Fundamentals of

Business Process Management

Marlon Dumas · Marcello La Rosa
Jan Mendling · Hajo A. Reijers

Second Edition

Springer

Marlon Dumas • Marcello La Rosa •
Jan Mendling • Hajo A. Reijers

Fundamentals of Business Process Management

Second Edition

Springer

Marlon Dumas
Institute of Computer Science
University of Tartu
Tartu, Estonia

Marcello La Rosa
School of Computing and Information Systems
The University of Melbourne
Melbourne, Australia

Jan Mendling
Institute for Information Business
Vienna University of Economics and Business
Vienna, Austria

Hajo A. Reijers
Department of Computer Sciences
Vrije Universiteit Amsterdam
Amsterdam, The Netherlands

ISBN 978-3-662-56508-7 ISBN 978-3-662-56509-4 (eBook)
https://doi.org/10.1007/978-3-662-56509-4

Library of Congress Control Number: 2018934715

Printed on acid-free paper

This Springer imprint is published by the registered company Springer-Verlag GmbH, DE part of Springer Nature.
The registered company address is: Heidelberger Platz 3, 14197 Berlin, Germany

Contents

List of Figures

List of Tables

List of Acronyms

6 M	Machine, Method, Material, Man, Measurement, Milieu
4 P	Policies, Procedures, People, Plant/Equipment
7PMG	Seven Process Modeling Guidelines
ABC	Activity-Based Costing
ACM	Adaptive Case Management
API	Application Programming Interface
APQC	American Productivity and Quality Center
ATAMO	And Then, A Miracle Occurs
B2B	Business-to-Business
BAM	Business Activity Monitoring
BOM	Bill-of-Material
BPA	Business Process Analysis
BPE	Business Process Excellence
BPEL	Web Service Business Process Execution Language
BPM	Business Process Management
BPMN	Business Process Model & Notation
BPMS	Business Process Management System
BPR	Business Process Reengineering
BTO	Build-To-Order
BVA	Business Value-Adding
CEO	Chief Executive Officer
CEP	Complex Event Processing
CFO	Chief Financial Officer
CIO	Chief Information Officer
CMMI	Capability Maturity Model Integrated
CMMN	Case Management Model and Notation
CNC	Coefficient of Network Connectivity
COO	Chief Operations Officer
CPIO	Chief Process and Innovation Officer
CPM	Critical Path Method
CPN	Colored Petri Net

CPO	Chief Process Officer
CRM	Customer Relationship Management
CSV	Comma Separated Values
CT	Cycle Time
CTC	Cost-To-Company
CTE	Cycle Time Efficiency
DBMS	Database Management System
DCOR	Design Chain Operations Reference (product design)
DES	Discrete-Event Simulation
DMN	Decision Model and Notation
DMR	Department of Main Roads
DMS	Document Management System
DRG	Decision Requirements Graph
DUR	Drug Utilization Review
DVS	Deputy Vice Chancellor
EDI	Electronic Data Interchange
EF	Early Finish
EHS	Environmental Health and Safety
EPA	Environment Protection Agency
EPC	Event-driven Process Chain
ERP	Enterprise Resource Planning
ES	Early Start
eTOM	Enhanced Telecom Operations Map
FIFO	First-In-First-Out
HR	Human Resources
IDEF3	Integrated Definition for Process Description Capture Method
ISP	Internet Service Provider
IT	Information Technology
ITIL	Information Technology Infrastructure Library
JSON	JavaScript Object Notation
KM	Knowledge Management
KPI	Key Performance Indicator
LF	Late Finish
LS	Late Start
NESTT	Navigate, Expand, Strengthen, and Tune/Take-off
NRW	Department of Natural Resources and Water
NVA	Non-Value-Adding
OASIS	Organization for the Advancement of Structured Information Standards
OMG	Object Management Group
OS	Operating System
PAIS	Process-Aware Information System
PCG	Productivity Consulting Group
PCF	Process Classification Framework
PD	Product Development

PDCA	Plan-Do-Check-Act
PDF	Portable Document Format
PICK	Possible, Implement, Challenge, Kill
PLM	Product Lifecycle Management
PMBOK	Project Management Body of Knowledge
PO	Purchase Order
POS	Point-of-Sale
PPI	Process Performance Indicator
PPM	Process Performance Measurement
PRINCE2	Projects in Controlled Environments
RBAC	Role-based Access Control
REST	Representational State Transfer
RFID	Radio-Frequency Identification
RFQ	Request for Quote
ROI	Return-On-Investment
RPA	Robotic Process Automation
RPH	Reference Process House
SCAMPI	Standard CMMI Appraisal Method for Process Improvement
SCM	Supply Chain Management
SCOR	Supply Chain Operations Reference Model
S-FEEL	Simple Friendly Enough Expression Language
SIPEX	Siemens Processes for Excellence
Smart eDA	Smart Electronic Development Assessment System
SOA	Service-Oriented Architecture
SPICE	Software Process Improvement and Capability Determination
STP	Straight-Through-Processing
TCT	Theoretical Cycle Time
TOC	Theory of Constraints
TPS	Toyota Production System
TQM	Total Quality Management
UIMS	User Interface Management System
UEL	Universal Expression Language
UML	Unified Modeling Language
UML AD	UML Activity Diagram
URI	Uniform Resource Identifier
VA	Value-Adding
VCH	Value Creation Hierarchy
VCS	Value Creation System
VOS	Voice of the Customer
VRM	Value Reference Model
WIP	Work-In-Process
WfMC	Workflow Management Coalition
WfMS	Workflow Management System
WS-BPEL	Web Service Business Process Execution Language
WSDL	Web Service Definition Language

XES	Extensible Event Stream
XML	Extensible Markup Language
XPATH	XML Path Language
XSD	XML Schema Definition
YAWL	Yet Another Workflow Language

Chapter 1
Introduction to Business Process Management

Ab ovo usque ad mala.
Horace (65 BCE–8 BCE)

Business Process Management (BPM) is the art and science of overseeing how work is performed in an organization to ensure consistent outcomes and to take advantage of improvement opportunities. In this context, the term "improvement" may take different meanings depending on the objectives of the organization. Typical examples of improvement objectives include reducing costs, reducing execution times, and reducing error rates, but also gaining competitive advantage through innovation. Improvement initiatives may be one-off or of a continuous nature; they may be incremental or radical. Importantly, BPM is not about improving the way individual activities are performed. Rather, it is about managing entire chains of events, activities, and decisions that ultimately add value to the organization, and its customers. These chains of events, activities, and decisions are called *processes*.

In this chapter, we introduce the essential concepts behind BPM. We start with a description of typical processes that are found in contemporary organizations. Next, we discuss the basic ingredients of a business process and provide a definition of business process and BPM. In order to place BPM in a broader perspective, we then provide a historical overview of the BPM discipline. Finally, we discuss how a BPM initiative in an organization typically unfolds. This discussion leads us to the definition of a BPM lifecycle, around which the book is structured.

1.1 Processes Everywhere

Each organization—be it a governmental agency, a non-profit organization, or an enterprise—has to manage a number of processes. Typical examples of processes that can be found in most organizations include:

- *Order-to-cash*. This is a type of process performed by a vendor, which starts when a customer submits an order to purchase a product or a service and ends

M. Dumas et al., *Fundamentals of Business Process Management*,
https://doi.org/10.1007/978-3-662-56509-4_1

when the product or service in question has been delivered to the customer and the customer has made the corresponding payment. An order-to-cash process encompasses activities related to purchase order verification, shipment (for physical products), delivery, invoicing, payment receipt, and acknowledgment.

- *Quote-to-order*. This type of process typically precedes an order-to-cash process. It starts from the point when a supplier receives a Request for Quote (RFQ) from a customer and ends when the customer in question places a purchase order based on the received quote. The order-to-cash process takes the relay from that point on. The combination of a quote-to-order and the corresponding order-to-cash process is called a *quote-to-cash* process.
- *Procure-to-pay*. This type of process starts when someone in an organization determines that a given product or service needs to be purchased. It ends when the product or service has been delivered and paid for. A procure-to-pay process includes activities such as obtaining quotes, approving the purchase, selecting a supplier, issuing a purchase order, receiving the goods (or consuming the service), and paying the invoice. A procure-to-pay process can be seen as the counterpart of the quote-to-cash process in the context of business-to-business interactions. For every procure-to-pay process there is a corresponding quote-to-cash process on the supplier's side.
- *Issue-to-resolution*. This type of process starts when a customer raises a problem or issue, such as a complaint related to a defect in a product or an issue encountered when consuming a service. The process continues until the customer, the supplier, or preferably both of them agree that the issue has been resolved. A variant of this process can be found in insurance companies that have to deal with insurance claims. This variant is called *claim-to-resolution*.
- *Application-to-approval*. This type of process starts when someone applies for a benefit or privilege and ends when the benefit or privilege in question is either granted or denied. This type of process is common in government agencies, for example when citizens apply for building permits or when entrepreneurs apply for business licenses (e.g., to open a restaurant). Another process that falls into this category is the admissions process in a university, which starts when a student applies for admission into a degree program. Yet another example is the process for approval of vacation or special leave requests in a company.

As the above examples illustrate, business processes are what companies do whenever they deliver a service or a product to customers. The way processes are designed and performed affects both the *quality of service* that customers perceive and the *efficiency* with which services are delivered. An organization can outperform another organization offering similar kinds of service if it has better processes and executes them better. This is true not only for customer-facing processes, but also for internal processes such as the procure-to-pay process, which is performed for the purpose of fulfilling an internal need.

As we go along in this book, we will use a concrete example of a procure-to-pay process for renting construction equipment, as described below.

Example 1.1 Equipment rental at BuildIT.

BuildIT is a construction company specialized in public works, such as roads, bridges, pipelines, tunnels and railroads. Within BuildIT, it often happens that engineers working at a construction site (called *site engineers*) need a piece of equipment, such as a truck, an excavator, a bulldozer, a water pump, etc. BuildIT owns very little equipment and instead it rents most of its equipment from specialized suppliers.

The existing business process for renting equipment goes as follows. When site engineers need to rent a piece of equipment, they fill in a form called "Equipment Rental Request" and send this request by email to one of the clerks at the company's depot. The clerk at the depot receives the request and, after consulting the catalogs of the equipment suppliers, selects the most cost-effective equipment that complies with the request. Next, the clerk checks the availability of the selected equipment with the supplier via phone or email. Sometimes the selected option is not available. In these cases, the clerk has to select an alternative piece of equipment and check its availability with the corresponding supplier.

