact does not have to be a person, but can also be a website, an intranet, a knowledge management system or the like.

To 'avoid that single processes should handle too much variation' means that an excessive simplification perspective on process design should be avoided. If a process handles too much variation, in many cases, such a process will be less efficient and a more costly solution than dividing the process into multiple processes.

To 'ensure a continuous flow' means that the steps that add value directly to the customer represent the main sequence of a flow. Thus, these activities should have the main focus in a process optimization project.

To 'reduce batch size' means: To avoid waiting time caused by large batches. Thus, a definition of the batch sizes in a more holistic perspective can produce improvements.

To 'bring downstream information needs upstream' means: To explore at each step of a process what may cause frustration among the employees. If problems cannot be solved by training, a solution is that the downstream person is brought upstream, so that this person will receive information more directly from the source.

To 'capture information once at the source and share it' means: To avoid that the same data are registered more than once and that the data are accessible to relevant parties. A typical solution to such problems is the implementation of an ERP system.

To 'involve as few as possible' means: To limit the number of people involved in specific processes in order to limit handovers and communication errors. To achieve this (while avoiding bottlenecks), cross-functional training of employees can be a means.

To 'redesign then automate' means: To plan the process changes before thinking in too much detail about the use of information technology. A problem of focusing too much on information technology instead of the needed process changes is that this may lead to expensive solutions, where less expensive solutions could have been equally effective. Another problem is that the information technology may not actually solve a problem as intended if adequate time is not used to understand the problem in depth before defining a solution.

To 'ensure quality at the beginning' means: To be aware of the fact that quality problems encountered during the first steps of a process may produce exponentially negative effects downstream. Thus, if focusing on fixing the problem too late in the process, this may be wasted energy.

To 'standardize processes' means: To avoid that people are doing the same thing in different ways. If fewer processes can perform the same activities just as efficiently, it's a good reason to reduce the number of processes. Such simplifications will simplify the management task and ease implementing future improvements.

To 'use co-located teams for complex issues' means that if complex problems occur regularly, co-locating team members may be a means of improving efficiency.

To 'consider outsourcing of business processes' means that in some cases, the best decision is to outsource one or more processes if this means that these are solved better and/or are less costly. For example, many small companies find it cheaper and/or are getting better quality by outsourcing IT service operations.

Process Redesign Principles

There are two basic approaches to redesign business processes (Boddy et al., 2008, p. 135, based on Harmon, 2007):

- Systematic redesign: improve current processes
- Clean sheet: fundamentally rethink the relevant processes from scratch.

The advantage of a 'systematic redesign' approach compared to a 'clean sheet' approach is that costs and risks generally are smaller, while improvements may occur faster. Furthermore, often a systematic redesign project will typically get more support from the employees who are actively involved in the processes. The major drawback of a 'systematic redesign' approach compared to a 'clean sheet' approach is that taking your starting point in the current situation may limit radical rethinking of processes.

For operationalization of the systematic approach, processes Boddy et al. (2008, p. 136, based on Harmon, 2007) suggest four questions:

1. Is it possible to eliminate process steps? Some processes contain unnecessary steps which consequently cause unnecessary waiting time.
2. Is it possible to simplify process steps? In many cases, processes are made complex because of unnecessary forms and too many procedures. Also the use of new technology can provide such improvements.
3. Is it possible to integrate process steps? In some cases, tasks that are carried out separately and executed by different people can be merged in order to make them easier to manage and ensure a clearer placement of responsibilities.
4. Is it possible to automate process steps? In many companies, tasks are carried out that are so simple and repetitive that it would be an advantage to automate them.

With the four questions above and the process redesign guidelines from the previous section in mind, a structured approach for engaging in the work of designing new processes could be (Boddy et al., 2008, p. 138):

1. First focus on the most critical process
2. Eliminate unnecessary process steps
3. Transform processes (sequence of tasks) into events (something happening at a specific point in time)
4. Minimize travel distance
5. Make processes and events parallel
6. Reduce the waiting time before a process can begin and eliminate waiting time before events.

Process Diagrams of the Future Processes

In order to ensure a common understanding of the new business process design to be implemented, the creation of diagrammatic models is an important means. Such diagrams serve as written documentation of the process design by describing relevant activities, customer interactions, business rules and process outputs. The process diagramming sequence can be carried out in two steps:

1. As-is diagram: If needed, formalize the 'as-is' diagrams made in the analysis phase.
2. To-be diagram: Modify as-is diagrams to describe the future processes.

These two steps are exemplified in the example in Figure 8.4 and Figure 8.5 where the Rummler-Brache notation is used (described in chapter 3). In the as-is diagram in Figure 8.4, focus is on an order process in relation to reduction of used human resources. Thus, the use of man-hours in relevant processes is stated.

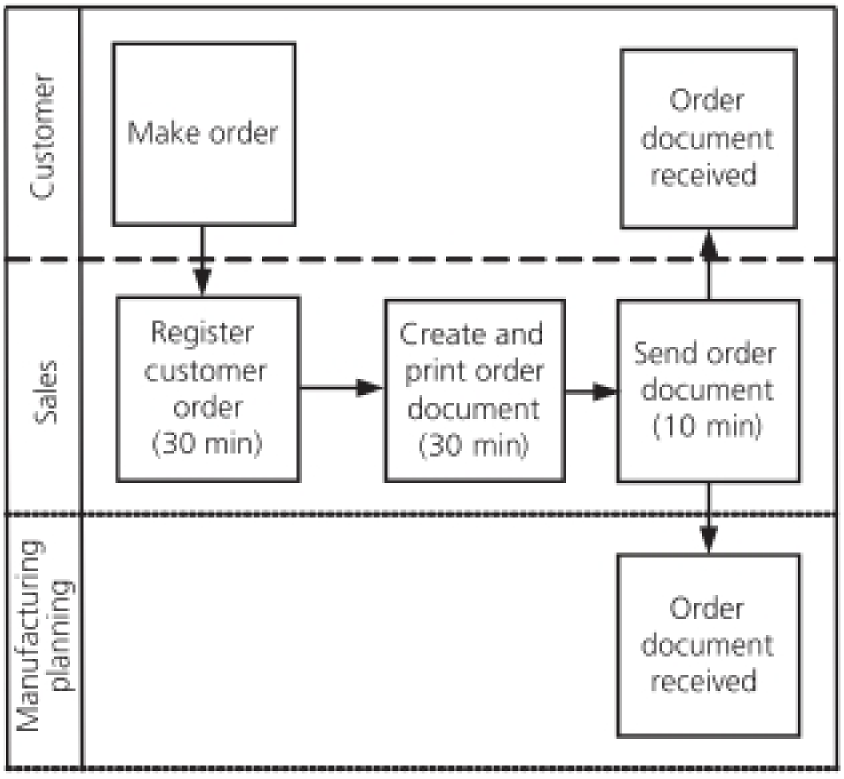


Figure 8.4: Example of an As-Is Diagram

With a basis in the as-is diagram, the planned changes can be described, hereby creating a to-be diagram. In Figure 8.5, this is exemplified. In the example, an e-shop solution has replaced the tasks of the sales persons of registering customer orders, creating order documents and sending the order. Instead, the sales person only has to check and confirm each order. As seen, this has reduced the use of man-hours in the sales department from 70 to 15 minutes per order.

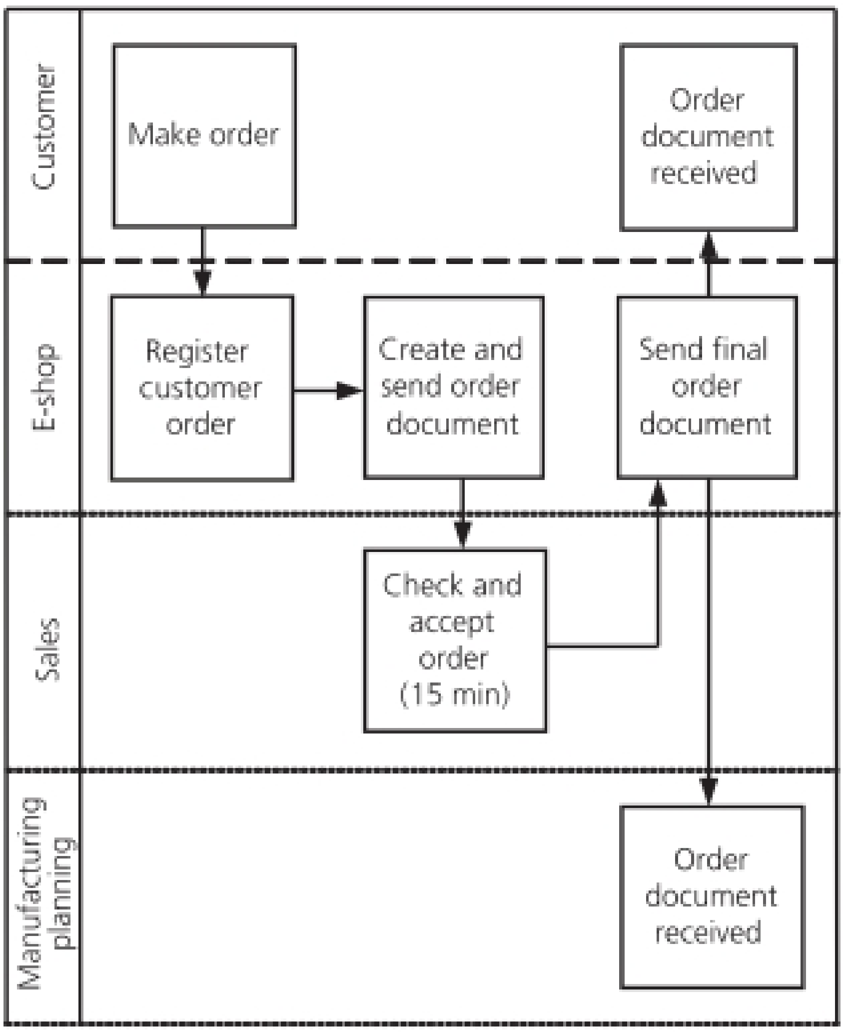


Figure 8.5: Example of a To-Be Diagram

Altan.dk is a Danish contracting company that produces balcony solutions for existing buildings. Altan.dk experienced internal and external communication problems and had problems in ensuring that their business processes were carried out according to the defined procedures. Thus, Altan.dk decided to implement a system for the management of digital content and the project workflow, in the form of an ECM system (described in chapter 7). One of the core elements of the ECM system is a display of the steps and milestones of balcony projects. The stage of the process at which the project is, is highlighted. When the milestone check box is checked, the next process stage is highlighted. For each stage of the process, specific fields for typing in information are available and relevant documents accessible. The previous problems and the main effects that Altan.dk believes that the ECM system has produced are listed below.

Problem	**Effects of using the ECM system**
Much time was used on managing documents.	The percentage of documents in a project found in electronic form has been increased from around 25% to almost 100%. The time used for finding documents has been significantly reduced.
Difficult to know at what stage a specific project was.	The process progress indicator of the ECM system now shows the status of all projects.
Misunderstandings occurred when employees exchanged information internally and with suppliers.	Before information was spread across physical documents and in the heads of employees. Now, there are fewer misunderstandings by far, since almost all information can be retrieved from the ECM system.
It was difficult to overview project documentation.	The ECM system provides an overview of all documents associated with a project.

The assembly personnel needed more uniform instructions.	Templates for the creation of assembly instructions are placed in the ECM system and are now used in all cases.
Information disappeared.	All information is placed in the ECM system or ECM system-controlled documents. Now documents no longer disappear during a project.
It was difficult to find and share information.	All project information is placed in the ECM system or in documents controlled by the ECM system.
Incomplete order specifications occurred frequently.	The ECM system provides templates for most specifications. This has resulted in more complete specifications.
Errors in specifications occurred frequently.	The ECM system provides templates for almost all specifications, which has implied that the number of errors in specifications has been reduced.
The naming in specifications was inconsistent.	The ECM system provides templates and centralizes metadata, which has implied much greater naming consistency.
There was little uniformity of procedures carried out across different projects.	The project process is controlled by the ECM system and therefore, it has become much more uniform.

Table 8.6: The Implementation of an IT System to Manage Processes at Altan.dk
Source: Haug and Frederiksen (2009)

Discussion Questions

1. What are the techniques for evaluation of existing processes?
2. What is the brown paper method?
3. What are process change capabilities?
4. What can gap analysis be used for?
5. Which activities are generally carried out during the design phase?
6. What is a business case in the context of a process optimization project?
7. How can success of a process optimization project be defined from an overall perspective?
8. What are the guidelines for process redesign?
9. What are the process redesign principles?
10. What are as-is and to-be diagrams?