After finding a suitable and available piece of equipment, the clerk adds the details of the selected equipment to the rental request. Each rental request has to be approved by a works engineer, who also works at the depot. In some cases, the works engineer rejects the equipment rental request. Some rejections lead to the cancelation of the request, i.e., no equipment is rented at all. Other rejections are resolved by replacing the selected equipment with another equipment—such as a cheaper piece of equipment or a more appropriate piece of equipment for the job. In this latter case, the clerk needs to lodge another availability request.

When a works engineer approves a rental request, the clerk sends a confirmation to the supplier. This confirmation includes a Purchase Order (PO) for renting the equipment. The PO is produced by BuildIT's financial information system using information entered by the clerk. The clerk also records the equipment rental in a spreadsheet that is used to monitor all ongoing equipment rentals.

In the meantime, the site engineer may decide that the equipment is no longer needed. In this case, the engineer asks the clerk to cancel the request for renting the equipment.

In due time, the supplier delivers the rented equipment to the construction site. The site engineer then inspects the equipment. If everything is in order, the site engineer accepts the engagement and the equipment is put into use. In some cases, the equipment is sent back because it does not comply with the requirements of the site engineer. In this case, the site engineer has to start the rental process all over again.

When the rental period expires, the supplier comes to pick up the equipment. Sometimes, the site engineer asks for an extension of the rental period by contacting the supplier via email or phone 1 to 2 days before pick-up. The supplier may accept or reject this request.

A few days after the equipment is picked up, the equipment's supplier sends an invoice to the clerk by email. At this point, the clerk asks the site engineer to confirm that the equipment was indeed rented for the period indicated in the invoice. The clerk also checks if the rental prices indicated in the invoice are in accordance with those in the PO. After these checks, the clerk forwards the invoice to the financial department. The financial department eventually pays the invoice.

□

1.2 Ingredients of a Business Process

The BuildIT example in the previous section shows that a business process encompasses a number of *events* and *activities*. Events correspond to things that happen atomically, which means that they have no duration. The arrival of a piece of equipment at a construction site is an event. This event may trigger the execution of a series of activities. For example, when a piece of equipment arrives, the site engineer inspects it. This inspection is an activity, in the sense that it takes time.

When an activity is rather simple and can be seen as one single unit of work, we call it a *task*. For example, if the equipment inspection is simple—e.g., just checking that the equipment received corresponds to what was ordered—we can say that the equipment inspection is a task. If on the other hand the equipment inspection involves several checks—such as checking that the equipment fulfills the specification included in the purchase order, checking that the equipment is in working order, and checking the equipment comes with all the required accessories and safety devices—we will call it an activity instead of a task. In other words, the term task refers to a fine-grained unit of work performed by a single process participant, while the term activity is used to refer to both fine-grained or coarse-grained units of work.

In addition to events and activities, a typical process includes *decision points*, that is, points in time when a decision is made that affects the way the process is executed. For example, as a result of the inspection, the site engineer may decide that the equipment should be returned or that the equipment should be accepted. This decision affects what happens later in the process.

A process also involves:

- *Actors*, including human actors, organizations, or software systems acting on behalf of human actors or organizations.
- *Physical objects*, such as equipment, materials, products, paper documents.
- *Informational objects*, such as electronic documents and electronic records.

For example, the equipment rental process involves three human actors (clerk, site engineer, and works engineer) and two organizational actors (BuildIT and the equipment supplier). The process also involves a physical object (the rented equipment), electronic documents (equipment rental requests, POs, invoices), and electronic records (equipment engagement records maintained in a spreadsheet).

Actors can be internal or external. The internal actors are those who operate inside the organization where the process is executed. These actors are called *process participants*. In the example at hand, the clerk, the site engineer, and the works engineer are process participants. On the other hand, external actors operate outside the organization where the process is executed. For example the equipment supplier is an external actor (a.k.a. *business party*).

Finally, the execution of a process leads to one or several *outcomes*. For example, the equipment rental process leads to a piece of equipment being used by BuildIT, as well as a payment being made to the equipment's supplier. Ideally, an outcome should deliver value to the actors involved in the process, which in this example are BuildIT and the supplier. In some cases, this value is not achieved or is only partially achieved. For example, when a piece of equipment is returned, no value is gained, neither by BuildIT nor by the supplier. This corresponds to a *negative outcome*, as opposed to a *positive outcome* that delivers value to the actors involved.

Among the actors involved in a process, the one who consumes the output is called the *customer*. In the above process, the customer is the site engineer, since it is the site engineer who puts the rented equipment to use. It is also the site engineer who is dissatisfied if the outcome of the process is unsatisfactory (negative outcome) or if the execution of the process is delayed. In this example, the customer is an employee of the organization (internal customer). In other processes, such as an order-to-cash process, the customer is external to the organization. Sometimes, there are multiple customers in a process. For example, in a process for selling a house, there is a buyer, a seller, a real estate agent, one or multiple mortgage providers, and at least one notary. The outcome of the process is a sales transaction. This outcome provides value both to the buyer who gets the house and to the seller who monetizes the house. Therefore, both the buyer and the seller are customers in this process, while the remaining actors provide various services.

Exercise 1.1 Consider the following process for the admission of international graduate students at a university.

> In order to apply for admission, students first fill in an online form. Online applications are recorded in an information system to which all staff members involved in the admissions process have access. After a student has submitted the online form, a PDF document is generated and the student is requested to download it, sign it, and send it by post together with the required documents, which include:
>
> - certified copies of previous degree and academic transcripts,
> - results of English language test,
> - curriculum vitae,
> - two reference letters.
>
> When these documents are received by the admissions office, an officer checks the completeness of the documents. If any document is missing, an email is sent to the student. The student has to send the missing documents by post. Assuming the application is complete, the admissions office sends the certified copies of the degrees to an academic recognition agency, which checks the degrees and gives an assessment of their validity and equivalence in terms of local education standards. This agency requires that all documents be sent to it by post, and that all documents be certified copies of the originals. The agency sends back its assessment to the university by post as well. Assuming the degree verification is successful, the English language test results are then checked online by an officer at the admissions office. If the validity of the English language test results cannot be verified, the application is rejected (such notifications of rejection are sent by email).
>
> Once all documents of a given student have been validated, the admissions office forwards these documents by internal mail to the corresponding academic committee responsible for deciding whether to offer admission or not. The committee makes its decision based on the academic degrees and transcripts, the CV, and the reference letters. The committee meets once every three months to examine all applications that are ready for academic assessment at the time of the meeting.
>
> At the end of the committee meeting, the chair of the committee notifies the admissions office of the selection outcomes. This notification includes a list of admitted and rejected candidates. A few days later, the admissions office notifies the outcome to each candidate via email. Additionally, successful candidates are sent a confirmation letter by post.

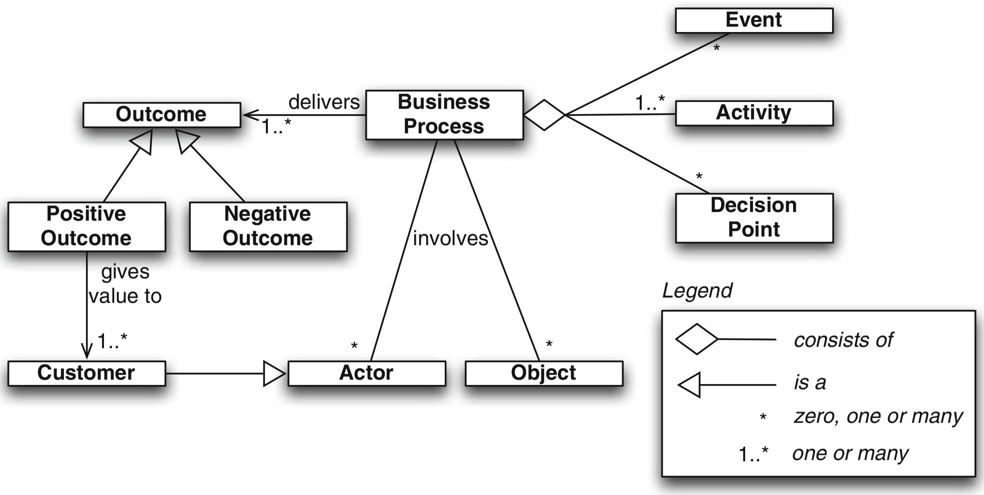

Fig. 1.1 Ingredients of a business process

With respect to the above process, consider the following questions:

1. Who are the actors in this process?
2. Which actors can be considered as customers in this process?
3. What value does the process deliver to its customers?
4. What are the possible outcomes of this process?

In light of the above, we define a business process as *a collection of inter-related events, activities, and decision points that involve a number of actors and objects, which collectively lead to an outcome that is of value to at least one customer*. Figure 1.1 depicts the ingredients of this definition and their relations.

Armed with this definition of a business process, we define BPM as *a body of methods, techniques, and tools to identify, discover, analyze, redesign, execute, and monitor business processes in order to optimize their performance*. This definition reflects the fact that business processes are the focal point of BPM. It also reflects the fact that BPM involves different phases and activities in the lifecycle of business processes, as we will discuss later in this chapter.

Other disciplines besides BPM deal with business processes in different ways, as explained in the box "Related Disciplines". One of the features commonly associated with BPM is its emphasis on the use of process models throughout the lifecycle of business processes. Accordingly, two chapters of this book are dedicated to process modeling and almost all other chapters use process models in some way. In any case, while it is useful to know that multiple disciplines share the aim of improving business processes, we should remain pragmatic and not pitch one discipline against the other as if they were competitors. Instead, we should embrace any technique that helps us to improve business processes, whether or not this technique is perceived as being part of the BPM discipline (in the strict sense) and regardless of whether or not it uses process models.

RELATED DISCIPLINES

BPM is by no means the only discipline that is concerned with improving the operational performance of organizations. Below, we briefly introduce some related disciplines and identify key relations and differences between these disciplines and BPM.

Total Quality Management (TQM) is an approach that both historically preceded and inspired BPM. The focus of TQM is on continuously improving and sustaining the quality of products, and by extension also of services. In this way, it is similar to BPM in its emphasis on the necessity of *ongoing* improvement efforts. But where TQM puts the emphasis on the products and services themselves, the view behind BPM is that the quality of products and services can best be achieved by focusing on the improvement of the processes that create these products and deliver these services. It should be admitted that this view is somewhat controversial, as contemporary TQM adepts would rather see BPM as one of the various practices that are commonly found within a TQM program. Not so much a theoretical distinction but an empirical one is that applications of TQM are primarily found in manufacturing domains—where the products are tangible—while BPM is more oriented to service organizations.

Operations Management is a field concerned with managing the *physical* and *technical* functions of a firm or organization, particularly those relating to production and manufacturing. Probability theory, queuing theory, decision analysis, mathematical modeling, and simulation are all important techniques for optimizing the efficiency of operations from this perspective. As will be discussed in Chapter 7, such techniques are also useful in the context of BPM initiatives. What is rather different between operations management and BPM is that operations management is generally concerned with controlling an existing process without necessarily changing it, while BPM is often concerned with making changes to an existing process in order to improve it.

Lean is a management discipline that originates from the manufacturing industry, in particular from the *Toyota Production System*. One of the main principles of Lean is the *elimination of waste*, i.e., activities that do not add value to the customer as we will discuss in Chapter 6. The customer orientation of Lean is similar to that of BPM and many of the principles behind Lean have been absorbed by BPM. In that sense, BPM can be seen as a more encompassing discipline than Lean. Another difference is that BPM puts more emphasis on the use of information technology as a tool to improve business processes and to make them more consistent and repeatable.

(continued)

Six Sigma is another set of practices that originate from manufacturing, in particular from engineering and production practices at Motorola. The main characteristic of Six Sigma is its focus on the minimization of defects (errors). Six Sigma places a strong emphasis on measuring the output of processes or activities, especially in terms of quality. Six Sigma encourages managers to systematically compare the effects of improvement initiatives on the outputs. In practice, Six Sigma is not necessarily applied alone, but in conjunction with other approaches. In particular, a popular approach is to blend the philosophy of Lean with the techniques of Six Sigma, leading to an approach known as *Lean Six Sigma*. Nowadays, many of the techniques of Six Sigma are commonly applied in BPM as well. In Chapter 6, we will introduce a few business process analysis techniques that are shared by Six Sigma and BPM.

In summary, we can say that BPM inherits from the continuous improvement philosophy of TQM, embraces the principles and techniques of operations management, Lean and Six Sigma, and combines them with the capabilities offered by modern information technology, in order to optimally align business processes with the performance objectives of an organization.

1.3 Origins and History of BPM

Below, we look into the drivers of the BPM discipline from a historical perspective. We start with the emergence of functional organizations, continue with the introduction of process thinking, and conclude with the innovations and failures of business process reengineering. This discussion gives us the basis for the definition of the BPM lifecycle we provide afterwards.

1.3.1 The Functional Organization

The key idea of BPM is to focus on processes when organizing and managing work in an organization. This idea may seem intuitive and straightforward at first glance. Indeed, if one is concerned with the quality of a particular product or service and the speed of its delivery to a customer, why not consider the very steps that are necessary to produce it? Yet, it took several evolutionary steps before this idea became an integral part of the work structures of organizations. Figure 1.2 provides an overview of some historical developments relevant to BPM.

In prehistoric times, humans mostly supported themselves or the small groups they lived in by producing their own food, tools, and other items. In such early

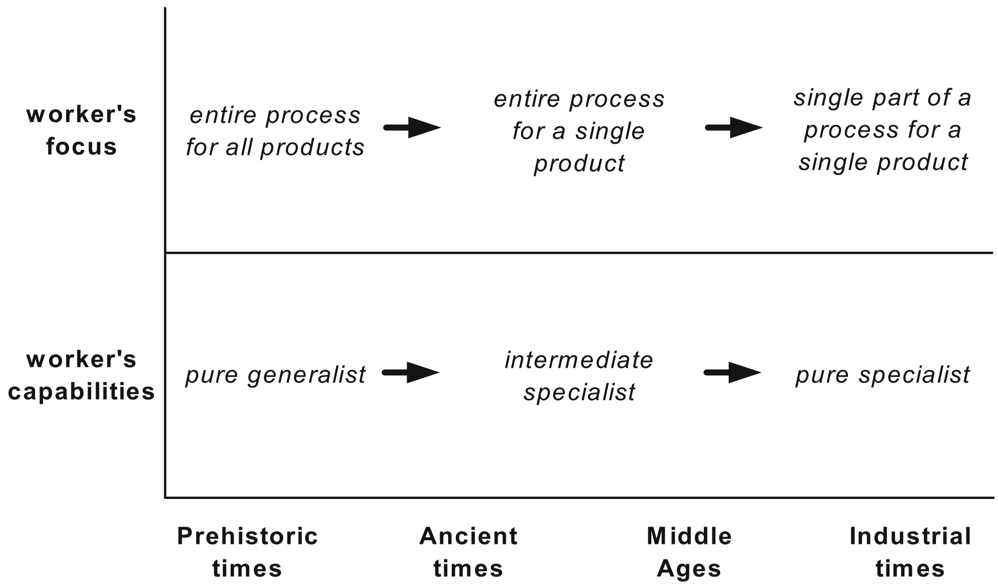

Fig. 1.2 How the process moved out of focus through the ages

societies, the consumers and producers of a given good were often the same persons. In industrial terms, we can say that people in that time carried out their own production processes. As a result, they had knowledge of how to produce many different things. In other words, they were generalists.

In ancient times, in parallel with the rise of cities and city states, this work structure based on generalists started to evolve towards what can be characterized as an *intermediate level of specialism*. People started to specialize in the art of delivering one specific type of goods, such as pottery, or providing one particular type of service, such as lodging for travelers. This widespread development towards a higher level of specialism of the workforce culminated in the guilds of the craftsmen during the Middle Ages. These guilds were essentially groups of merchants and artisans concerned with the same economic activity, such as barbers, shoemakers, masons, surgeons, and sculptors. Workers in this time would have a good understanding of the entire process they were involved in, but knew little about the processes that produced the goods or services they obtained from others.

This higher degree of specialization of the medieval worker shifted further towards a form of pure specialization during the Industrial Revolution. A witness of these developments was Adam Smith (1723–1790), Scottish economist and philosopher, who is best known for his book "An inquiry into the nature and causes of the wealth of nations".[1] Among others, this book discusses the *division of labor* that is used by a manufacturing company for producing pins. While Smith emphasizes division of labor, it is actually the design of the process (what he calls

[1] Full book available at http://www.econlib.org/library/Smith/smWN.html.

combination) that contributes to the good performance of the manufacturer. Smith explains the process of pin-making as follows:

> One man draws out the wire, another straights it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on, is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into the paper; and the important business of making a pin is, in this manner, divided into about eighteen distinct operations, which, in some manufactories, are all performed by distinct hands, though in others the same man will sometimes perform two or three of them. I have seen a small manufactory of this kind where ten men only were employed, and where some of them consequently performed two or three distinct operations. [. . .] Those ten persons, therefore, could make among them upwards of forty-eight thousand pins in a day. Each person, therefore, making a tenth part of forty-eight thousand pins, might be considered as making four thousand eight hundred pins in a day. But if they had all wrought separately and independently, and without any of them having been educated to this peculiar business, they certainly could not each of them have made twenty, perhaps not one pin in a day; that is, certainly, not the two hundred and fortieth, perhaps not the four thousand eight hundredth part of what they are at present capable of performing, in consequence of a proper division and combination of their different operations.

In the second half of the nineteenth century towards the First World War, many of such small manufacturers had grown to become major factories. A name that is inseparably linked with these developments is that of Frederick W. Taylor (1856–1915), who proposed a set of principles known as *scientific management*.[2] A key element in Taylor's approach is an extreme form of labor division and work analysis. By meticulously studying labor activities, such as the individual steps that were required to handle pig iron in steel mills, Taylor developed very specific work instructions for workers. Workers would only be involved with carrying out one of the many steps in the production process. Not only in industry, but also in administrative settings, such as government organizations, the concept of division of labor became the most dominant form of organizing work. The upshot of this development was that workers became pure specialists who were concerned with only a single part of one business process.

A side effect of the ideas of Taylor and his contemporaries was the emergence of an altogether new class of professionals—the class of *managers*. After all, someone needed to oversee the productivity of groups of workers concerned with the same part of a production process. Managers were responsible for pinning down the productivity goals for individual workers and making sure that such goals were met. In contrast to the masters of the medieval guilds, who could only attain such a rank on the basis of a masterpiece produced by themselves, managers are not necessarily experts in carrying out the job they oversee. Their main interest is to optimize how a job is done with the resources under their supervision.

After the emergence of managers, organizations became structured along the principles of labor division. A next and obvious challenge arose then: How to differentiate between the responsibilities of all these managers? The solution was to create functional units in which people with a similar focus on part of the production

---

[2] An excerpt of Taylor's book, "The Principles of Scientific Management", is available at http://sourcebooks.fordham.edu/mod/1911taylor.asp.

process were grouped together. These units were overseen by managers with different responsibilities. Moreover, the units and their managers were structured hierarchically. For example, groups are placed under departments, departments are placed under business units, etc. What we see here is the root of the functional units, which are still familiar to us today when we think about organizations: purchasing, sales, warehousing, finance, marketing, human resource management, etc.

The *functional organization* that emerged from the mindset of the Second Industrial Revolution, dominated the corporate landscape for the greatest part of the nineteenth and twentieth centuries. Towards the end of the 1980s, however, major American companies such as IBM, Ford, and Bell Atlantic (now Verizon) came to realize that their emphasis on functional optimization was creating inefficiencies in their operations that were affecting their competitiveness. Costly projects that introduced new IT systems or reorganized work within a functional department with the aim of improving its efficiency, were not notably helping these companies to become more competitive. It seemed as if customers remained oblivious to these efforts and continued to take their business elsewhere, for example to Japanese competitors.

1.3.2 The Birth of Process Thinking

One of the breakthrough events for the development of BPM was Ford's acquisition of a big financial stake in Mazda during the 1980s. When visiting Mazda's plants, one of the things that Ford executives noticed was that units within Mazda seemed considerably understaffed in comparison with comparable units within Ford, yet operated normally. A famous case study illustrating this phenomenon, first narrated by Michael Hammer [59] and subsequently analyzed by many others, deals with Ford's purchasing process. This inspired what became known as Business Process Reengineering (BPR), which Hammer and Champy define 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."