PART 3: IMPLEMENTATION

CHAPTER 9

Project Management

Introduction

> Take one step at a time up the slippery mountainside, and make absolutely sure that each hoof is on solid ground before you take the next step. (Mike Cohn, founder of Mountain Goat Software)

To this point, we have been through the first two phases of the four-phase model (the analysis and design phases). This chapter is the opening of the third phase, the implementation phase, and is about project management. Basically, the key learning points from this chapter is relevant for all phases in the overall implementation model presented in this chapter. The chapter is included since, typically, business process optimizations are carried out in projects. Thus, it is relevant to include project management elements in the book. However, project management is a broad management practice area and also a distinct research area. Thus, there is far more project management problem areas than presented in this chapter. The purpose of this chapter is to highlight the relevance of project management in business optimization projects. Referring to chapter 6, project management was also mentioned as one of the critical factors of success for IT implementations. This chapter is dedicated to focusing on eight important project management-related topic areas. The first of these concerns the concept of a project. After follows a section that is dedicated to a brief introduction to project management standards. Then follows a section that presents the square of project constraints – the tradeoffs among major project parameters. Subsequently, a project model with clearly defined phases and operational templates for documentation is presented. Then follows a section that presents the project organization with the different roles and responsibilities. This is followed by a section that introduces a stakeholder analysis as an important element in all business optimization projects. The second-last section includes a brief description of nine team roles in effective project teams. Finally, the chapter is closed by a section focusing on the concept of risk analysis in projects.

The Characteristics of a Project

The term 'project' is used in many connections. Usually, it is associated with a plan, a collection of tasks or the achievement of a given result. A project involves a life cycle with a conclusion. Turner and Müller (2003) define a project as:

> An endeavor in which human, material and financial resources are organized in a novel way, to undertake a unique scope of work, of given specification, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives.

The above definition states that a project is temporary. This means that a project has a clear starting point and end destination. Thus, projects can include all types of tasks in which the achievement of a given goal marks the conclusion of the activity. Contrasts to projects are permanent and regular activities such as production, book keeping and canteen management. Key characteristics of a project can be summarized as:

- A project seeks to fulfill defined goals.
- A project has to deliver results at a defined quality level.
- A project runs within a specified time frame.
- A project takes place within a specified amount of financial resources.
- A project involves risks.
- A project is performed by a temporary project organization.

Turner and Müller (2003) discuss five ways to interpret the temporariness of projects and project organizations:

- The project as a production function.
- The project as a temporary organization.
- The project as an agency for change.
- The project as an agency for resource utilization.
- The project as an agency for uncertainty management.

These interpretations each signal different, but important characteristics of a project. The production function element draws attention to something that has a beginning and an end and goals to be achieved. The temporariness means that it's something that works alongside the formal organizational hierarchy. The change element stresses that projects will lead to new ways of working. Basically, projects are well suited for managing changes compared to formal organizations. The resource utilization part denotes the importance of the necessary resources being assigned to the project. The project cannot deliver better results than the staff that works in it. Thus, the simple logic is that the better resource allocation the better results. Finally, uncertainty management concerns the scope and structure of the project. Projects often imply that new products, services, processes and organizations have to be developed. When such conditions are present, different forms of risks also need to be managed.

Project Management Standards

Standards for project management have contributed to the professionalization of project management by encouraging common benchmarks for competence between practitioners (Crawford et al., 2002). The term 'standard' has its origin in Middle English and in Old French and has found its way into conventional language use (Ahlemann et al., 2009). There is a great number of different project management standards around the globe. Despite the many differences at the detailed level, project management standards seem to cover, according to Ahlemann et al. (2009), some shared elements:

- *Terminology*: One of the most basic tasks of project management standards is to harmonize project management terminology that allows practitioners to communicate without friction.
- *Functions*: Project management standards typically contain a functional decomposition of project management. This may be in the form of so-called knowledge areas or simply by presenting an outline that structures the field of project management in terms of its main tasks, such as resource management or cost management.
- *Process descriptions*: A functional decomposition of project tasks does not usually contain information about the meaningful sequence in which project management tasks should be carried out. Such a sequence is provided by process descriptions that frequently also define which inputs are necessary for certain process steps and what their outputs are.
- *Organizational models*: A growing number of standards contain organizational models for executing projects, e.g. organizational units like project offices being introduced and project committees being defined.

Organizations that have made significant contributions to project management standards are, for example, The Project Management Institute (PMI) (that publishes its body of knowledge in the name of 'PMBOK'), the American National Standardization Institute (ANSI) and the Association of Project Management (APM).

The Square of Project Constraints

In every project, there will be competing project priorities that may also shift during a project life cycle. These priorities concern project goals, quality, economy and time, as shown in Figure 9.1. In this chapter, these competing project priorities are called "the square of project constraints".

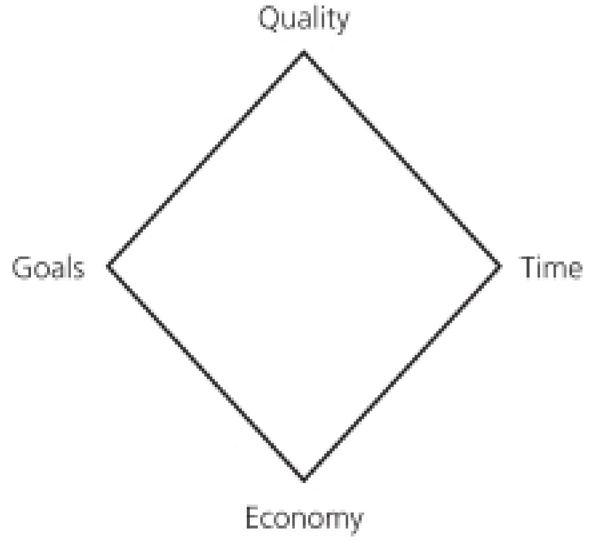


Figure 9.1: The Square of Project Constraints

The goals include the expectations of the project in the form of requirements or wishes for the project's result goals and effect goals. At the end of the project, the question should be asked: What have we achieved?

The quality element includes the quality of the solution or the product that the project has as a result goal. We must be able to answer the question: How good should the results be?

The time element describes the time frame within which the project must be implemented. In other words, how much time does the project organization have to create the results?

The economy part covers the financial budget for the project. In other words, what are the financial frames for the project to deliver the agreed goals?

Very often, there are tradeoffs between the four competitive constraints. If a steering group demands a better quality, this often requires more resources (economy). If a steering group demands that the project is completed faster, it may influence the quality. And if the steering group modifies the project goals, it will also influence the other three parameters. Thus, in an actual project it is important to be conscious about this square of project constraints in order to avoid that one falls into a trap where the project is impossible to complete due to insufficient conditions.

A Five-Phase Project Model

In the literature and in practice, there is a great number of different project models. A project model consists of the different phases through which a project flows in its life cycle. In this textbook, we introduce a simple project model consisting of five phases. IT vendors have also developed their own project models in order to get a common language in the organization. In spite of different names and also the number of phases, the logic is the same in all models. This logic is a life cycle approach. The project model presented here has the following five phases:

1. Idea phase
2. Preparation phase
3. Realization phase
4. Implementation phase
5. Evaluation phase.

After each of the first four phases, there is a point where the people with the overall responsibility for the companies' projects make decisions on whether the project is mature to move to the next phase or not. The project model is shown in Figure 9.2.

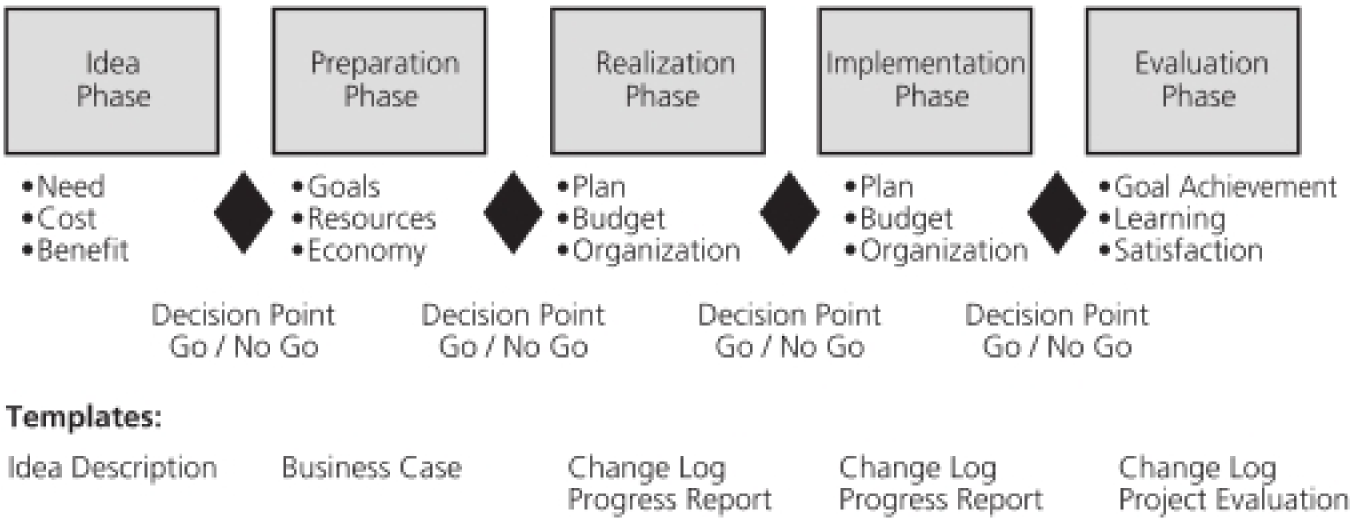


Figure 9.2: Project Model

As shown in Figure 9.2, template documents are related to each of the five phases. These templates are: 1) Idea description, 2) Business case, 3) Change log, 4) Progress report and 5) Project evaluation. The five phases and the templates will be briefly commented in the following.

Idea Phase

The practice in several companies that do not operate with a common project model is that many projects can be initiated without any coordination of goals, resources and economy. Such projects can be initiated on a too slender foundation. The purpose of the idea phase is to handle such a practice in order to avoid waste of resources. The objective of this phase is to ensure that the project has a sound basis before resources are spent developing a business case. Another objective is to agree on the required resources for the first phase of the project. The template linked to this phase is the Idea Description template. In this template, the person that gets the idea or another assigned resource describes the basic idea of the project. Why should the company spend resources on such a project? What can be obtained in the project? How much will it roughly cost? When such a document is filled out it is possible to evaluate how well it fits the company's ongoing project portfolio. Below, we have included the sample content of an Idea Description.

The Idea Description

1. Background for the project
   - Why?
   - Existing solution/performance of this solution
   - Which new opportunities exist?
2. Objectives
   - Purpose
   - Initial project goals
   - Criteria for success.
3. Overall project plan
   - Start date
   - End date
   - Overall milestones.
4. Cost/benefit analysis
   - Costs and investments
     - Hardware
     - Software
     - Implementation
     - Consultants
     - Internal hours.
   - Benefit
     - Financial/quantitative benefits
     - Non-financial/qualitative benefits
     - Pay-back time.
5. Stakeholders
   - Organizations

- Running projects
- People
- Systems.

Preparation Phase

The second phase is called the preparation phase. This phase concerns the process of formally authorizing the project. The idea description is now investigated in depth. Several pre-analyses can be conducted in order to get closer to whether there is true potential in the project or not. Such pre-analyses also deliver valuable knowledge to be used when goals are to be defined for the project. Several activities are carried out in order to deliver the final business case that is the output of the phase.

It should be agreed whether there is sufficient justification to proceed with the project or not. If the project is to proceed, a stable management basis needs to be established. In this phase, the person responsible must also ensure that there is an accepted foundation for the project prior to commencement of the work and that there is a commitment of resources. Furthermore, the project organization must be defined. In other words, the business case serves as a contractual basis for the parties involved. It contains detailed descriptions of the projects in terms of goals, benefits, costs, resources and milestones. Below, follows an example of a business case.

The Business Case

1. Background and objectives
   - Why?
   - Existing solution/performance of this solution
   - Which new opportunities exist?
   - Purpose
   - Project goals
   - Criteria for success.
2. Project plan
3. Project Organization
   - Project participants and their degree of allocation; their roles and responsibilities
   - Members of the steering group
   - Reference group.
4. Stakeholder analysis
   - Who, why and how should they be handled?
5. Risks
   - Types, probabilities, mitigation strategies.
6. Project economy

- Detailed budget
- Analyses of pay back times/return on investment
- Hard and soft benefits.

Realization Phase

In this third phase, the actual project work is taking place. The project is staffed with internal resources and perhaps external resources also participate in the project. The overall project objectives are broken down into concrete activities that need to be carried out in order to meet pre-planned milestones. Thus, in this phase, the project group must make project deliverables at the right time, at the right price and of the right quality. The project manager must ensure that the project stays within the scope and objectives stated in the idea and preparation stages. Further activities are concerned with evaluating the overall project performance, development of individual and group competences to enhance project performance and making needed information available to project stakeholders in a timely manner. In this phase, two templates are used: 1) a change log, and 2) a progress report. A change log is a 'living' document in which changes to the approved business case is logged. The assumptions behind the first approved business case can be changed as the project moves on. In the change log, changes in, for example, objectives, resources and economy can be registered. The progress report is an evaluation report which is used during the phase to communicate to, for example, the steering group how well the project performs on decided performance parameters. Such a report must be developed within a fixed time interval (e.g. each week). Below, we have included examples of how these two documents can be structured.

The Change Log

This document has the same structure as the business case. We refer to this document.

The Progress Report

1. Progress on project parameters
   - The project reaches its milestones as planned. ☺ 😐 ☹
   - Necessary resources are allocated. ☺ 😐 ☹
   - Project deliveries has the right quality. ☺ 😐 ☹
   - There are no notable risks. ☺ 😐 ☹
   - The project follows the planned budget. ☺ 😐 ☹
2. General verbal description of the project status
   - Events/action since last reporting.
   - Topics that in this reporting require special awareness/management focus.