Figure 1.3 depicts the way purchasing was done within Ford at the time. Every purchase that Ford would make needed to go through the purchasing department. On deciding that a particular quantity of products indeed had to be purchased, this department sent out an order to the vendor in question. It would also send a copy of that order to accounts payable. When the vendor followed up, the ordered goods would be delivered at Ford's receiving warehouse. Along with the goods came a shipping notice, which was passed on to accounts payable. The vendor would also send out an invoice to accounts payable directly.

Against this background, it becomes clear that the main task of accounts payable was to check the consistency between three documents (purchase order copy, shipping notice, and invoice), each document consisting of roughly 14 data items (type of product, quantity, price, etc.). Not surprisingly, numerous discrepancies

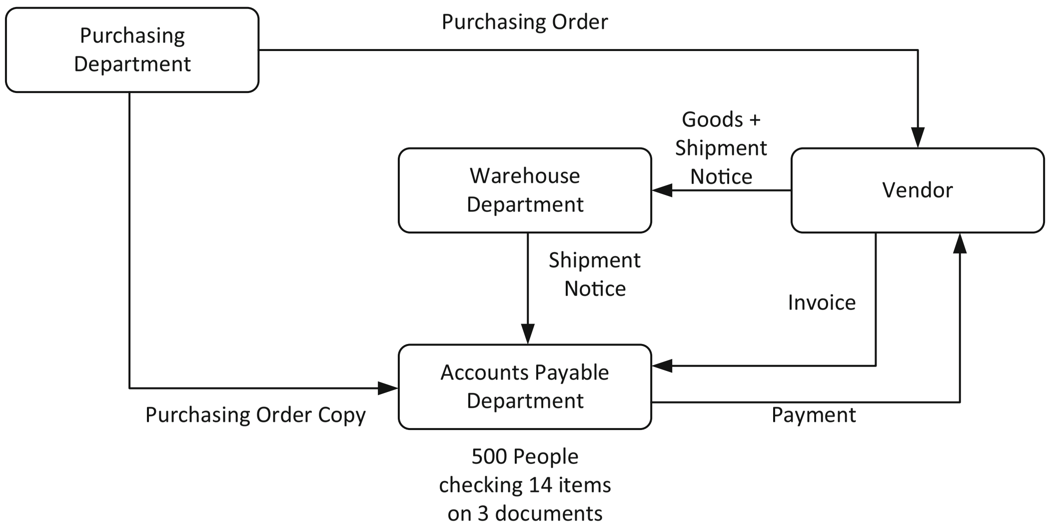

Fig. 1.3 Purchasing process at Ford at the initial stage

were discovered every day and sorting out these discrepancies occupied several hundred people within Ford. By contrast, at Mazda only five people worked in this department (as opposed to 500 people at Ford), while Mazda was not 100 times smaller than Ford in any relevant measure. Fundamentally, the problem is that Ford was detecting and resolving discrepancies one by one, while Mazda instead was avoiding the discrepancies in the first place. After a more detailed comparison with Mazda, Ford carried out several changes in its own purchasing process, which led to the redesigned process depicted in Figure 1.4.

First of all, a central database was developed to store information on purchases. This database was used by the purchasing department to store all the information on purchase orders. This database replaced one of the original paper streams. Secondly, new computer terminals were installed at the warehouse department which gave

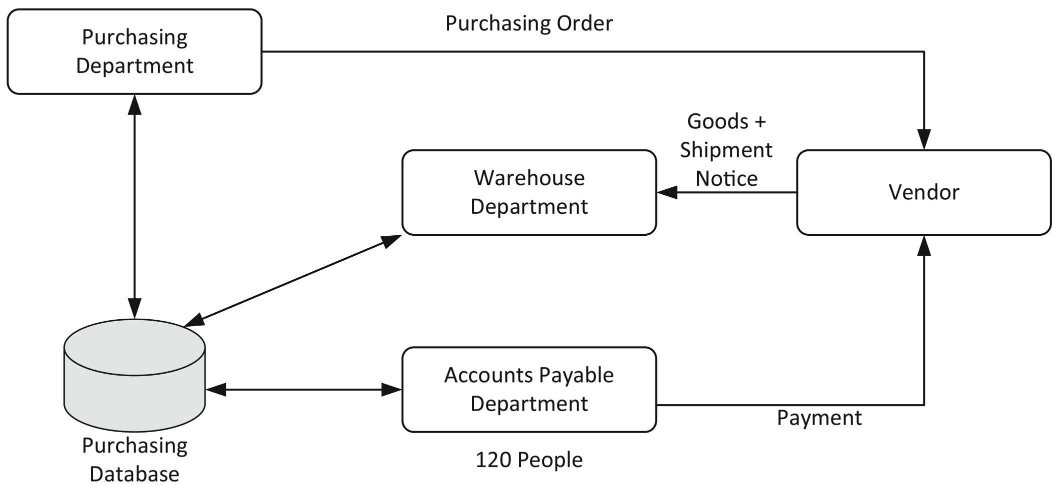

Fig. 1.4 Purchasing process at Ford after redesign

direct access to that database. When goods arrived, the warehouse personnel could immediately check whether the delivery actually matched what was originally purchased. If this was not the case, the goods were simply not accepted: This put the onus on the vendor to ensure that what was delivered was exactly what was requested. In cases where a match was found between the delivered goods and the recorded purchase order, the acceptance of the goods was registered. So, the only thing left to do for accounts payable was to pay what was agreed upon in the original purchase order. Following this new set-up, Ford managed to bring down their workforce in accounts payable from roughly 500 people down to 120 people—a 76% reduction.

Exercise 1.2 Consider the purchasing process at Ford.

1. Who are the actors in this process?
2. Which actors can be considered as customers in this process?
3. What value does the process deliver to its customers?
4. What are the possible outcomes of this process?

A key element in this case study is that a problematic performance issue (i.e., an excessive amount of time and resources spent on checking documents in accounts payable) is approached by considering an entire process. In this case, the accounts payable department plays an important role in the overall purchasing process, but the process also involves tasks by staff at the purchasing department and at the warehouse, and by the vendor. Regardless of these barriers, changes are made across the process and these changes are multi-pronged: They include informational changes (information exchanges), technological changes (database, terminals), and structural changes (checks, policies).

This characteristic view on how to look at organizational performance was put forward in a seminal article by Tom Davenport and James Short [31]. This article urged managers to look at *entire, end-to-end processes* when trying to improve the operations of their business, instead of looking at one particular task or business function. The article discussed various cases where indeed this particular approach proved to be successful. In the same paper, the important role of IT was emphasized as an enabler to come up with a redesign of existing business processes. Indeed, when looking at the Ford-Mazda example it would seem difficult to change the traditional procedure without the specific qualities of IT, which in general allows access to information in a way that is independent of time and place.

1.3.3 The Rise and Fall of BPR

The work by Davenport and Short, as well as that of others, chiefly Michael Hammer, triggered the emergence and widespread adoption of a management concept that was referred to as *Business Process Redesign* or *Business Process Reengineering*, often conveniently abbreviated as *BPR*. Numerous white papers, articles, and books appeared on the topic throughout the 1990s and companies throughout the world assembled BPR teams to review and redesign their processes.

The enthusiasm for BPR faded away by the late 1990s. Many companies terminated their BPR projects and stopped supporting further BPR initiatives. What had happened? In a retrospective analysis, a number of factors can be distinguished:

1. Concept misuse: In some organizations, just about every change program or improvement project was labeled BPR, even when business processes were not the core of these projects. During the 1990s, many corporations initiated considerable reductions of their workforce (downsizing) which, since they were often packaged as process redesign projects, triggered intense resentment among operational staff and middle management against BPR. After all, it was not at all clear that operational improvement was really driving such initiatives.
2. Over-radicalism: Some early proponents of BPR, including Hammer, emphasized from the very start that redesign had to be radical, in the sense that a new design for a business process had to overhaul the way the process was initially organized. A telling indication is one of Hammer's early papers on this subject which bore the subtitle: "Don't Automate, Obliterate". While a radical approach may be justified in some situations, it is clear that many other situations require a much more gradual (incremental) approach.
3. Support immaturity: Even in projects that were process-centered from the start and took a more gradual approach to improving the business process in question, people ran into the problem that the necessary tools and technologies to implement such a new design were not available or insufficiently powerful. One particular issue centered around the fact that much logic on how processes had to unfold was hard-coded in the supporting IT applications of the time. Understandably, people grew frustrated when they noted that their efforts on redesigning a process were thwarted by a rigid infrastructure.

Subsequently, two key events revived some of the ideas behind BPR and laid the foundation for the emergence of BPM. First of all, empirical studies appeared, showing that organizations that were process-oriented—that is, organizations that sought to improve processes as a basis for gaining efficiency and satisfying their customers—factually did better than non-process-oriented organizations. While the initial BPR gurus provided compelling case studies, such as the one on Ford-Mazda, it remained unclear to many whether these were exceptions rather than the rule. In one of the first empirical studies on this topic, Kevin McCormack [107] investigated a sample of 100 US manufacturing organizations. He found that process-oriented organizations showed better overall performance, tended to have a better *esprit de corps* in the workplace, and suffered less from inter-functional conflicts. Follow-up studies confirmed this picture, which gave renewed credibility to process thinking.

A second important development was technological in nature. Different types of IT systems emerged, most notably Enterprise Resource Planning (ERP) systems and Workflow Management Systems (WfMSs). ERP systems are essentially systems that store all data related to the business operations of a company in a consistent manner, so that all stakeholders who need access to these data can gain such access. This idea of a single shared and centralized database enables the optimization of information usage and information exchanges, which is a key enabler of process improvement (see Chapter 8).[3] WfMSs, on the other hand, are systems that distribute work to various actors in a company on the basis of process models. By doing so, a WfMS makes it easier to implement changes to business processes (e.g., to change the order in which steps are performed). Indeed, the changes made in the process model can be put into execution with relative ease, as compared to the situation where the rules for executing the process are hard-coded inside complex software systems and buried inside tens of thousands of lines of code. Also, a WfMS very closely supports the idea of working in a process-centered manner.

Originally, WfMSs were concerned mainly with routing work between human actors. Later on, these systems were gradually extended with modules to monitor and analyze the execution of business processes. In parallel, the emergence of Web services made it easier to connect a WfMS with other systems, in particular ERP systems. As WfMSs became more sophisticated and better integrated with other enterprise systems, they became known as Business Process Management Systems (BPMSs).