3. Milestones
   - Which milestones have been reached?
   - Which milestones have not been reached? Why have they not been reached and what is planned to make up for lost time?
4. Project economy
   - How much did the project cost to date compared to the budget?
   - If more costs are spent than budgeted, what are the plans to correct it?

Implementation Phase

The implementation phase concerns turning the project content into reality. The project shifts from being developed to being in operation. Such a phase could, for example, be the actual implementation of a new ERP system. A cut-over date from the old to the new system is planned and when the new system is implemented, a lot of elements need to be monitored and contingency plans need to be prepared. During the implementation, additional training might be necessary in order for the users of the new system to fully understand the new way of working. Furthermore, during the implementation phase, mistakes in the program might be found that have passed the test phase of the new software. In such situations, contingency plans are needed. It is not uncommon that the company performance during the implementation phase will decrease (Markus et al., 2000). However, a well-managed project should avoid that the performance falls below acceptance level for too long. Basically, a project may not enter into the implementation phase if one of the following three criteria cannot be realized: 1) There is a new system with the right applications of the right quality, 2) Master data to run the new system are cleaned and ready to use, and 3) The users of the new system are trained in the new system and are able to handle the new system. In the implementation phase, the same two templates are used as in the realization phase. We thus refer to the previous subsection for a discussion of these templates.

Evaluation Phase

The final phase in the project model illustrated in Figure 9.2 is an evaluation phase. When this phase is active, the project is implemented and has moved to operation. In the business case, it is suggested that it is defined when the evaluation of the business targets are to be evaluated. Often, the system has to be in operation for some time before it makes sense to evaluate the business goals. When the time is appropriate, the objective of the evaluation is to evaluate both the project process and project product. Does the new system perform according to the specification? The evaluation can also take place in order to learn what can be improved in future projects (e.g. project management, information and communication about the project and bonus programs for project participants). In this phase, it is suggested to use two templates: 1) the change log and 2) the project evaluation. The change log has to be used in this final evaluation phase in order to check if there have been documented changes to the business case during the project life cycle. If so, these need to be included in the overall evaluation of the project. Since this template has previously been described, we only describe the project evaluation template in the following.

The Project Evaluation

1. Background and objectives
   - Why was the project carried out?
   - Is the purpose of the project fulfilled?
   - Are the project goals accomplished?
   - Are the criteria for success met?
2. Project economy
   - How much did the project cost compared to the budget?
   - Analyses of pay-back times/return on investment
   - What are the hard benefits?
   - What are the soft benefits?
3. Learning
   - What was good practice during the project (and thus should be repeated in future projects)?
   - What was bad practice during the project (and thus should be avoided in future projects)?

Project Organization

Projects are carried out by temporary organizations consisting of people who have different roles and responsibilities. An example of a project organization chart is illustrated in Figure 9.3.

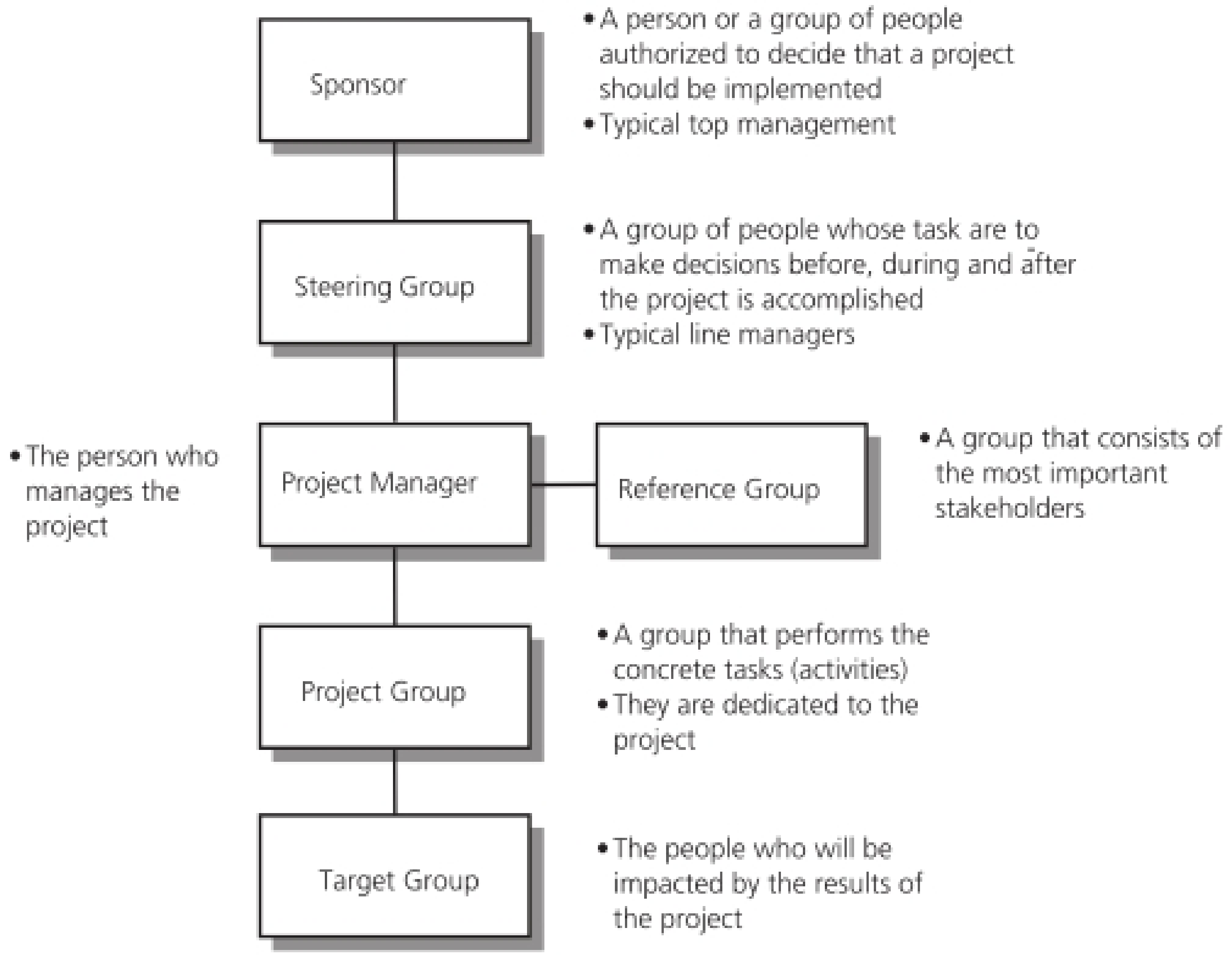


Figure 9.3: A Project Organization Chart

The Project Manager. The project manager is the person responsible for the project and also for the achievement of the project goals. The project manager has several roles. According to Briner et al. (1990, p. 4), the project manager has to look in different directions concurrently. They provide six directions to which a project manager should pay attention. Firstly, the project manager has to look upwards – to the sponsor of the project. It is important to know the sponsor's interest and motives for the project and also his or her reactions to proposals for solutions during the project. Secondly, the project manager also needs to look outwards towards the clients of the project and other stakeholders. These upward and outward looks especially concern managing stakeholder relations. The third and fourth direction is to look both backwards and forwards. The project manager needs control systems that can say whether the targets are being reached (looking backward) or not. However, the past performance needs to be compared to the plans (looking forward). These two directions basically concern managing the project life cycle. The fifth direction of which a project manager must be aware is to look downwards towards the project group. It is the responsibility of the project manager that the project participants perform both individually and collectively. Furthermore, the project manager must secure job satisfaction among the project participants. The last direction is to look inwards. The project manager has to remember to evaluate him or herself and remember to ask for assistance if help is required. The last two directions – looking downwards and inwards – concern the management of performance. For a comprehensive literature overview of the project management leadership style as a factor of success, we refer to Turner and Müller (2005).

The Steering Group. The steering group is responsible for making the decisions that the project manager cannot make. Such decisions could be adjustments to the project goals, allocating more resources or making a high economical investment in equipment. The steering group has other duties, such as helping the project manager to solve conflicts in relation to specific persons or a department in the company. The project manager is a born member of the steering group. Normally, the project manager has no right to vote in this group. It is important that the members of the steering group have experience with the content of the project.

The Sponsor. The sponsor of a project is responsible for directing the project to ensure that the benefits are achieved. The sponsor is the owner of the business case and primary risk taker. Thus, the sponsor is the one who pays for the project's implementation in terms of financial and human resources. It is important that the sponsor is available for the project manager in situations of difficult decisions (e.g. to find solutions to conflicts in relation to the operating organization and other stakeholders). Normally, the project sponsor is the chairman of the steering committee.

The Reference Group. Some projects have a complexity that makes it an overwhelming task for the project manager to monitor the details of the professional or technical solution alone. In such cases, a reference group composed of advisers can be applied. The reference group's members will participate in the project as required and are typically included on an ad hoc basis. The reference group is only responsible for their own advice and not for the result of the project.

The Project Group. The project group performs the actual work in the project. It is critical for the success of the project that the participants in the project group understand which tasks to perform and that they are capable of solving them. The project group is responsible for performing the agreed tasks. They have to report on status, progress, changes and problems to the project manager.

The Target Group. The target group consists of the people who will be impacted by the project and is thus a major stakeholder. It is very important that the target group is involved in the process. Such an involvement can, for example, consist of participation in information meetings where it is possible to raise questions about the new functionality, new business processes and advantages and disadvantages of the chosen design.

Stakeholder Analysis

One of the pioneers of the development of stakeholder theory is Freeman (1984). The stakeholder approach moves a step further from judging a company solely on economy (profit). Based on a literature review, Jones and Wicks (1999) describe the basic premises of the stakeholder theory as: 1) The company has relationships with constituent (stakeholder) groups, 2) The processes and outcomes associated with these relationships are of interest, 3) The interests of all legitimate stakeholders have value, and 4) The focus of the stakeholder theory is on managerial decision-making.

In IT projects, it is important to continuously develop stakeholder analyses. The purpose of a stakeholder analysis is to identify and analyze the different people or groups, the stakeholders, who are or will be affected by the results of the project. In many cases, the success of the project will depend on how well the cooperation between the stakeholder and the project team is. There are different ways to conduct a stakeholder analysis. A simple way is to develop a table with, for example, the following columns: 1) Name, 2) Reason for being a stakeholder, 3) Requirements, 4) Positive/negative towards the project, and 5) Need for communication. In addition to this, a simple 2*2 matrix can be developed, as shown in Figure 9.4.

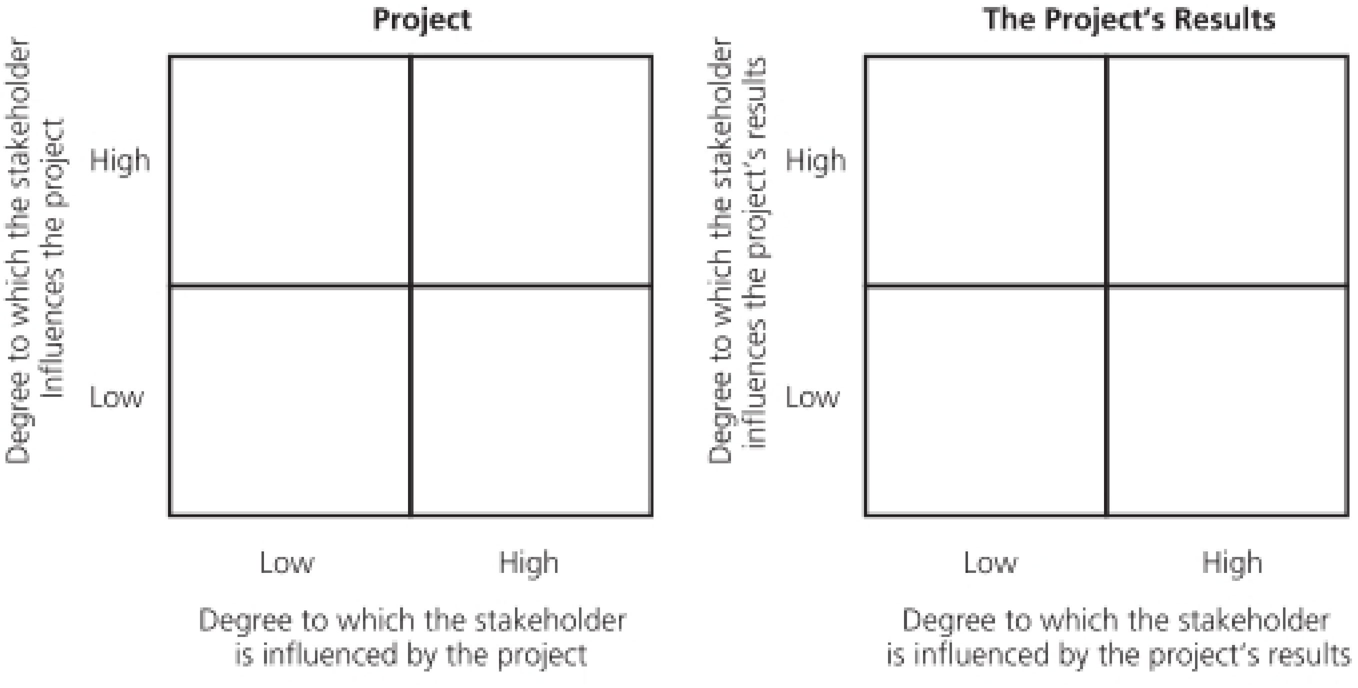


Figure 9.4: Examples of Stakeholder Analysis Matrixes

Other dimensions, than the ones in the diagrams in Figure 9.4., could be applied, such as positive/negative towards the project or whether the stakeholder is audible or silent.