BPMSs are just one type of IT tool that supports the implementation and execution of business processes. There are many others, including ERP systems, Customer Relationship Management (CRM) systems, and Document Management Systems (DMSs). These tools are known under the umbrella term of Process-Aware Information Systems (PAISs). Chapter 9 will discuss the functionality of PAISs in general and of BPMSs in particular. How business processes can be implemented using process models and a BPMS is the focus of Chapter 10.

The above historical view suggests that BPM is a revival of BPR, as indeed BPM adopts the process-centered view on organizations. Some caution is due, though, when BPR and BPM are equated. The relation is much better understood on the basis of Figure 1.5.

This figure shows that a manager that is responsible for a business process—also called the *process owner*—is concerned with planning and organizing the process on the one hand and monitoring the process on the other. The figure allows us to explain the differences in *scope* between BPR and BPM. While both approaches take the business process as a starting point, BPR is primarily concerned with planning and organizing the process. By contrast, BPM provides concepts, methods, techniques, and tools that cover all aspects of managing a process—to plan, organize, and monitor it—as well as its actual execution. In other words, BPR should be seen as a subset of techniques that can be used in the context of BPM.

[3] In reality, ERP systems are much more than a shared database. They also incorporate numerous modules to support typical functions of an organization such as accounting, inventory management, production planning, logistics, etc. However, from the perspective of process improvement, the shared database concept behind ERP systems is a major enabler.

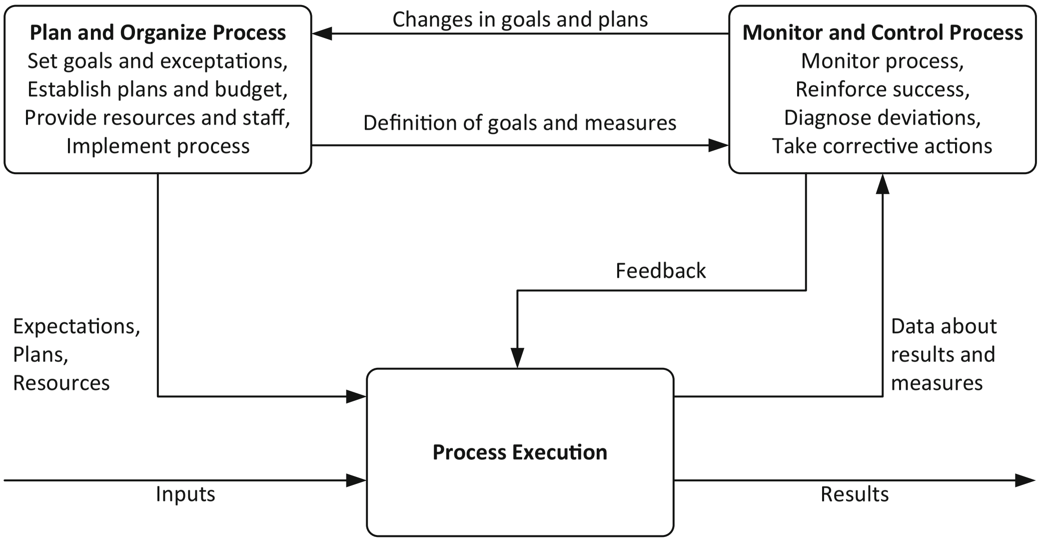

Fig. 1.5 Job functions of a manager responsible for a process (a.k.a. process owner), based on Rummler & Brache [153]

This discussion highlights that BPM encompasses the entire lifecycle of business processes. Accordingly, the next section provides an overview of the concepts, methods, techniques, and tools that compose the BPM discipline through the lens of the *BPM lifecycle*. This lens provides a structured view of how a given process can be managed.

1.4 The BPM Lifecycle

In general, the first question that a team embarking on a BPM initiative needs to clarify is: Which business processes do we aim to improve? Right at the outset and before the possibility of applying BPM is put on the table, there will probably already be an idea of what operational problems the team has to address and which business processes are posing those operational problems. In other words, the team will not start from scratch. For example, if the problem is that site engineers complain that their job is being hampered by difficulties in securing construction equipment when needed, it is clear that this problem should be addressed by looking at the equipment rental process. Still, one has to delimit this process in more precise terms. In particular, one has to answer questions such as: Does the process start right from the moment when rental suppliers are selected? Does it end when the rented equipment is delivered to the construction site? Or does it end when the equipment is returned? Or does it continue until the fee for equipment rental has been paid to the supplier?

These questions might be easy or hard to answer depending on how much *process thinking* has taken place in the organization beforehand. If the organization has engaged in BPM initiatives before, it is likely that an inventory of business processes is available and that the scope of these processes has been defined, at least to some extent. In organizations that have not engaged in BPM before, the BPM team has to start by at least identifying the processes that are relevant to the problem on the table, delimiting the scope of these processes, and identifying relations between these processes. This initial phase of a BPM initiative is termed *process identification*. This phase leads to a so-called *process architecture*: a collection of inter-linked processes covering the bulk of the work that an organization performs in order to achieve its mission in a sustainable manner.

In general, the purpose of engaging in a BPM initiative is to ensure that the business processes covered by the BPM initiative lead to consistently positive outcomes and deliver maximum value to the organization in servicing its clients. Measuring the *value* delivered by a process is a crucial step in BPM. As renowned software engineer Tom DeMarco once famously put it: “You can’t control what you can’t measure”. So, before starting to analyze any process in detail, it is important to clearly define the *process performance measures* (also called *process performance metrics*) that will be used to determine whether a process is in good shape or in bad shape. Typical process performance measures relate to cost, time, quality, and flexibility.

Cost-related measures are a recurrent class of performance measures in the context of BPM. For example, coming back to the equipment rental process, a possible performance measure is the total cost of all equipment rented by BuildIT per time interval (e.g., per month). Another broad and recurrent class of measures are those related to time. An example is the average amount of time elapsed between the moment an equipment rental request is submitted by a site engineer and the delivery of the equipment to the construction site. This measure is generally called *cycle time*. A third class of recurrent measures are those related to quality, specifically error rates. Error rate is the percentage of times that an execution of the process ends up in a negative outcome. In the case of the equipment rental process, one such measure is the number of pieces of equipment returned because they are unsuitable, or due to defects in the delivered equipment. Finally, flexibility measures capture the extent to which the performance of a process is maintained under changing or abnormal conditions, for example when a works engineer resigns suddenly or when a supplier goes bankrupt.

The identification of performance measures (and associated performance objectives) is crucial in any BPM initiative. This identification is generally seen as part of the process identification phase, although in some cases it may be postponed until later phases.

Exercise 1.3 Consider the student admission process described in Exercise 1.1 (page 5). Taking the perspective of the customer, identify at least two performance measures that can be attached to this process.

Once a BPM team has identified which processes they are dealing with and which performance measures should be used, the next phase for the team is to understand the business process in detail. We call this phase *process discovery*. Typically, one of the outcomes of this phase is one or several *as-is* process models. These as-is process models reflect the understanding that people in the organization have about how work is done. Process models are meant to facilitate communication between stakeholders involved in a BPM initiative. Therefore, they have to be easy to understand. In principle, we could model a business process by means of textual descriptions, like the textual description in Example 1.1. However, such textual descriptions are cumbersome to read and easy to misinterpret because of the ambiguity inherent in free-form text. This is why it is common practice to use diagrams in order to model business processes. Diagrams allow us to more easily comprehend the process. Also, if a diagram is made using a modeling language that is understood by all stakeholders, there is less room for any misunderstanding. Note that these diagrams may still be complemented with textual descriptions. In fact, it is common to see analysts documenting a process using a combination of diagrams and text.

There are many languages for modeling business processes diagrammatically. Perhaps one of the oldest are *flowcharts*. In their most basic form, flowcharts consist of rectangles, which represent activities, and diamonds, which represent points in the process where a decision is made. More generally, we can say that regardless of the specific notation used, a diagrammatic process model typically consists of two types of nodes: activity nodes and control nodes. Activity nodes describe units of work that may be performed by humans or software applications, or a combination thereof. Control nodes capture the flow of execution between activities. Although not all process modeling languages support it, a third important type of element in process models are event nodes. An event node tells us that something may or must happen, within the process or in the environment of the process, that requires a reaction, like for example the arrival of a message from a customer requesting the cancelation of purchase order. Other types of nodes may appear in a process model, but we can say that activity nodes, event nodes, and control nodes are the most basic ones.

Several extensions of flowcharts exist, such as cross-organizational flowcharts. Here, the flowchart is divided into so-called *swimlanes*, which denote different organizational units (e.g., different departments in a company). If you are familiar with the Unified Modeling Language (UML), you have probably come across *UML Activity Diagrams*. At their core, UML Activity Diagrams are cross-organizational flowcharts. However, UML Activity Diagrams go beyond basic cross-organizational flowcharts by providing symbols to capture data objects, signals, and parallelism among other aspects. Yet another language for process modeling are *Event-driven Process Chains* (*EPCs*). EPCs have some similarities with flowcharts but they differ from flowcharts in that they treat events as first-class citizens. Other languages used for process modeling include *data-flow diagrams* and *Integrated DEFinition for Process Description Capture Method* (*IDEF3*).