It is important to identify all stakeholders for the purpose of identifying their criteria for success and turning these into quality goals. A stakeholder analysis can be performed by the entire project group or by several selected members. If the project is problematic with many different political factions (which may be the case with an ERP implementation) one could also decide to keep such an analysis confidential.

Team Roles

In 1981, the English doctor in psychology, Meredith Belbin, introduced nine basic roles that need to be present in every effective team (Belbin, 1981). An effective team is necessary in business optimization projects. The nine team roles are:

- Shaper
- Planter
- Coordinator
- Monitor Evaluator
- Resource Investigator
- Implementer
- Team Worker
- Completer
- Specialist

Most people cover two or three of the above-mentioned nine team roles. In this way, an effective team may consist of three to six persons if the right competences are present. It is important that all roles are filled out because all projects demand the generic tasks in which each of the team roles excels. Below, each of the nine team roles are briefly examined.

Shaper

The shaper is full of energy and has a high need to reach results. The shaper is often an aggressive type, easy to provoke, extrovert and has a huge drive to make a difference. The shaper likes to challenge other people and is ready to gamble in order to win. The shaper is a good direction setter and is good at pushing other team members to start their work. He or she is normally a good manager due to his or her action orientation skills. The shaper is doing fine under pressure and is very important when it comes to kick-starting change processes. He or she has no problems making unpopular decisions – sometimes he or she tries to start discussions. This team role can be perceived as being impatient and opinionated. Often the shaper lacks empathy.

Planter

The planter role is the initiator. He or she is often a creative type. The planter plants seeds and ideas from which business developments take place. Normally, the planter prefers to work independently with a certain distance to the other project participants. He or she can work in special modes and uses his or her fantasy in the work. The planter can be an introvert which is easy to hear when he or she receives criticism and/or praise. When new proposals have to be created the planter is a good performer. The same is true when complicated problems have to be solved. However, the ideas are often radical in nature and not all of them can be implemented. The planter is an original and independent person who has his or her challenges to communicate with the other project participants.

Coordinator

The coordinator is comfortable if he or she has responsibility for a team of people with different skills. He or she is motivated by working together with colleagues at the same competency level. Problems are typically solved quietly. The coordinator has flair for motivating other project participants to work towards common goals by delegating tasks. Through personal dialogue, he or she is fast to spot talents and utilize them in order to reach the goals of the project. The coordinator can have a propensity to manipulate and to be an empire builder. He or she is not necessarily the most knowledgeable in the project, but is generally broadly oriented towards the surroundings. The coordinator is normally fenced with respect.

Monitor Evaluator

The monitor evaluator team role is the serious type. He or she is of often late in decision-making and prefers considering before acting. Normally, he or she has a critical faculty. The monitor evaluator is capable of delivering glaring lights on tasks and solution proposals that are holistically considered. This team role is often right in discussions. He or she prefers to solve problems and judge ideas and proposals where pros and cons are weighted. The monitor evaluator is doing well in positions at a high level. Sometimes, some positions are dependent on success or failure in few decisions which is an ideal situation for this team role. The monitor evaluator is often perceived as being critical, skeptical and bad-tempered.

Resource Investigator

The resource investigator is often an enthusiastic type, quick to react and has an extrovert personality. He or she has good communication skills both internally in the organization and externally with other business partners. Furthermore, this team role possesses good negotiation skills and is capable of seeing and exploiting new opportunities and developing new contacts. The resource investigator is a good listener and is good at including the ideas of others in solution proposals. He or she is often relaxed and curious to see new opportunities. This team role has a tendency to speak much. Great enthusiasm is demonstrated, however, it can fade out if he or she does not obtain continuous feedback from the other project participants.

Implementer

The implementer is practically minded with common sense, self-control and self-discipline. He or she is motivated by systematic, hard work and in problem-solving is more driven to solve company objectives than personal objectives. The implementer is important in projects because he or she is reliable and effective. He or she has good prioritization skills to judge what is most essential to be solved first. The implementer conducts the work that is needed whether it is exciting or not. He or she can be criticized for the lack of intuition and can appear as being inflexible. Often this team role reacts slowly to new possibilities.

Team Worker

The team worker is the role among the nine roles that provides the most support. He or she is often mild, sociable and worries about other team members. The team worker is often flexible and therefore easily adapts to different working situations and persons. The team worker is a fast and sharp observer and the primary role is to secure that all team members perform most effectively. He or she is social, has diplomatic traits, is good at listening and is generally a popular member of a team. The team worker makes sure that updates flow across the members of the project organization. He or she does not like disagreements, but is instead focused on getting progress in tasks. When the team worker is present, the work ethic is high and the project team often finds that collaboration works better. The team worker acts reasonably, but can be indecisive if critical situations in the project arise.

Completer

The completer has a special competency in carrying out tasks with an eye for detail. This team role can start up tasks that are not completed. He or she is driven by an internal need to finalize tasks. Often, the completer has an introvert personality. The completer plays an important role in projects that require much concentration and precision. He or she actualizes how important certain activities are in the project and is very committed to keeping the timetable. The completer is a champion in details and in being persistent to closing activities. The completer is often intolerant to people who act without thoughtfulness. Often he or she is left with the entire task. However, the completer does not worry unnecessarily.

Specialist

The specialist is a person who is absorbed in tasks. He or she is proud of his or her own technical skills and special knowledge. Maintaining the professional level is important for the specialist who has expertise in narrow areas. He or she plays an important role in projects due to his or her special reservoir of competences. Several project members seek advice from the specialist. He or she exudes professional pride. He or she can cut him or herself off and rarely displays an interest in the working areas of other team members.

Risk Analysis

Before starting a project, the project manager must have a clear view of the nature of the risk and the potential for disaster (Briner et al., 1990, p. 52). One way of obtaining such an overview is through the completion of a risk analysis. A risk analysis aims to identify and analyze risk factors, i.e. issues that are especially risky and important for the achievement of the project's objectives, goals and criteria for success. The risk analysis can help to reduce or eliminate barriers for achieving the project's goals and milestones. There are several types of risks of which different mitigation strategies can be considered, as shown in Table 9.1.

Risk	Possible Mitigation Strategies
Natural risks (e.g. building on different terrain in other climates)	Statistical probability analysis based on previous data; drawing on personal experience – your own or that of others
Product liability risks (faulty design in components causing damage)	Thorough planned testing; product recall procedures; insurance; total quality management
Technical risks (new engineering; new production processes which do not perform or have to be reworked)	Build in extra budget; prototype; milestone reviews

Business risks (financial loss; dented reputation in market; dissatisfied clients)	Good project leadership; recognize your limitations and use experts to help assess and plan (for example those with financial or marketing skills); do not ignore early warning signs of problems
Personnel risks (loss of key experts; labor disputes)	Build in contractual obligations; make it attractive to stay; probability analysis on past activity; no strike agreements; build in extra budget
Psychological risks (effect on future career; feeling stretched beyond past experience and current competence; fear of failure)	Have a good coach, counselor or mentor; do not bottle it up.

Table 9.1: Different Types of Risk
Source: Briner et al. (1990, p. 53)

Risk analysis is typically performed before the start of a new project and during the project when there is a need to clarify the consequences and obstacles of the implementation of planned changes in general. Risk analysis is performed with close connection to the project's objectives and goals. Furthermore, the project's potential solution plans must also be considered in such analyses.

Risk analyses can be conducted through a brain-storming exercise in the project group. The identified risks can be categorized in different types of risks, as in the examples of Table 9.1. Each identified risk should then be evaluated in relation to the consequence of the risk if it becomes a reality and the probability for occurrence (see Figure 9.5).

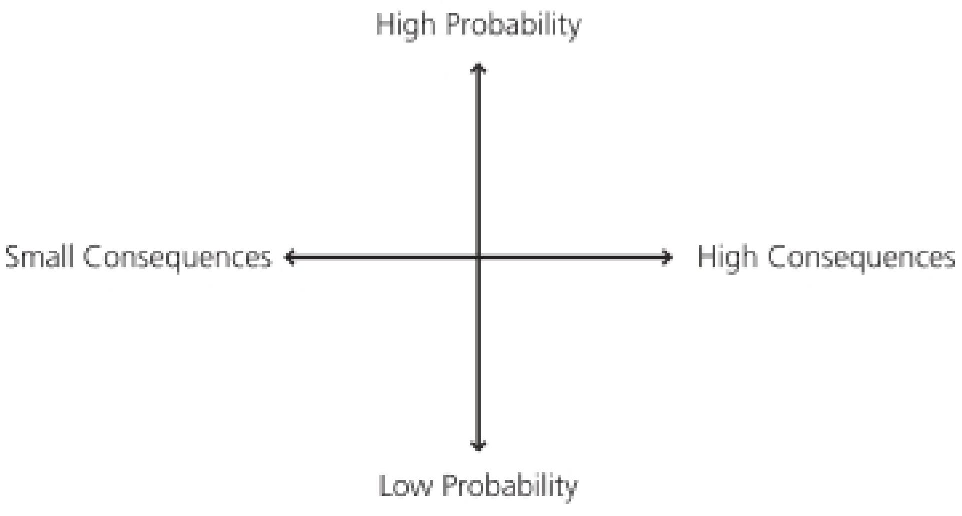


Figure 9.5: Example of a Risk Analysis Matrix

When the identified risks are positioned in a matrix like 9.5, strategies to handle the risks if they occur can be made. An example of a risk could be that the projects will be delayed due to the steering group's lack of decisions. A strategy for this could be to send reminder mails to the steering group that the decisions need to be taken and that the consequence of lacking decisions will be a delay. In Figure 9.5, especially the risks located in the upper right corner should have high attention (high consequences and high probability).

Discussion Questions

1. What is a project?
2. Explain the benefits that a company can obtain by working with a common project model.
3. What is the logic of operating with project stages and decision gates?
4. Explain the five stages and templates in the project model presented in this textbook?
5. What is a stakeholder analysis and should this be carried out?
6. What is a project organization?
7. Why are team roles important in projects?
8. Explain the nine team roles of Belbin?
9. What is a stakeholder analysis?
10. What is a risk analysis and could such an analysis be carried out?

CHAPTER 10

Change Management

Introduction

> When the winds of change blow, some people will build shelters, others will build windmills. (Chinese proverb)

In this book about business process optimization, we have argued that optimization initiatives are often carried out in projects. In this chapter, we now turn to another important aspect of business process optimization; the change management tasks that such initiatives inevitably will also bring about. Thus, a concurrent focus on project management and change management is believed to be an important factor of success in order to make business process optimization initiatives a reality. Project management and change management can be viewed as Yin and Yang. At first sight, change management can be viewed as having much in common with project management. Both disciplines are concerned with concrete projects, including tools and methods to be used in different phases of the project. Hence, a number of concepts are used in both disciplines, such as project manager, stakeholders, project group, and goal formulation. However, the project management discipline can, due to its roothold in engineering science, be characterized as being tangible and based on a system perspective when approaching problem areas. Change management as a discipline has another basis. The discipline originates from psychology and sociology and is primarily focused on soft issues in projects, such as collaboration, individual roles and group roles. The change management discipline concerns changed behavioral patterns among the impacted persons of a project and on the way in which the organization will work when the project is implemented. Change management is an important topic to be aware of and to have knowledge about since studies have documented that about 70% of change initiatives fail (Griffith, 2002; Kotter, 2008, p. 13).

The purpose of this chapter is to introduce the important topic area of change management. This area is comprehensive. For detailed discussions on the included topic areas and other things, we refer to further literature on the area. The chapter is structured into six sections. In the next section, we provide a comparison of management and leadership. Then follows a section that contrasts a planning vs. emergent change perspective. In the subsequent section, a change model is presented. Then follows a section that briefly introduces different change processes. This is followed by a short section with examples of different change strategies. The final section discusses the importance of communication in change management.

Management vs. Leadership

What is the difference between management and leadership? It is a question that has been asked more than once and also answered in different ways. The biggest difference between managers and leaders is the way that they motivate the people who work for them or follow them, and this sets the tone for most other aspects of what they do. Comparison differences are shown in Table 10.1.

	Management	**Leadership**
Systems	Works within the systems	Works on the systems
Rules	Forces organizational rules (makes)	Changes organizational rules (breaks)
Approach	Controls staff by pushing them in the right direction	Motivates staff by satisfying basic needs
Methods	Defines instructions	Coaches, self-management, empowerment
Focus	Managing work	Leading people
Ambition	Plans detail	Sets directions
Seeks	Objectives	Vision
Wants	Results	Achievements
Concerns	Being right	What is right
Appeals to	Head	Heart

Table 10.1: Management vs. Leadership

Basically, management concerns what we do, how we do it, when we do it and how much we do it. Management is driven by objectives. In contrast, leadership concerns where we are going and why we are going there. Leadership is driven by striving towards a vision. In practice, many people, by the way, master both elements. They have management jobs, but soon realize that one cannot buy hearts, especially to follow them down a difficult path, and so they act as leaders too. In change management programs, there are both management and leadership tasks.

Planning and Emergent Change Perspectives

Burnes (1996) has provided an overview of two major streams of literature within change management. These streams are denoted as a planning perspective on change management and an emergent perspective on change management. This separation is rooted in strategic management (Mintzberg and Waters, 1985). In the following two subsections, we will introduce these two different perspectives on change management.

A Planning Change Perspective

Change management as a concept can be traced back to the pioneering work of Kurt Lewin that founded a perspective which today is called a planning perspective on change management. Kurt Lewin is well-known for theories such as the Field Theory (Lewin, 1947a), the Group Dynamics (Lewin, 1947b), the Action Research (Lewin, 1946) and the three-step model to change management (Lewin, 1947a). All his contributions are based on the planning perspective. In spite of the fact that the Field Theory, the Group Dynamics, the Action Research and the three-step model for change management are often treated as separate themes, Kurt Lewin perceived them as an entity where one element supported and strengthened the other elements. All elements were important in order to understand and accomplish planned changes, whether they were at an individual, group, organizational or society level (Burnes, 2004).

Lewin (1947a) has characterized a successful change project as consisting of three steps:

1. *Unfreezing the present level.* Stability in the present situation should be established before an old behavior can be discarded and a new behavior can successfully begin.
2. *Moving to the new level.* One has to look at all forces that exist at the workplace in order to identify and evaluate the possibilities for change through trial and error processes.
3. *Refreezing the new level.* It is attempted to stabilize the employees at equilibrium in order to secure that the new behavior is resistant to recurrence.

In spite of the fact that Lewin's theories about change are more than fifty years old, still much modern change management theory and practice is based on Lewin's three-step model for change (Elrod II and Tippett, 2002). Thus, Lewin's contributions are still valid for today's work with change management.

While much of Lewin's theoretical work, especially the part concerned with refreezing the organizational culture in the wake of change, has been included in later and modern thinking and experience, the core belief to break with the status quo (the basic belief) and to encourage people to see and join the need for change is still valid. Without a certain level of dissatisfaction with the present situation and accompanying wishes to make changes, the efforts to obtain organizational changes can easily be lost (Smith, 2005). In Table 10.2, the steps of two planning-based change management approaches are outlined.

	Jick (1991)	**Kotter (1995)**
1	Analyze the organization and its need for change	Establish sense of urgency
2	Create a shared vision and common direction	Form a powerful guiding coalition
3	Separate from the past	Create a vision
4	Create a sense of urgency	Communicate the vision
5	Support a strong leader role	Empower others to act on vision
6	Line up political sponsorship	Plan and create short-term wins
7	Craft an implementation plan	Consolidate improvements – produce more change
8	Develop enabling structures	Institutionalize new approaches.
9	Communicate, involve people, and be honest	
10	Reinforce and institutionalize the change	

Table 10.2: Examples of Planning-Based Approaches to Change Management

In summary, the planning perspective to change finds it possible to divide the overall change task into smaller separated parts (often in different steps or phases). According to Burnes (1996), the main points of criticism to the planning perspective to change are:

- It is based on the assumption that organizations work under regular conditions and that it can move from one stable stage to another based on a planned course.
- The emphasis is placed on small, gradual changes, which is why it is not applicable in situations that require fast and radical changes.
- The planning perspective ignores situations where more direction-setting approaches should be applied as in situations of crisis.
- It is assumed that involved parties can reach a common agreement and that they are willing to and interested in implementing the project.

An Emergent Change Perspective

Over the last decades, an emergent perspective on change management has become more widely used. Instead of viewing change processes as being managed top-down, they are now viewed as being managed bottom-up. Change is viewed as an organizational learning process (Burnes, 1996). Companies are perceived as actors who function in turbulent, dynamic and unpredictable environments. Proponents for an emergent change perspective, such as Wilson (1992) and Dawson (1994), do not believe that prescriptions for managing change processes can be developed. Successful changes are not as dependent on detailed plans and predictions as on obtaining an understanding of the often complex questions that exist and possible ways to solve these.

Senge (1990) suggests that five disciplines are developed in interaction: 1) Personal mastery, 2) Mental models, 3) Building shared vision, 4) Team learning and 5) System thinking. Personal mastery concerns a continuous focus clarifying and deepening our personal visions and developing our patience. Mental models constitute a discipline covering paradigms about how we see and interpret the world. Building a shared vision concerns developing shared pictures of the future in order to create commitment. Team learning begins with dialogue. In order to learn, people need to communicate and think together. The role for system thinking is not intended for the individual, but for the collectiveness spread around the organization. Influence is made by the people who are able to see a whole, instead of single parts, and how problems are tied together. It is important to have tools for mapping such connections. Senge (1990) views system thinking as the discipline that can integrate the four other disciplines (Carr, 1997).

Choice of Perspective

Instead of arguing for pros and cons for a planning and an emergent perspective on change management, we can view these two perspectives as approaches that focus on different situational factors. One can argue that the planning perspective is most appropriate in situations with stability and predictability while the emergent change perspective is more suitable in unstable and unpredictable situations (see also the discussion on these differences in connection with strategy perspectives in chapter 6). Thus, best practice within change management does not exist (Burnes, 1996). Instead, we should think of these two perspectives in terms of appropriateness of an approach regarding the circumstances being addressed.

Sirkin et al. (2005) argue that recent change management literature has been too concerned with the soft sides of the change management tasks such as culture, leadership and motivation. They believe that there is a lack of awareness of the often unpopular aspects of change management tasks, i.e. the hard sides of change management. Such sides have three characteristics: 1) Companies are able to measure these both directly and indirectly, 2) Companies can easily communicate these both internally and externally and 3) Companies are able to affect the elements quickly. According to Sirkin et al. (2005), the hard sides of change management are expressed through the factors of success for change management: 1) Duration, 2) Integrity, 3) Commitment and 4) Effort.

1. Duration concerns the time until the change program is completed if it has a short life span; if not, the amount of time between reviews of milestones.
2. Integrity concerns the project team's performance; i.e. its ability to complete the initiative on time. That depends on the skills and traits of the members relative to the requirements of the project.
3. Commitment to change is displayed by top management and the staff is impacted by the change.
4. Effort over and above the usual work that change initiatives often require from the employees.

According to Sirkin et al. (2005), the above-mentioned four factors determine the results of any change process. They pinpoint that the simplicity in this view is perhaps the biggest obstacle because change managers often search for more complex answers. Overlooking often basic factors frequently leads to entering agreements which contain compromises that do not work in practice.

Leavitt's System Model for Change

Within the literature about organizational change, the Leavitt model for change is one of the classical contributions (Leavitt, 1965). Leavitt (1965) views organizations as open and complex systems that are capable of developing and adapting to changes in the environment. The first Leavitt model for organizational change, see Figure 10.1, consists of four variables: 1) Task, 2) People (actors), 3) Technology and 4) Structure.

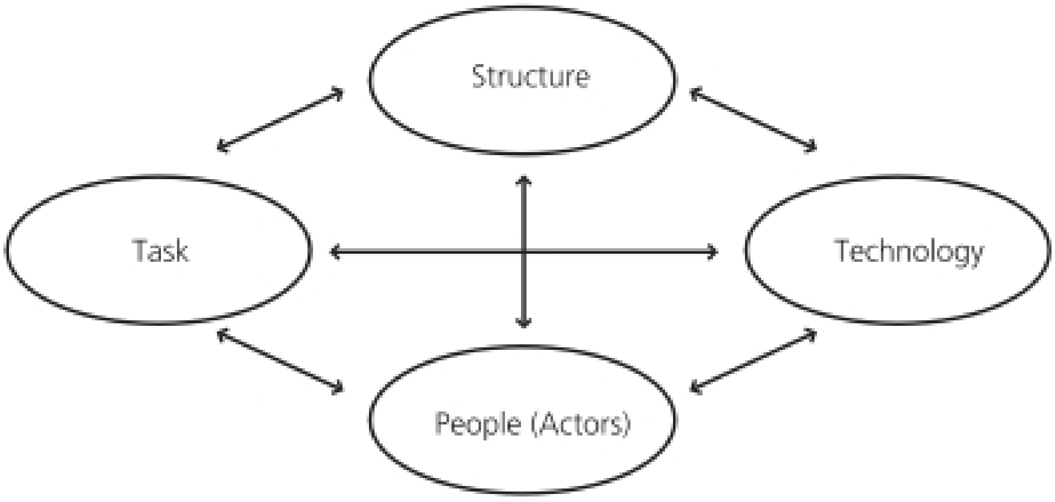


Figure 10.1: Leavitt-Model for Change
Source: Leavitt (1965, p. 1145)

Task refers to the livelihood of the organizations. Which types of tasks does the organization perform in order to deliver physical products or services? People (actors) refer to the people in the organization who perform the tasks. Technology refers to machines, methods and programs used by the people in performing their tasks. Finally, structure refers to the communication system, the authority system and the division of labor (structure of the work). The system tells us that if we make changes in the content of one of the components it will affect the content of the three other components (cf. the double arrows between the components). Thus, if a new system (technology) is implemented in order to avoid manual work, it will change the way in which tasks are performed (in business processes). It will perhaps also require new skills (or people) and the decision process might also be changed (a structure element). Another example is if a company is hiring a new CEO. This new CEO affects the people component, and he or she will probably make changes in structure and tasks in order to demonstrate powerfulness. When structure and tasks are affected, it can also influence the technology component (e.g. need for new data fields in existing systems that can deliver new management data to be processed in performance management systems). The model can also be used for diagnosing organizational problems – for focusing on imbalances between the four components. Lastly, the model can also be used for comparing different organizational units within the same company or group or for comparing the company to other external companies. One of the major points of criticism of Leavitt's first model was its lack of emphasis on the fact that the environment may also affect the components. Leavitt (1978) therefore introduced a modified version of his model for organizational change in 1978 that also included influence from the environment, as shown in Figure 10.2.

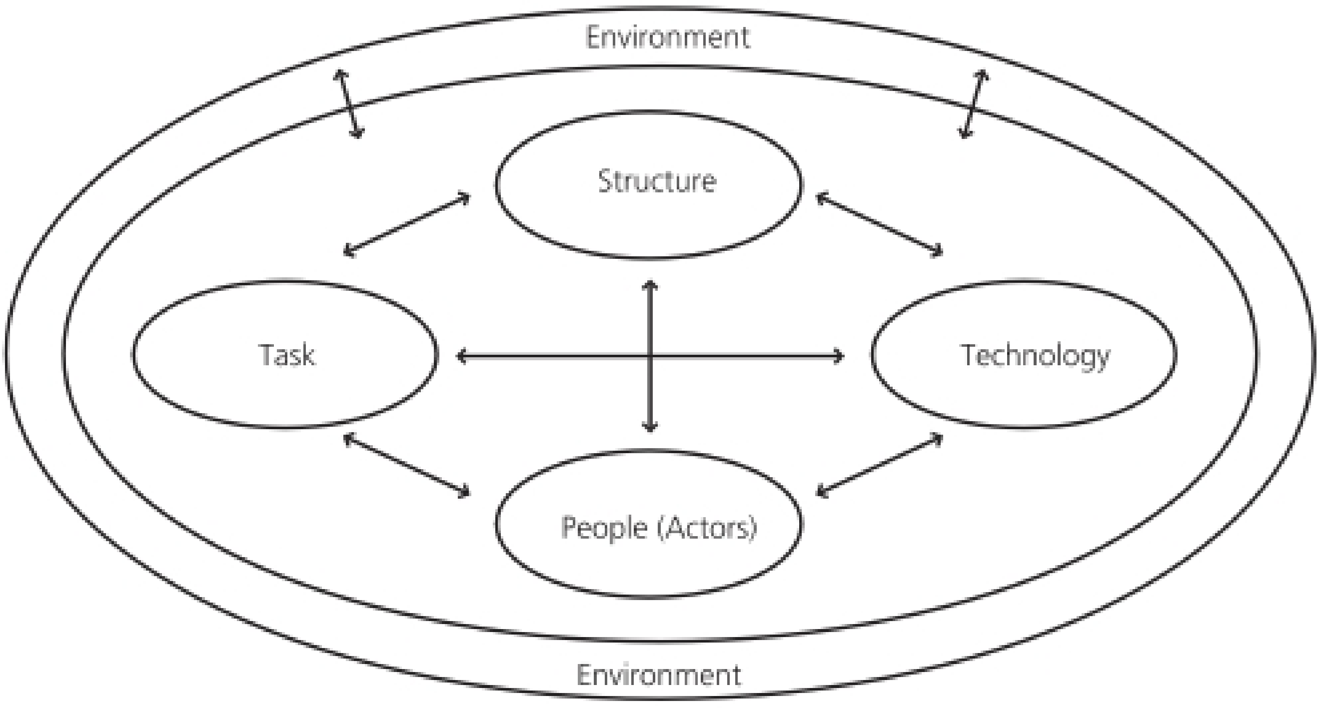


Figure 10.2: The Revised Leavitt-Model for Change
Source: Leavitt (1978, p. 287)

The environment can influence each of the four components in Figure 10.2. The degree of dependency between companies and complexity of the business environment is increased due to changes in e.g. relationships between companies, technology and globalization (Arlbjørn, 2006). Relationship-related issues may, for example, be:

- The company's boundary is stretched into the extended enterprise with deep relations to certain customers, suppliers and even competitors.
- There is an increased need for knowledge transfers between companies.
- More specialized suppliers are used and organized in clusters and networks.