It would be mind-boggling to learn all these languages. Fortunately, nowadays there is a widely-used standard for process modeling, namely the Business Process Model and Notation (BPMN). The latest version of BPMN is BPMN 2.0.2. It was released as a standard by the Object Management Group (OMG) in December 2013. In BPMN, activities are represented as rounded rectangles. Control nodes (called

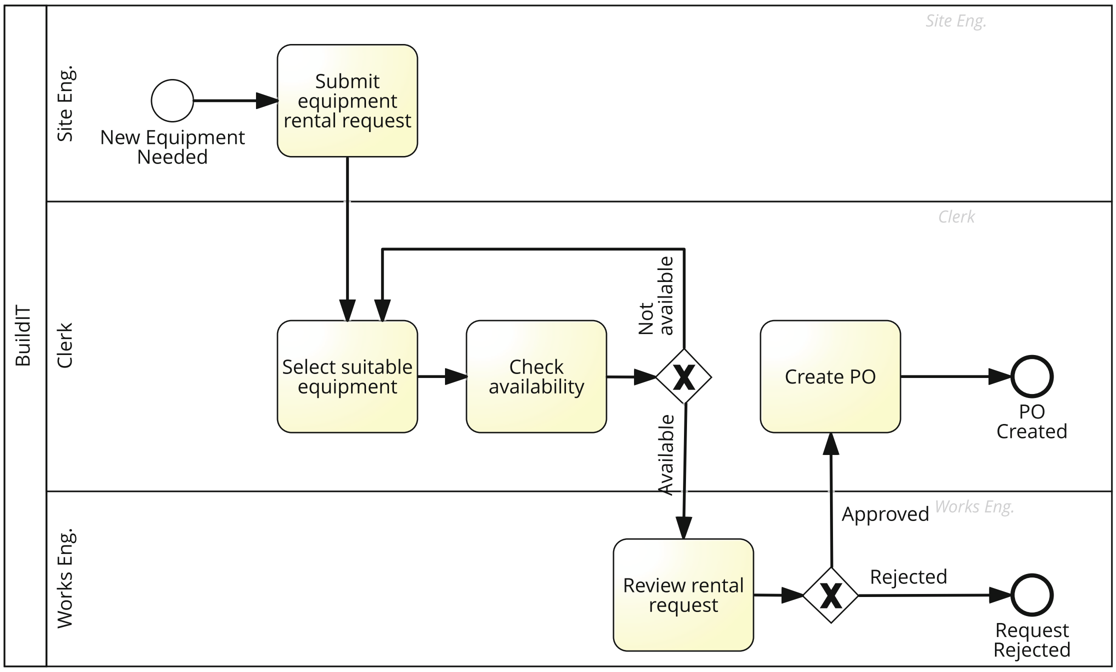

Fig. 1.6 Process model for the initial fragment of the equipment rental process

gateways) are represented using diamond shapes. Activities and control nodes are connected by means of arcs (called sequence flows) that determine the order in which the process is executed. Figure 1.6 contains a model of an initial fragment of the equipment rental process, up to the point where the works engineer accepts or rejects the equipment rental request. This process model shows two decision points. In the first one, the process takes one of two paths depending on whether the equipment is available or not. In the second, the equipment rental request is either approved or rejected. The model also shows the process participants involved in this fragment of the process, namely the site engineer, the clerk, and the works engineer. Each of these participants is shown as a separate *lane*, which contains the activities performed by the participant in question.

The process model in Figure 1.6 is minimalistic. At best, it can serve to give to an external person a summary of what happens in this process. Generally, a process model needs to have more details to be useful. Which additional details should be included in a process model depends on its purpose. Some process models are intended to serve as documentation for new employees. In this case, additional text annotations may be added to the process model to clarify the meaning of certain activities or events. Other times, process models are intended to be analyzed quantitatively, for example in order to calculate performance measures. If so, further details may be required such as how much time each task takes on average. Finally, some process models are intended to be deployed into a BPMS to coordinate the execution of the process (see Section 1.3.3). In this latter case, the model should contain details about the inputs and outputs of the process and of each of its tasks.

Once we have understood the as-is process in detail, the next step is to identify and analyze the issues in this process. One potential issue in BuildIT's equipment rental process is that the cycle time is too high. As a result, site engineers do not manage to get the required equipment on time. This may cause delays in various construction tasks, which may ripple down into delays in the construction projects. In order to analyze these issues, an analyst needs to collect information about the time spent in each task of the process. Moreover, the analyst needs to gather information regarding the amount of rework that takes place in the process. Here, rework means that one or several tasks are repeated because something went wrong. For example, when the clerk identifies a suitable piece of equipment in a supplier's catalog, but later finds out that the piece of equipment is not available on the required dates, the clerk might need to search again for an alternative piece of equipment from another supplier. Valuable time is spent by the clerk going back and forth between consulting the catalogs and contacting the suppliers to check the equipment availability. In order to analyze this issue, the analyst needs to find out in what percentage of cases the clerk needs to identify an alternative piece of equipment (rework). Given this information, the analyst may employ various techniques to be discussed throughout this book to track down the causes of long cycle times.

Another potential issue in BuildIT's equipment rental process is that sometimes the equipment delivered at the construction site is unsuitable. The site engineer then has to reject it—an example of a negative outcome. To analyze this issue, an analyst needs to find out how often such negative outcomes occur. Furthermore, the analyst needs to find out why these negative outcomes are happening; in other words, where do things go wrong in the first place. Sometimes, a negative outcome might stem from miscommunication, for example between the site engineer and the clerk. On other occasions, it might come from inaccurate data (e.g., errors in the description of the equipment) or from an error on the supplier's side. By identifying, classifying, and understanding the main causes of such negative outcomes, the analyst can ultimately find ways of eliminating or minimizing them. The identification and assessment of issues and opportunities for process improvement is called the *process analysis* phase.

We observe that the two issues discussed above are tightly related to performance measures. For example, the first issue above is tied to cycle time and waiting time, both of which are typical performance measures of a process. Similarly, the second issue is tied to the percentage of equipment rejections, which is essentially an error rate—another typical performance measure. Thus, assessing the issues of a process often goes hand-in-hand with measuring the current state of the process with respect to certain performance measures.

Exercise 1.4 Consider again the student admission process described in Exercise 1.1 (page 5). Taking the perspective of the customer, think of at least two issues that this process might have.

Once issues in a process have been analyzed and possibly quantified, the next phase is to identify and analyze potential remedies for these issues. At this point, the analyst will consider multiple possible options for addressing a problem. In doing so, the analyst needs to keep in mind that a change in a process to address one issue may potentially cause other issues down the road. For example, in order to speed up the equipment rental process, one might think of removing the approval steps involving the works engineer. If pushed to the extreme, however, this change would mean that the rented equipment might sometimes not be optimal since the works engineer viewpoint is not taken into account. The works engineer has a global view on the construction projects and may be able to propose alternative ways of addressing the equipment needs of a construction project in a more effective manner.

Changing a process is not as easy as it sounds. People are used to working in a certain way and are often inclined to resist changes. Furthermore, if the change implies modifying the information systems underpinning the process, the change may be costly or may require changes not only in the organization that coordinates the process, but also in other organizations. For example, we could eliminate rework in the equipment rental process if the suppliers provided an online interface allowing clerks to easily retrieve all the available pieces of equipment that can be used for a given job. However, this change in the process would require that the suppliers change their information system, so that their system exposes up-to-date equipment availability information to BuildIT. This change is, at least partially, outside the control of BuildIT. Assuming that suppliers would be able to make such changes, a more radical solution would be to provide mobile devices to the site engineers, so that they can consult the equipment catalog (including availability information) anytime and anywhere. In this way, the clerk would not need to be involved in the process during the equipment search phase. Whether or not this more radical change is viable would require an in-depth analysis of the cost of changing the process in this way versus the benefits that such change would provide.

Exercise 1.5 Given the issues in the student admission process identified in Exercise 1.4 (page 20), what possible changes do you think could be made to this process in order to address these issues?

Armed with an understanding of the issues in a process and a candidate set of potential remedies, analysts can propose a redesigned version of the process. This *to-be* process design is the main output of the *process redesign phase*. Here, it is important to keep in mind that analysis and redesign are intricately related. There may be multiple redesign options. Each of these options needs to be analyzed, so that an informed choice can be made as to which option is preferable.

Once redesigned, the necessary changes in the ways of working and the IT systems of the organization should be implemented so that the to-be process can eventually be put into execution. This phase is called *process implementation*. In the case of the equipment rental process, the process implementation phase would involve putting in place an information system to record and to track equipment rental requests, POs associated with approved requests, and invoices associated with these POs. Deploying such an information system means more than deploying a new IT system. It also entails getting the process participants to embrace the new system and training them so that they perform their work in the spirit of the redesigned process.

More generally, process implementation involves two complementary facets: *organizational change management* and *process automation*. Organizational change management refers to the set of activities required to change the way of working of all participants involved in the process. These activities include:

- Explaining the changes to the process participants to the point that they understand both what changes are being introduced and why these changes are beneficial to the company.
- Putting in place a change management plan so that stakeholders know when the changes will come into effect and what transitional arrangements will be employed to address problems during the transition to the to-be process.
- Training users to the new way of working and monitoring the changes in order to ensure a smooth transition to the to-be process.

Process automation, on the other hand, involves the configuration or implementation of an IT system (or the re-configuration of an existing IT system) to support the to-be process. This IT system should support process participants in the performance of the tasks of the process. This may include assigning tasks to process participants, helping process participants to prioritize their work, providing process participants with the information they need to perform a task, and performing automated cross-checks and other automated tasks where possible. There are several ways to implement such an IT system. This book focuses on one particular approach, which consists of extending the to-be process model obtained from the process redesign phase in order to make it executable by a BPMS.

Over time, adjustments may be required in the implemented business process when it does not meet expectations any longer. To this end, the process needs to be monitored. Analysts ought to scrutinize the data collected by monitoring the process in order to identify needed adjustments. These activities are encompassed by the *process monitoring* phase. Lack of continuous monitoring and improvement of a process leads to degradation. As Hammer once put it: "every good process eventually becomes a bad process", unless continuously adapted and improved to keep up with the ever-changing landscape of customer needs, technology and competition. This is why the BPM lifecycle should be seen as circular: the output of the monitoring phase feeds back into the discovery, analysis, and redesign phases.

To sum up, we can view BPM as a continuous cycle comprising the following phases (see Figure 1.7):

- *Process identification.* In this phase, a business problem is posed. Processes relevant to the problem being addressed are identified, delimited, and interrelated. The outcome of process identification is a new or updated process architecture, which provides an overall picture of the processes in an organization and their relationships. This architecture is then used to select which process or set thereof to manage through the remaining phases of the lifecycle. Typically, process identification is done in parallel with performance measure identification.
- *Process discovery* (also called *as-is process modeling*). Here, the current state of each of the relevant processes is documented, typically in the form of one or several as-is process models.
- *Process analysis.* In this phase, issues associated with the as-is process are identified, documented, and whenever possible quantified using performance

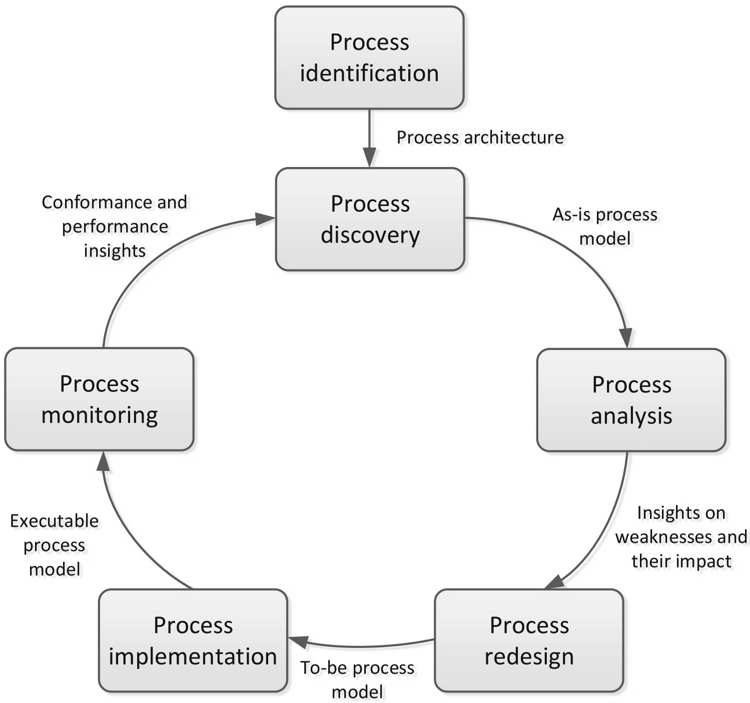

Fig. 1.7 The BPM lifecycle

measures. The output of this phase is a structured collection of issues. These issues are prioritized based on their potential impact and the estimated effort required to resolve them.

- *Process redesign* (also called *process improvement*). The goal of this phase is to identify changes to the process that would help to address the issues identified in the previous phase and allow the organization to meet its performance objectives. To this end, multiple change options are analyzed and compared in terms of the chosen performance measures. Hence, process redesign and process analysis go hand-in-hand: As new change options are proposed, they are analyzed using process analysis techniques. Eventually, the most promising change options are retained and combined into a redesigned process. The output of this phase is typically a to-be process model.
- *Process implementation.* In this phase, the changes required to move from the as-is process to the to-be process are prepared and performed. Process implementation covers two aspects: organizational change management and automation. Organizational change management refers to the set of activities required to change the way of working of all participants involved in the process. Process automation refers to the development and deployment of IT systems (or enhanced versions of existing IT systems) that support the to-be process. In this book, our focus with respect to process implementation is on automation. We will only briefly touch upon change management, which is a field on its own.
- *Process monitoring.* Once the redesigned process is running, relevant data are collected and analyzed to determine how well the process is performing with respect to its performance measures and performance objectives. Bottlenecks,

recurrent errors, or deviations with respect to the intended behavior are identified and corrective actions are undertaken. New issues may then arise, in the same or in other processes, which requires the cycle to be repeated on a continuous basis.

The BPM lifecycle also helps us to understand the role of technology in BPM. Technology in general, and especially Information Technology (IT), is a key instrument to improve business processes. Not surprisingly, IT specialists such as system engineers often play a significant role in BPM initiatives. However, to achieve maximum efficacy, system engineers need to be aware that technology is just one instrument for managing and executing processes. System engineers need to work together with process analysts in order to understand what issues are affecting a given process, and how to best address these issues, be it by means of automation or by other means. As a renowned technology businessman, Bill Gates, once famously put it: "The first rule in any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency". This means that learning how to design and improve processes—and not only how to build an IT system to automate a narrow part of a business process—is a fundamental skill that should be in the hands of any IT graduate. Reciprocally, business graduates need to understand how technology, and particularly IT, can be used to optimize the execution of business processes. This book aims at bridging these two viewpoints by presenting an integrated viewpoint covering the whole BPM lifecycle.

A complementary viewpoint on the BPM lifecycle is given by the box "Stakeholders in the BPM lifecycle". This box summarizes the roles in a company that are directly or indirectly involved in BPM initiatives.[4] The list of roles described in the box highlights the fact that BPM is inter-disciplinary. A typical BPM initiative involves managers at different levels in the organization, administrative and field workers (called process participants in the box), business and system analysts, and IT teams. Accordingly, the book aims at giving a balanced view of techniques both from management science and IT, as they pertain to BPM.

STAKEHOLDERS IN THE BPM LIFECYCLE

Many stakeholders are involved in a business process throughout its lifecycle [93]. Among them we distinguish the following individuals and groups.

- **Management Team.** Depending on how the management of a company is organized, one might find the following positions. The *Chief Executive Officer* (CEO) is responsible for the overall business success of the company. The *Chief Operations Officer* (COO) is responsible for defining the way operations are set up. In some companies, the COO is also responsible

(continued)

[4]The role of the customer is not listed in the box as this role has been discussed previously.

for process performance, while in other companies there is a dedicated executive position of *Chief Process Officer* (CPO) [78] or *Chief Process and Innovation Officer* (CPIO) for this purpose. The *Chief Information Officer* (CIO) is responsible for the efficient and effective operation of the information system infrastructure. In some organizations, process redesign projects are driven by the CIO. The *Chief Financial Officer* (CFO) is responsible for the overall financial performance of the company. The CFO may also be responsible for certain business processes, particularly those that have a direct impact on financial performance. Other management positions that have a stake in the lifecycle of processes include the *Human Resources (HR) director*. The HR director plays a key role in processes that involve significant numbers of process participants. In any case, the management team is responsible for overseeing all processes, initiating process redesign initiatives, and providing resources and strategic guidance to stakeholders involved in all phases of the BPM lifecycle.

- **Process Owners.** A process owner is responsible for the efficient and effective operation of a given process. As discussed in the context of Figure 1.5, a process owner is responsible on the one hand for planning and organizing, and on the other hand for monitoring the process. In the planning and organizing role, the process owner is responsible for defining performance measures and objectives as well as initiating and leading improvement projects related to their process. The process owner is also responsible for securing resources so that the process runs smoothly on a daily basis. In their monitoring role, process owners are responsible for ensuring that the performance objectives of the process are met, and for taking corrective actions in case these objectives are not met. Process owners also provide guidance to process participants on how to resolve exceptions and errors that occur during the execution of the process. Thus, the process owner is involved in process modeling, analysis, redesign, implementation, and monitoring. Note that the same individual could well be responsible for multiple processes. For example, in a small company, a single manager might be responsible both for the company's order-to-cash process and for the after-sales customer service process.
- **Process Participants.** Process participants are human actors who perform the activities of a business process on a day-to-day basis. They conduct routine work according to the standards and guidelines of the company. Process participants are coordinated by the process owner, who is responsible for dealing with non-routine aspects of the process. Process participants are also involved as domain experts during process discovery and process analysis. They support redesign activities and implementation efforts.
- **Process Analysts.** Process analysts conduct process identification, discovery (in particular modeling), analysis, and redesign activities. They

(continued)

coordinate process implementation as well as process monitoring. They report to management and process owners and closely interact with process participants. Process analysts typically have one of two backgrounds. Process analysts concerned with organizational requirements, performance, and change management have a business background, while those concerned with process automation have an IT background.

- **Process Methodologist.** The process methodologist provides expert knowledge and advice to process analysts on the choice of suitable methods, techniques and software tools to use in each phase of the BPM lifecycle. This role is also in charge of coordinating the technical training on BPM for the process analysts. The process methodologist is typically available only in large-scale BPM initiatives.
- **System Engineers.** System engineers are involved in process redesign and implementation. They interact with process analysts to capture system requirements. They translate requirements into a system design and are responsible for the implementation, testing and deployment of this system. System engineers also liaise with the process owner and process participants to ensure that the developed system supports their work effectively. Oftentimes, system implementation, testing and deployment are outsourced to external providers, in which case the system engineering team will at least partially consist of contractors.
- **BPM Group** (also called *BPM Center of Excellence*). Large organizations that have been engaged in BPM for several years possess a wealth of valuable knowledge on how to plan and execute BPM projects as well as substantial amounts of process documentation. The BPM group is responsible for preserving this knowledge and documentation and ensuring that they are used to meet the organization's strategic goals. Specifically, the BPM group is responsible for maintaining the process architecture, prioritizing process redesign projects, giving support to the process owners and process analysts, and ensuring that the process documentation is maintained in a consistent manner and that the process monitoring systems are working effectively. In other words, the BPM group is responsible for maintaining a BPM culture and aligning the BPM efforts with the strategic goals of the organization. Not all organizations have a dedicated BPM group. BPM groups are most common in large organizations with several years of BPM experience.

The BPM lifecycle encompasses a range of methods and tools to identify processes and to manage individual processes. While these methods and tools are important, the success of BPM in an organization depends on many other factors beyond their scope. As mentioned in the box "Stakeholders in the BPM lifecycle", it is important to ensure that BPM initiatives are aligned with the strategic goals of the organization (*strategic alignment*). It is also important that the roles and responsibilities in BPM initiatives and the associated decision-making processes are clearly defined, and that measurement systems, guidelines, and conventions are in place to ensure that BPM initiatives are conducted in a consistent manner (*governance*). It is further important that process participants are engaged in and informed of the BPM initiatives that affect their processes and that managers and analysts who engage in such initiatives have the necessary skills. Last but not least, it is important to develop an organizational culture that is responsive to process change and embraces process thinking. In other words, the role that an organization's *people* and *culture* play for the success of BPM should not be underestimated. In sum, for BPM to be sustainably successful, an organization has to treat BPM as an enterprise capability, at the same level as other organizational management capabilities such as risk management and performance management.

In the rest of the book, we will dive consecutively into each of the phases of the BPM lifecycle. Chapter 2 deals with the process identification phase. Chapters 3–4 provide an introduction to process modeling, which serves as background for subsequent phases in the BPM lifecycle. Chapter 5 deals with the process discovery phase. Chapters 6–7 present a number of process analysis techniques. We classify these techniques into qualitative (Chapter 6) and quantitative ones (Chapter 7). A quantitative technique focuses on performance measures, while a qualitative technique involves human judgement, for example in order to classify tasks or issues according to subjective criteria. Next, Chapter 8 gives an overview of process redesign methods. Chapters 9–10 deal with the process implementation phase. Chapter 9 introduces different types of PAISs. Meanwhile, Chapter 10 shows concretely how to use a process model to drive the implementation of a process using one specific type of PAIS, namely a BPMS. Chapter 11 introduces a range of techniques for process monitoring, thus closing the BPM lifecycle. Finally, Chapter 12 discusses the question of how to make BPM sustainably successful by treating it as an enterprise capability and assessing this capability using a maturity model.