Technology-related issues may, for example, be:

- Rapid technological developments are providing companies with new tools to communicate and create traceability through global supply chains (such as Radio Frequency Identification and Global Positioning Systems).
- New technologies are used as a differentiation parameter which creates new possibilities regarding products and processes.
- New systems set new requirements for the integration of the company's entire system platform.

Globalization-related issues may, for example, be:

- Customers, suppliers, competitors and other industrial actors are doing business on a global scale – from local to global (some companies are even born global).
- Globalized operations may lead to higher complexity and require excellent documentation management (master data management, drawings, bill-of-materials, certificates etc.).
- Long-distance relationships across many time-zones (capacity, inventory levels demand higher competency levels).

Change Processes

In connection with business optimization projects, it is important to think of different types of change processes. In Figure 10.3, three types of change processes are illustrated. The processes contain examples of which initiatives can be launched in order to secure support to the change that the company faces.

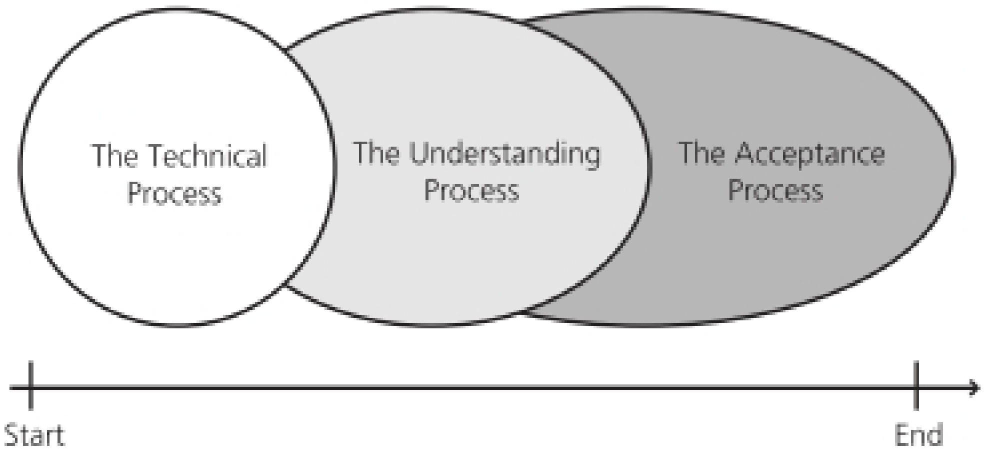


Figure 10.3: Three Types of Change Processes

The three change processes in Figure 10.3 are: A technical process, an understanding process and an acceptance process. The three processes can take place both parallel and sequentially. The actual initiatives that will be conducted within each of the processes should be considered early in the project. The degree of overlap between the processes is dependent on the actual project.

The Technical Process

The technical process should secure that the project rests on a solid foundation. The technical process is mostly dominating in the first phases of a project. The process should provide an input to a vision for the change – or a burning platform, a demarcation of the project in order to develop the contours of the scope and resource needs of the project. Essential activities in the process are:

- Analyses of the need for change
- Envisioning the need for change
- Goal setting
- Identification of improvement areas
- Defining a project organization
- Choice of change method and change strategy
- Resource dedication.

The Understanding Process

The technical process should, among other things, deliver a clear vision for the change that now needs to be communicated to the stakeholders of the change program. In this process, resistance to change can be encountered. That may, for example, be the case if employees are aware that the project can lead to changes of their working procedures. Thus, when this understanding process is started up it is important that management is a couple of steps ahead regarding considerations on questions like:

- How should the sense of urgency and the vision be communicated internally and externally?
- How should resistance to change be handled?
- How much should be communicated during the change program (e.g. information meetings, newsletters, staff magazines, press coverage) and in which way?
- How are good ideas and concrete solution proposals from the stakeholders included?

The Acceptance Process

As illustrated in Figure 10.3, the acceptance process is the process that covers the longest time span. Especially in this process, attitudes and behavior constitute the object of study. The acceptance process is often the most complicated among the three processes. Employees might, for example, understand why a change is necessary, but they could have much more trouble with the actual changes that are needed to make a difference. Thus, communication is a keyword during this process. It is also important that change leaders not only listen to good ideas and frustration, but that they also demonstrate that the affected stakeholders actually have an influence on the change program. Through communication, learning can take place in both directions. Thus, the acceptance process is quite central, since, when the change is accepted, the foundation for changing behavior is obtained. During this process, the following points can be considered:

- Identify the points that provide resistance.
- Include proponents for the change program in the preparation part of the change.
- Write down a strategy for continued education if this should turn out to be necessary.
- Create room for real employee influence during the change program.

Change Strategies

In the planning and implementation of change programs, different types of change strategies can be applied. In this chapter, we will briefly discuss four change strategies: 1) a process strategy, 2) a line manager strategy, 3) a project strategy, and 4) an expert strategy. Table 10.3 provides an overview of the advantages and disadvantages of these four change strategies.

	Advantages	Disadvantages
A process strategy	• Activate and develop a high number of employees. • Changes are anchored in the target group.	• Opens up for political 'games'. • Resource and time demanding.
A line manager strategy	• Changes are integrated in daily operations. • Clear placement of responsibility.	• Daily operation wins easily over development. • The line manager quickly becomes a bottleneck.
A project strategy	• Joins committed employees. • Makes cross-functional considerations and solutions possible.	• The change can be isolated from the basis organization. • Hidden power struggles can arise.
An expert strategy	• Calm analyses. • Logistical solutions. • Does not burden internal resources.	• No anchoring. • Negative signal = the organization cannot cope with the task. • No educational value.

Table 10.3: Advantages and Disadvantages of Four Change Strategies
Source: Based on Andersen (2000, p. 165)

A process strategy is focused on including as many stakeholders from the company as possible in the work on developing new solutions. In a line manager strategy, the goals of the change are defined by top management and then it is the line manager's responsibility to put it into operation. A project strategy to change builds on a number of internal and external resources that together develop the new situation. Finally, if a company applies an expert strategy, the change and thereby the new solution will be planned by a number of experts either from the company or from outside (or a combination). The task for top management is to implement the solutions. This strategy is often applied by companies in crisis.

Communication

This final section in the change management chapter is dedicated to an emphasis on the communication element that is often very neglected in change programs. The entire change management should be divided into three categories – the technical part of the change program, the planning element to do the change program and the management part of the change (communication and behavior) and the percentages will most likely be divided in the following way: 10% on the technical solution, 15% on the project planning part and 75% on change management. In other words, defining the technical solution for the improvement in the company and making a plan to overcome it is the easiest part. The real challenges appear when this has to reach the level of reality. Here, communication plays a crucial role. Basically, the reason why a given change should take place must be communicated in a language that is understandable to everyone. Here, the concept of sense of urgency can be applied. Kotter (2008) addresses the fact that the sense of the urgency part is overlooked in many change programs. He distinguishes between complacency, fail urgency and true urgency, as shown in Table 10.4.

	Complacency	A False Sense of Urgency	A True Sense of Urgency
Roots	Successes: Real or perceived wins, usually over a period of time	Failures: Recent problems with short-term results or long-standing, incremental decline	Leadership: People not only at the top but up and down the hierarchy who create true urgency and recreate it when needed
People Think	"I know what to do, and I do it"	"What a mess this is"	"Great opportunities and hazards are everywhere"
People Feel	Content with the status quo (and sometimes anxious of the unknown)	Very anxious, angry, and frustrated	A powerful desire to move, and win, now
Behavior	Unchanging activity: action which ignores an organization's new opportunities or hazards, focuses inwards, does whatever has been the norm in the past (many meetings or no meetings, 9 to 5 or 8 to 6)	Frenetic activity: meeting-meeting, writing-writing, going-going, projects-projects, with task force after task force and PowerPoint to the extreme – all of which exhausts and greatly stresses people	Urgent activity: action which is alert, fast moving, focused externally on the important issues, relentless, and continuously purging irrelevant activities to provide time for the important and to prevent burnout.

Table 10.4: Complacency, False and Truce Senses of Urgencies
Source: Kotter (2008, p. 10-11)

According to Kotter (2008), many organizations demonstrate too much complacency. Complacency might exist due to success or perceived success. It embraces the status quo. Such a behavior is more pervasive than people recognize. It is insidious and often invisible to insiders. In such situations, the real need for change is rarely communicated. In the organization, a false sense of urgency might also appear. False urgency is typically the product of failures or some form of intense pressure that is put on a group. It is built on anxiety and anger. When this takes place, it is also pervasive and insidious. Such a behavior can initiate much communication in the organization, but it is often unhealthy since the urgency is false where many activities are carried out in order to demonstrate diligence. Finally, true sense of urgency is immeasurable (Kotter, 2008). Here, there is a conscious assessment of what is important and what is not. This is also what is communicated to the stakeholders of the organization.

Communication must also be relevant for the different types of receivers. Table 10.5 contains an overview of the ways in which three groups in a change program may perceive each other.

Line Managers' Failings	**Users' Failings**	**BPO Staff Failings**
No clear business plan available	No clear expression of needs and expectations of business processes	Inability to match information systems to business needs
Inability to spot strategic uses of business processes	Focus only on operational support, no strategic vision	Preoccupation with the technicalities of business processes
Failure to communicate requirements to business process staff	Lack of appreciation for technical complexities	Lack of understanding of business environment
Lack of appreciation of technical complexities	No contribution to planning and policy of business processes	Failure to market business successes of information systems and business processes.
Insistence on cost justifying all investments		

Table 10.5: Perceived Failings from other Parties Perspectives
Source: Adjusted based on Boddy et al. (2005, p. 187)

The above list of perceived failings often is the result of a lack of information, limited information or disinformation. Line managers may view the project from a more overall level that does not take into consideration several constraints that might exist in practice. Users of the system may have difficulty expressing what their needs are and to see the benefits of, for example, new technology. Finally, staff dedicated to business process optimization initiatives may be so technically occupied with their project that they have almost developed their own language in the project group which can be difficult to understand for people outside the project. The technical language used in organizations signal affiliation and identity. The language sets up invisible borders between different employee groups or 'tribes' (Arlbjørn et al., 2008, p. 200). An unconscious use of technical language and technical concepts (such as business processes) can be a very effective way of communicating internally across professional boundaries.

Thus, in change programs, plans for communication must be developed. The overall communication might also need to be differentiated and adjusted to the receivers, the media and the situation. Certain elements can be communicated in a standard format to all employees in a company such as on the company's intranet. However, other staff groups need other forms of communication, such as meetings, that allow for mutual dialogue between developers and users.

Discussion Questions

1. What does the concept of change management cover?
2. Why is change management important to consider when working with business process optimization?
3. What are the differences between management and leadership?
4. Explain the concept of "sense of urgency".
5. What is the difference between a planning and an emergent approach to change management?
6. Explain Leavitt's basic model for change.
7. Explain different forms of change processes.
8. Explain different change strategies and the advantages and disadvantages.
9. Explain the role of communication in change programs.
10. How can different stakeholders fail in change programs?

PART 4: EVALUATION

CHAPTER 11

Project Evaluation

Introduction

> The scientist is not a person who gives the right answers; he is one who asks the right questions. (Claude Levi-Strauss)

This final part of this textbook concerns an often neglected area in business optimization projects, namely evaluation. Evaluation is an important activity for several reasons. First, an evaluation should outline to which extent the project goals have been reached. This is of special interest for the project sponsor, but also for the project participants who might have a bonus salary package connected to the fulfillment of project goals. Not least the employees affected by the optimization would be interested in the new work conditions matching what they expected. Besides these economical and tangible evaluation measures there are also soft evaluation points in terms of, for example, learning. This chapter has set out to touch the hard and soft elements of evaluation briefly. In order to do so, the chapter is further organized in four sections. The next section is about two central templates introduced in connection with the project model in the previous chapter. Then follows a section that evaluates an optimization through both tangible and intangible benefits. Subsequently, a section follows with a brief overview of six different capital budgeting models. The final section elaborates on single-loop and double-loop learning.

Returning to the Business Case and the Change Log

As discussed in chapter 9, business process optimization projects can benefit from being structured by a project model. We provided an example of such a model consisting of five phases to which five document templates could be applied. Two of these templates are the business case and the change log. In the business case, one has to provide the basis for developing benefits of carrying out the project. Such benefits could both be tangible and intangible. The business case should also contain a cost budget. With these two elements at hand, it is possible to provide information about the expected pay-back time. The change log is an important document to use since changes on what is originally agreed in the decided business case is logged in this document. Thus, the change log should deliver the information that establishes against which foundation the business optimization project should actually be evaluated.

Tangible and Intangible Benefits

The developed business case could both include tangible and intangible benefits as mentioned in chapter 8 and 10. Tangible benefits are immediately measurable and directed towards cost savings (see Table 11.1).

Tangible Benefits (Cost Savings)	Intangible Benefits
Increased productivity	Improved asset utilization
Lower operational costs	Improved resource control
Reduced workforce	Improved organizational planning
Lower computer expenses	Increased organizational flexibility
Lower outside vendor costs	More timely information
Lower clerical and professional costs	More information
Reduced rate of growth in expenses	Increased organizational learning
Reduced facility costs	Legal requirements attained
	Enhanced employee goodwill
	Increased job satisfaction
	Improved decision-making
	Improved operations
	Higher client satisfaction
	Better corporate image.

Table 11.1: Tangible and Intangible Benefits of Process Optimization
Source: Based on Laudon and Laudon (2006, p. 538)

Regardless of the nature of tangibility of the benefit, as practitioners working with such benefits and measures, we ought to make them as measurable and operational as possible. In chapter 5, we introduced the SMART criteria for defining measures (Specific, Measurable, Assignable, Realistic and Time-related). Although a benefit can be intangible, this does not mean that the benefit is not measurable. Thus, one has to define, for example, what is meant by 'job satisfaction' and 'more information'. A way to achieve this is to develop different categories of the content of such elements and then ask the employees how they view them. This could be done before the optimization begins in order to have a fix point and then again and after the implementation in order to measure any progress. Business process changes produce new information systems (not to be confused with IT systems; see chapter 7). Thus, in the evaluation of the business process optimizations, one can also use the different categories of measures, shown in Table 11.2.

Item	Description
Systems quality	Information system projects achieve high levels of system quality (e.g. system reliability, features and functions, response time).
Information quality	Information system projects achieve high levels of information quality (e.g. clarity of information, completeness, usefulness, accuracy).
Information use	Information system projects achieve high levels of information use (e.g. regularity of use, number of inquiries, duration of use, frequency of report requests).
User satisfaction	Information systems projects achieve high levels of user satisfaction (e.g. overall satisfaction, enjoyment, difference between information needed and received, software satisfaction).
Individual impact	Information systems projects achieve high levels of individual impact (e.g. problem identification, correctness of decision, decision effectiveness, time to make decision, improved individual productivity).
Organizational impact	Information systems projects achieve high levels of organizational impact (e.g. contribution to achieving goals, cost/benefit ratio, return on investment, service effectiveness).

Table 11.2: Item Measures for Systems Success
Source: Doherty et al. (2003)

The measures in Table 11.2 are both tangible and intangible. In a practical application, they first need to be operationalized. Again the SMART criteria and the procedure for defining a measure, as described in chapter 5, are of special importance.

Capital Budgeting Models

The business case of the business optimization project should contain a cost-benefit analysis. The evaluation point is to justify that the benefits have outweighed the costs. In this section, six capital budgeting models will briefly be examined. These models are:

- The pay-back method
- The accounting rate of return on investment (ROI)
- The new present value
- The cost-benefit ratio
- The profitability index
- The internal rate of return (IRR).

Figure 11.1 contains an example of the budget spreadsheet of a project concerning the implementation of a supply-chain optimization module. The figure contains data to be used to exemplify the six above-listed budgeting models. The data in Figure 11.1 concern a project implemented in 2010 and its costs and benefits are calculated in an overall duration of five years (ends in 2014). The costs of the project are divided into different categories (i.e. hardware, network infrastructure, software, labor, maintenance and support). Furthermore, the benefits fall into three areas: 1) Reduced labor costs, 2) Reduced inventory carrying costs, and 3) Reduced transportation costs. The total costs of the project are calculated to be DKK 13,130,000. The total benefits are calculated to be DKK 23,200,000. In the following, the six capital budgeting models will briefly be examined. Each model will refer to a concrete calculation, outlined in Figure 11.2.

Year		Number	Unit price	2005	2006	2007	2008	2009	2010
Cost: Hardware									
	Servers	7	80000	560.000					
	Backup servers	4	80000	320.000					
	PCs at loading dock	100	1250	125.000					
	Radio-frequency devices	1000	1175	1.175.000					
	Storage			800.000					
Network Infrastructure									
	Routers and hubs	300	4100	1.230.000					
	Firewalls	2	6300	12.600					
	Wireless FR network			1.750.000					
	Backup network system			1.150.000					
	Telecom links			74.250	225.000	225.000	225.000	225.000	225.000
Software									
	Database			475.000					
	Web servers (apache)			0					
	Supply chain planning & execution models			1.187.500					
Labor									
	Business staff			425.000	115.000	115.000	115.000	115.000	115.000
	IS staff			1.225.000	525.000	525.000	525.000	525.000	525.000
	External consultants			576.000	95.000	95.000	95.000	95.000	95.000
	Training (end users)			382.000	35.000	35.000	35.000	35.000	35.000
Subtotal				11.467.350	995.000	995.000	995.000	995.000	995.000
Maintenance and support									
	Hardware maintenance & upgrades			0	240000	240000	240000	240000	240000
	Software maintenance & upgrades			0	275000	275000	275000	275000	275000
	Subtotal			0	515000	515000	515000	515000	515000
Total per year				11.467.350	1.510.000	1.510.000	1.510.000	1.510.000	1.510.000
Total costs				19.017.350					
Benefits									
	Reduced labor costs				1.650.000	1.400.000	1.400.000	1.400.000	1.400.000
	Reduced inventory costs				3.500.000	3.500.000	3.500.000	3.500.000	3.500.000
	Reduced transportation costs				1.300.000	1.300.000	1.300.000	1.300.000	1.300.000
	Reduced telecommunication costs				250.000	250.000	250.000	250.000	250.000
Subtotal				0	6.700.000	6.450.000	6.450.000	6.450.000	6.450.000
Net Cash Flow				(-11.467.350)	5.190.000	4.940.000	4.940.000	4.940.000	4.940.000
Total Benefits				32.500.000					
	NPV	21.625.710							
		(-11.467.350)							
		10.158.360							

Figure 11.1: Costs and Benefits of a Supply Chain Optimization Project

		Number	Unit price	2010	2011	2012	2013	2014
Hardware Costs								
	Servers	5	50.000	250.000				
	Backup servers	2	50.000	100.000				
	New PCs	25	8.000	200.000				
Network Infrastructure Costs								
	Routers	50	2.500	125.000				
	Firewalls	2	25.000	50.000				
	WAN			550.000				
	LAN			225.000				
Software Costs								
	Database			335.000				
	Supply Chain Optimization module			225.000				
Labour Costs								
	Business staff			1.700.000	500.000	500.000	500.000	500.000
	IS staff			995.000	800.000	400.000	400.000	400.000
	External consultants			1.200.000	250.000	100.000	100.000	100.000
	Training (end users)			450.000	115.000	0	0	0
Subtotal				6.405.000	1.665.000	1.000.000	1.000.000	1.000.000
Maintenance and Support Costs								
	Hardware maintenance & upgrades			0	75.000	75.000	75.000	75.000
	Software maintenance & upgrades			0	55.000	55.000	55.000	55.000
	Subtotal			0	515.000	515.000	515.000	515.000
Total Per Year (Subtotal + Maintenance and Support Costs)				6.405.000	2.180.000	1.515.000	1.515.000	1.515.000
Total Costs				**13.130.000**				
Benefits								
	Reduced labour costs				2.500.000	2.500.000	2.500.000	2.500.000
	Reduced inventory costs				2.300.000	2.300.000	2.300.000	2.300.000
	Reduced transportation costs				1.000.000	1.000.000	1.000.000	1.000.000
Subtotal				0	5.800.000	5.800.000	5.800.000	5.800.000
Net Cash Flow				(-6.405.000)	3.620.000	4.285.000	4.285.000	4.285.000
Total Benefits				**23.200.000**				
	A	B	C	D	E	F	G	
1	Year		2010	2011	2012	2013	2014	
2	Net cash flow (not including original investment) for years 2010-2014		0	3.620.000	4.285.000	4.285.000	4.285.000	
3	Net cash flow (including original investment for years 2010-2014		(-6.405.000)	3.620.000	4.285.000	4.285.000	4.285.000	
5	**Pay Back Period: 2,65 years**			Cummulative cash flow				
6	Initial investment	2010	(-6.405.000)	(-6.405.000)				
7		2011	3.620.000	(-2.785.000)				
8		2012	4.285.000	1.500.000				
9		2013	4.285.000	5.785.000				
10		2014	4.285.000	10.070.000				
11	**Accounting Rate of Return**							
12	(Total Benefits - Total Costs - Depreciation) / Useful Life			Total Benefits		23.200.000		
13				Total Costs		13.130.000		
14				Depreciation		6.405.000		
15		Total Benefits - Total Costs - Depreciation				3.665.000		
16				Life		5		
17		DKK	Life					
18	Net Benefit	3.665.000	5	733.000				
19	**Return on Investment**	733.000	6.405.000	11,44%				
20	Cost-Benefit Ratio					1,77		
21	Total Benefits - Total Costs - Depreciation			23.200.000				
22	Total Costs			13.130.000				
23	**Net Present Value**							
24	Present Value of Expected Cash Flows	13.867.681						
25	Initial Investment Costs	(-6.405.000)						
26	= Net Present Value	7.462.681						
27	**Profitability Index**							
28	Present Value of Expected Cash Flows	13.867.681						
29	Initial Investment Costs	6.405.000						
30	= Net Present Value	2,17						
31	**Internal Rate of Return**	50%						

Figure 11.2: Examples of Calculations Based on Six Models

The Pay Back Method

The pay-back method calculates the number of years it will take before the initial investment of the project is paid back. The shorter the pay-back time, the more attractive a project is due to a less risky investment. The method is quite popular due to its simplicity. The weakness of this method is that it ignores the time value of money.

$$\text{Number of Years to Pay Back} = \frac{\text{Original Investment}}{\text{Annual Net Cash Inflow}}$$

As shown in Figure 11.2, the pay-back time is calculated to 2.65 years. The first two years have a negative cumulative cash flow, but this is changed in year 3.

Accounting Rate of Return on Investment (ROI)

This method calculates the return of an investment (ROI) by adjusting the cash inflows produced by the investment for depreciation. The investment inflows are totaled and the investment costs subtracted to derive the profit. The profit is divided by the number of years invested, then by the investment cost, to estimate an annual rate of return. A ROI analysis calculates the difference between the stream of benefits and the stream of costs over the lifetime of system discounted by the applicable interest rate. In order to find ROI, the average net benefit has to be calculated:

$$\text{Net Benefit} = \frac{\text{Total Benefits} - \text{Total Cost} - \text{Depreciation}}{\text{Useful Life}}$$

The net benefit is calculated in Figure 11.2 to be of DKK 733,000. Total benefits are DKK 23,200,000. The total costs are DKK 13,130,000. Depreciation is DKK 6,405,000. The useful life constitutes 5 years.

The new benefit is then divided by the initial investment costs to calculate the ROI:

$$\text{ROI} = \frac{\text{Net Benefits}}{\text{Initial Investment}}$$

The ROI calculation in Figure 11.2 provides a result of 11.44%.

The Net Present Value (NPV)

The net present value (NPV) approach calculates the amount of money which an investment is worth, taking into account its cost, earnings, and the time value of money (inflation). Thus, it compares the economic value of a project today with the value of the same project in the future, taking inflation and returns into account. If the NPV of a prospective project is positive, it should be accepted. If the NPV is negative, the project should probably be rejected because cash flows will also be negative. First, the present value must be calculated:

$$\text{Present Value} = \text{Payment} \cdot \frac{1-(1+\text{interest})^{-n}}{\text{Interest}}$$

The present value of the supply chain optimization project in Figure 11.1 is in Figure 11.2 calculated to be DKK 13,867,681 (=NPV(0.05,D3:G3)). D3:G3 refers to the cells in Figure 11.2 the formula to calculate the net present value is:

$$\text{Net Present Value} = \text{Present Value of Expected Cash Flows} - \text{Initial Investment Costs}$$

Thus, the NPV in Figure 11.2 is calculated to be DKK 7,462,681 (13,867,681-6,405,000).

The Cost-Benefit Ratio

This calculation method views the total benefits of an investment over the costs consumed to deliver these benefits.

$$\text{Cost Benefit Ratio} = \frac{\text{Total Benefits}}{\text{Total Costs}}$$

The cost-benefit ratio in Figure 11.2 can be calculated to be 1.77 (23,200,000 / 13,130,000). This measure means that the benefits are 1.77 times greater than the costs.

The Profitability Index

The profitability index attempts to identify the relationship between the costs and benefits of a project through the use of a ratio calculated as:

$$\text{Profitability Index} = \frac{\text{Present Value of Cash Flows}}{\text{Investment}}$$

The lowest acceptable level is a ratio of 1.0. Any value lower than 1.0 would indicate that the project's present value is less than the initial investment. As values on the profitability index increase, so does the financial attractiveness of the proposed project. The profitability index in Figure 11.2 is calculated to be 2.17 and means that the project returns more than it costs.

The Internal Rate of Return (IRR)

The internal rate of return (IRR) calculates the rate of return which an investment is expected to earn, taking into consideration the time value of money. The higher a project's internal rate of return is, the more desirable it is to carry out the project. If a company has several competing business optimization projects, the internal rate of return can be used in selecting which project to prioritize.

Single-Loop and Double-Loop Learning

Argyris and Schön (1974) have developed the concepts of single-loop and double-loop learning. Single-loop learning concerns providing solutions to present problems when they occur. It is like a thermostat that detects when the air around it is too hot or too cold. It then corrects the situation either by turning the heat on or turning the heat off (Argyris, 1990, p. 92). Single-loop learning is therefore not reflective to move beyond the basic problem-solving by asking why this problem emerged. The learning is instrumental. Single-loop learning is portrayed in the left side of Figure 11.3.

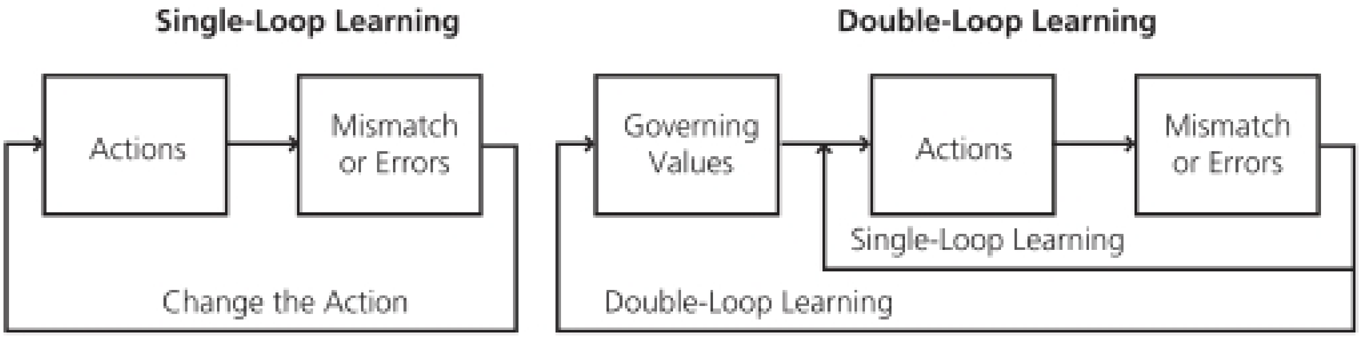


Figure 11.3: Single- and Double-Loop Learning
Source: Argyris (1990, pp. 92-94)

In single-loop learning, the learning episodes are mediated by organizational inquiry and it connects failures or errors compared to planned action back to organizational strategies of action. These strategies are then corrected in order to keep organizational performance within the range, set by existing organizational values and norms (Argyris and Schön, 1996, p. 21). Thus, the values related to what causes the mismatch or error remain unchanged. The drawbacks of single-loop learning can be solved with double-loop learning. Double-loop learning denotes learning that results in a change in the values of theory-in-use, as well as in its strategies and assumptions (Argyris and Schön, 1996, p. 21). As shown in the right side of Figure 11.3, the double-loop refers the two feedback loops that connect the observed effect of actions with the governing values.

In business process optimization, projects learning might also take place both during the project and when it is completed. In practice, both single-loop and double-loop learning occur. Single-loop learning will, for example, take place if an output of a new process does not fit with the expected performance after which a person manually has to correct the data for further analysis purposes. An example of double-loop learning could be the case when a company decides that, in future system development projects, there will be no coding of adjustments to system software before a signed user requirement specification is provided by the IT manager. In single-loop learning, one would, for example, just call the software system developer in order to change the code. In double-loop learning, new governmental values are included that should secure that the IT manager approves the coding and then makes sure that the error is corrected.

Discussion Questions

1. Explain tangible and intangible benefits of conducting a business process optimization project.
2. Explain what is meant by the pay back method.
3. Explain the content of the accounting rate of return on investment (ROI) method.
4. Which limitations are there to applying ROI?
5. Explain the Net Present Value (NPV) method.
6. Explain the Cost-Benefit Ratio method.
7. Explain the Profitability Index method.
8. Explain the Internal Rate of Return (IRR) method.
9. What is single-loop learning?
10. What is double-loop learning?

CHAPTER 12

The New Processes in Operation

Introduction

> I guess we all like to be recognized not for one piece of fireworks, but for the ledger of our daily work. (Neil Armstrong, American astronaut)

Having implemented new business processes in a company, the major challenge is to ensure that the processes are actually performed in accordance with the definitions. Also, there is a need for continuous evaluation of the processes in order to identify areas for improvement. Thus, the remainder of this chapter deals with the issues of ensuring that the new process design is properly implemented and how to make continuous evaluation of process performance.

Anchoring the New Process Design

To achieve the expected benefits of process changes it is essential that the processes are carried out as intended, instead of slipping back into old habits. At best, the new processes are more satisfying for the affected actors than the old ones and therefore, the relevant actors have no reason to slip back into old roles. However, this is not always possible, especially in cases where the new process design implies more registration and more control. In time-pressured situations, it is often seen that employees are tempted to perform an activity without making the required registration or control. However, such registrations and control procedures often constitute an important basis for the success of a business process design, consequently neglecting to carry out the defined tasks must be avoided. There are a number of ways to promote the procedures of the defined processes to be obeyed:

1. Management commitment
2. Process ownership
3. Removing the possibilities of using existing procedures
4. Rewards and incentive

5. Cross-functional collaboration
6. Training of relevant personnel
7. Control procedures
8. Continuous improvement
9. Commitment to investment
10. Implementing an IT-based process management system.

These ten aspects are described in the following sections.

Management Commitment

Management commitment is an important factor for the success of business process optimization projects. If an organization senses that management is not dedicated to the new way of thinking of business processes, the organization may begin to take shortcuts instead of sticking to the overall plan. This is especially the case when new processes require additional work which is not directly related to the creation of the core product, such as quality checks, registration of particular types of information, customer service, etc.

Process Ownership

Process ownership is a factor with an importance similar to that of management commitment. If it is not clear who has the responsibility for the way in which different processes are running and the authority to step in, there is a risk that eventually the process design would not be followed. However, if someone is given the responsibility for the success of the processes, the chance of commitment to the process design increases.

Removing the Possibilities of Using Existing Procedures

In certain situations, it may be a solution to make it impossible to carry out tasks as in the old processes. This is the case in particular if a process redesign includes the replacement of IT systems. In such cases, it can be ensured that the old IT systems are no longer available. However, it is often not the problem that an old IT system is still in operation, but rather that new IT systems emerge, such as Excel-based applications.

Rewards and Incentives

Reward systems can also be a contributory factor in relation to the proper implementation of a new process design. If choosing this path, it should be sought not to overcomplicate such systems in order to avoid too much administration.

Another type of motivation is company spirit. If the goals, visions and expected effects of the project are communicated to the employees, the employees may be more motivated towards the project as they would feel that they are part of a dynamic organization.

Cross-Functional Collaboration

To achieve streamlined business processes it is essential that cross-functional collaboration runs smoothly. A great killer of process efficiency lies in problems with getting timely and quality information from other departments. Thus, there is a need for the individual departments to have a more holistic perspective on the organization, i.e. to be a part of a large organization rather than just their specific department.

Training of Relevant Personnel

To ensure that the new processes are carried out as intended, it is crucial that the information about the new processes is communicated to the relevant persons. Also, in some cases more specific training is required in order to carry out the new processes. This is for example often the case when implementing new IT systems and various types of manufacturing machines.

Control Procedures

Another approach to promote the application of the process design in practice is to implement control procedures. This could be in the form of spot checks of particular tasks or the outputs produced. The extent of such controls need not be particularly extensive in order to get an idea of whether the intended use is achieved or not.

Continuous Improvement

To focus on continuous improvement implies that small process improvements happen frequently. This may have a great cumulative effect on the organization, i.e. that both workers in the process, supervisors, managers, customers and others feel motivated to contribute ideas and knowledge related to process improvements. In this context, it should be noted that the longer an initiative takes, the more likely it is that those involved lose interest or focus or even leave before the projects is completed. Thus, pace is a key issue when initiating process improvement projects.

Commitment to Investment

Although the goals of business process improvement projects typically relate to producing savings or increased revenue, it should be recognized that a project requires an initial financial investment. Furthermore, unexpected events may occur during a project and unbudgeted investments are needed in order to achieve success. Thus, to achieve success in such cases, it is essential that relevant decision-makers are willing to carry the project through in spite of extra costs.

Implementing an IT-Based Process Management System

The use of an IT-based process management system is a way to ensure that the relevant people receive adequate information about the processes and that relevant process tasks are carried out. Software-based process management systems define a series of tasks needed to produce desired outcomes. Normally, the basic concept of such systems is that a performed task is registered in the system which sends out a notification to the relevant people who need to execute the next stage of the process. Figure 12.1 shows an extract from a screenshot from such a system. In the top right frame, navigation between different processes is possible and in the bottom right frame, relevant people can be found. In the top left frame, a particular process is shown and in the frame below, the properties of the process are described.

Continuous Evaluation of Process Performance

In the operation phase, there is a need for continuous evaluation of the process performance to ensure that the expected benefits are achieved. Such post-implementation evaluations can include a number of aspects, such as:

- Determine the user satisfaction in relation to the use of procedures
- Identify to what extent the processes produce the expected effects
- Evaluation of the quality of the outputs produced by the processes, i.e. information, products and services
- Determine if additional training or education of employees is needed
- Evaluations of whether there are additional possible performance improvements
- Continuous work on cost-benefit analyses
- Create recommendations of how processes may be further improved.

Post-implementation evaluations should be carried out a least once a year or even more frequently.

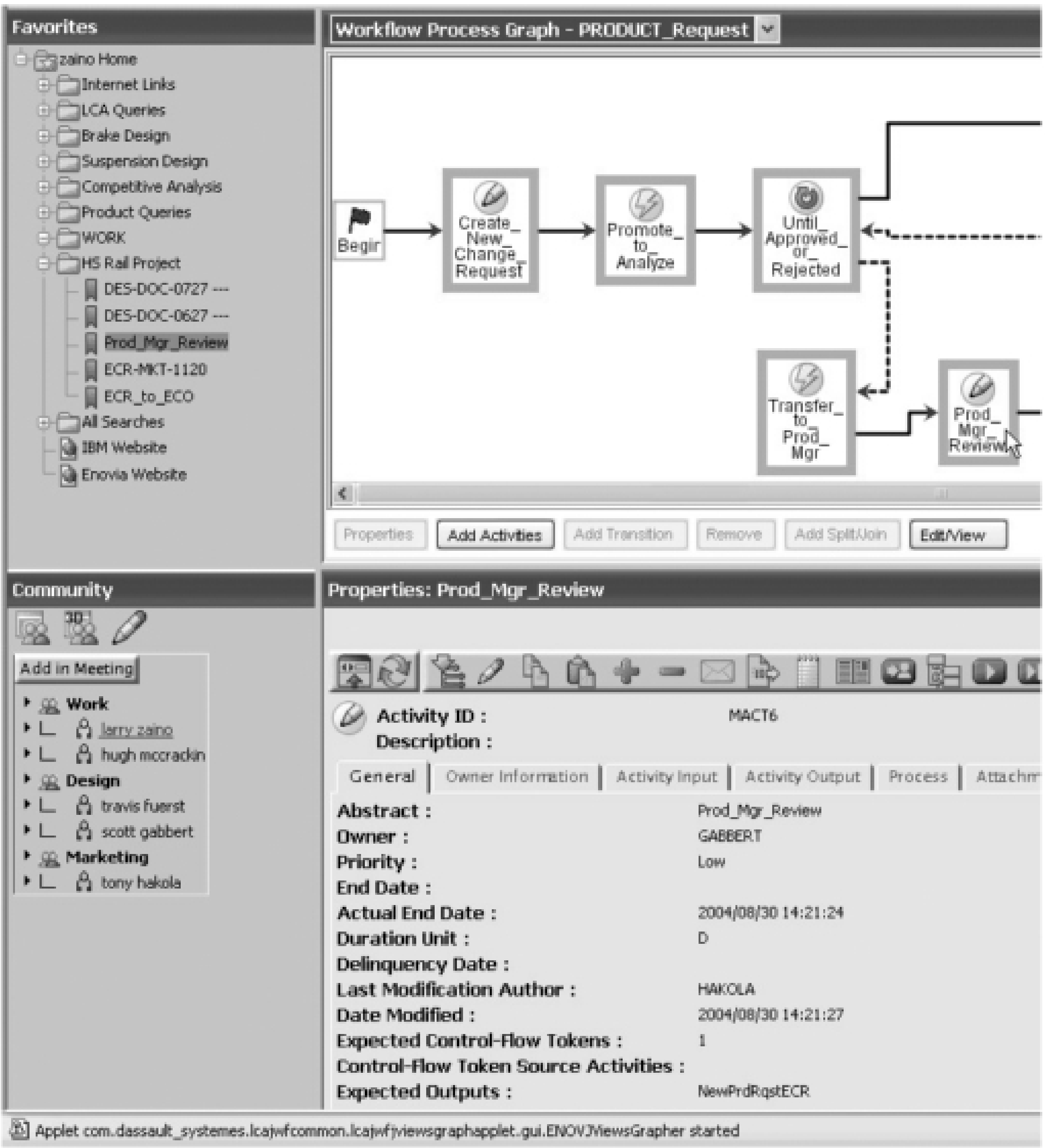


Figure 12.1: Extract of Screenshot from ENOVIA LCA Workflow Management
Source: IBM (2010)

Final Remarks

No matter how good the design of new business processes is, a project will not be a success unless it is implemented properly in the daily operations. This is an issue that many companies give too little focus, i.e. by perceiving a project as complete once it has been implemented. However, business process optimization is not a one-shot routine, but a continuous activity.

Discussion Questions

1. How can process improvement initiatives be anchored?
2. What is the purpose of continuous process evaluation?
3. What happens if there is a lack of management commitment?
4. What happens if there is no clear process ownership?
5. How can the possibility of using the old procedures be removed?
6. Give examples of rewards for doing processes properly.
7. Why is continuous improvement important?
8. Why is commitment to investment essential for a process improvement project?
9. What is an IT-based process management system?
10. What is a post-implementation evaluation?

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