1.5 Recap

We retain from this chapter that a process is a collection of events, activities, and decisions that collectively lead to an outcome that brings value to an organization's customers. Every organization has processes. Understanding and managing these processes in order to ensure that they consistently produce value is a key ingredient for the effectiveness and competitiveness of organizations.

If we wanted to capture BPM in a nutshell, we would say that BPM is a body of principles, methods, and tools to discover, analyze, redesign, implement, and monitor business processes. We have also seen that process models and performance measures are foundational pillars for managing processes. It is on top of them that much of the art and science of BPM builds. The provided definition encompasses the main phases of the BPM lifecycle and the various related disciplines that complement BPM, such as Lean, Six Sigma, and Total Quality Management. The aim of this chapter was to give a "sneak peek" of the activities and stakeholders involved in each of the phases of the BPM lifecycle. The rest of the book aims to shed light on many of the principles and methods that are used in each of these phases.

1.6 Solutions to Exercises

Solution 1.1

1. Admissions officer, applicant, academic recognition agency, and academic committee. The admissions office as an organizational unit can also be recognized as a separate actor.
2. The applicant.
3. One can argue that the *value* that the process provides to the applicant is the assessment of the application and the subsequent decision to accept or reject. In this case, the process delivers value whether the applicant is accepted or rejected, provided that the application is processed in due order. Another viewpoint would be to say that the process only gives value to the applicant if the application is accepted, and not if it is rejected. Arguments can be put forward in favor of either of these two viewpoints.
4. Applicant rejected due to incomplete documents; Applicant rejected due to English language test results; Applicant rejected due to assessment of academic recognition agency; Applicant rejected due to academic committee decision; Applicant accepted. A more in-depth analysis could reveal other possible outcomes such as "Application withdrawn by applicant" or "Applicant conditionally accepted subject to providing additional documents". However, there are not enough elements in the description of the process to determine if these latter outcomes are possible.

Solution 1.2

1. The unit with a purchasing need, the purchasing department, the vendor, the warehouse, and the accounts payable department.
2. The unit with a purchasing need.
3. The *value* that the process provides to the unit with a purchasing need is the timely, accurate, and cost-efficient provision of a particular purchasing item. In this case, the process delivers value if the purchasing need is fulfilled by means of a timely, accurate, and cost-efficient shipment of a vendor, accompanied by a timely and accurate payment.

4. The shipment of goods can be accepted if accurate, leading to a corresponding payment, or they can be rejected if the amount or type of shipment is not correct.

Solution 1.3 Possible measures include:

1. Average time between the moment an application is received and the moment it is accepted or rejected (cycle time). Note that if the university advertises a pre-defined deadline for notifying acceptance/rejection, an alternative performance measure would be the percentage of times that this deadline is met.
2. Percentage of applications rejected due to incomplete documents. Here we could distinguish between two variants of this measure: one that counts all cases where applications are initially rejected due to incomplete documents, and another one that counts the number of cases where applications are rejected due to incomplete documents and where the applicant does not resubmit the completed application, for example because the deadline for applications has expired before the applicant gathers the required documents.
3. Percentage of applications rejected due to expired, invalid, or low English language test results.
4. Percentage of applications rejected due to advice from academic recognition.
5. Percentage of accepted applications.

Note that the cost incurred by the university per application is not a measure that is relevant from the perspective of the applicant, but it may be relevant from the perspective of the university.

Solution 1.4 Possible issues include:

1. Long execution times.
2. Inconvenience of gathering and submitting all required documents.
3. Potentially: mishandled applications due to handoffs of paper documents between process participants.

Solution 1.5 To reduce cycle time as well as mishandled applications, applications could be shared in electronic format between admissions office and academic committee. To reduce the amount of preparation required to submit an application, applications could be evaluated in two stages. The first stage would involve purely electronically submitted documents (e.g., scanned copies instead of physical copies). Only applicants accepted by the academic committee would then need to go through the process of submitting certified copies of degrees by post for verification by the academic recognition agency.

1.7 Further Exercises

Exercise 1.6 Consider the following process at a pharmacy.

Customers drop off their prescriptions either in the drive-through counter or in the front counter of the pharmacy. Customers can request that their prescription be filled immediately. In this case, they have to wait between 15 min and 1 h depending on the current workload. However, most customers are not willing to wait that long, so they opt to nominate a pick-up time at a later point during the day. Generally, customers drop their prescriptions in the morning before going to work (or at lunchtime) and they come back to pick up the drugs after work, typically between 5 p.m. and 6 p.m. When a prescription is dropped off, a technician asks the customer for the pick-up time and puts the prescription in a box labeled with the hour preceding the pick-up time. For example, if the customer asks to have the prescription be ready at 5 p.m., the technician will drop it in the box with the label 4 p.m. (there is one box for each hour of the day).

Every hour, one of the pharmacy technicians picks up the prescriptions due to be filled in the current hour. The technician then enters the details of each prescription (e.g., doctor details, patient details and medication details) into the pharmacy system. As soon as the details of a prescription are entered, the pharmacy system performs an automated check called *Drug Utilization Review* (DUR). This check is meant to determine if the prescription contains any drugs that may be incompatible with other drugs that had been dispensed to the same customer in the past, or drugs that may be inappropriate for the customer taking into account the customer data maintained in the system (e.g., age).

Any alarms raised during the automated DUR are reviewed by a pharmacist who performs a more thorough check. In some cases, the pharmacist even has to call the doctor who issued the prescription in order to confirm it.

After the DUR, the system performs an insurance check in order to determine whether the customer's insurance policy will pay for part or for the whole cost of the drugs. In most cases, the output of this check is that the insurance company will only pay for a certain percentage of the costs, while the customer has to pay for the remaining part (also called the *co-payment*). The rules for determining how much the insurance company will pay and how much the customer has to pay are very complicated. Every insurance company has different rules. In some cases, the insurance policy does not cover one or several drugs in a prescription, but the drug in question can be replaced by another drug that is covered by the insurance policy. When such cases are detected, the pharmacist generally calls the doctor and potentially also the patient to determine if it is possible to perform the drug replacement.

Once the prescription passes the insurance check, it is assigned to a technician who collects the drugs from the shelves and puts them in a bag with the prescription stapled to it. After the technician has filled a given prescription, the bag is passed to the pharmacist who double-checks that the prescription has been filled correctly. After this quality check, the pharmacist seals the bag and puts it in the pick-up area. When a customer arrives to pick up a prescription, a technician retrieves the prescription and asks the customer for payment in case the drugs in the prescription are not fully covered by the customer's insurance.

With respect to the above process, consider the following questions:

1. What type of process is the above one: order-to-cash, procure-to-pay, application-to-approval, or issue-to-resolution?
2. Who are the actors in this process?
3. Who are the customers?
4. What are the tasks of this process?
5. What value does the process deliver to its customers?

6. What are the possible outcomes of this process?
7. Taking the perspective of the customer, what performance measures can be attached to this process?
8. What potential issues do you foresee this process might have? What information would you need to collect in order to analyze these issues?
9. What possible changes do you think could be made to this process in order to address the above issues?

Acknowledgement This exercise is inspired by [106].

Exercise 1.7 Consider the following process at a company of 800 employees in the early 1990s.

> Almost any employee at the company can initiate a purchase request by filling in a form. The purchase request includes information about the goods to be purchased, the quantity, the desired delivery date, and the approximate cost. The employee can nominate a specific vendor. Employees often request quotes from vendors in order to get the required information. Completing the entire form can take a few days as the employee often does not have the required data. The quote is attached to the purchase request. This completed request is signed by two supervisors. One supervisor has to provide a financial approval, while the other supervisor has to approve the necessity of the purchase and its conformance with the company's policy (e.g., if purchasing a software tool, is it compatible with the company's standard IT operating environment?). Collecting the signatures from the two supervisors takes on average 5 days. If it is urgent, the employee can hand-deliver the form, otherwise it is circulated via internal mail. A rejected purchase request is returned to the employee. Sometimes, the employee makes minor modifications and resubmits the purchase request.
>
> Once a purchase request is approved, it is returned to the initiator of the request. The employee forwards the form to the purchasing department. Employees often make a copy of the form for their own record, in case the form gets lost. The purchasing department checks the completeness of the purchase request and returns it to the employee if it is incomplete.
>
> The purchasing department then enters the approved request into the company's enterprise system. If the employee has not nominated any vendors, a clerk at the Purchasing Department selects one based on the quotes attached to the purchase requisition, or based on the list of vendors (also called *master vendor list*) available in the company's enterprise system.
>
> Sometimes, the quote attached to the request has expired in the meantime. In this case, an updated quote is requested from the corresponding vendor. Other times, the vendor who submitted the quote is not recorded in the company's enterprise system. In this case, the purchasing department should give preference to other vendors who are registered in the enterprise system. If no such vendors are available or if the registered vendors offer higher prices than the one in the submitted quote, the purchasing department can add the new vendor into the enterprise system.
>
> When a vendor is selected, the enterprise system automatically generates a purchase order. The purchase order is sent to the vendor by fax. A copy of the purchase order is sent to the accounts payable office. This office, part of the financial department, uses an accounting system that is not integrated with the enterprise system, where purchase orders are stored.
>
> The goods are always delivered to the goods receipt department. When goods are received, a clerk at this department selects the corresponding purchase order in the enterprise system. The clerk checks the quantity and quality, and generates a document called goods receipt form from the purchase order stored in the enterprise system. The goods are forwarded to the employee who initiated the purchase requisition. A print-out of the goods receipt form is sent to the accounts payable office. If there are any issues with the goods, they are returned

to the vendor and a note is sent to the purchasing department and to the accounts payable office for archival.

The vendor eventually sends the invoice directly to the accounts payable office. A clerk at this office compares the purchase order, the goods receipt and the invoice. This latter task is called three-way matching. Three-way matching is time-consuming because the clerk needs to carefully investigate each discrepancy. The payment process takes so long that the company often misses the deadline for invoice payment and has to pay a penalty.

At the end, the clerk triggers the bank transfer and sends a payment notice to the vendor. Some vendors explicitly indicate in their invoice the bank account number to which the transfer should be made. It happens that the bank account number and name indicated in the invoice differ from the one recorded in the vendor database. Sometimes payments bounce back, in which case the vendor is contacted by phone, email or postal mail. If new bank details are given, the transfer is attempted again. If the issue is still not resolved, the accounts payable office has to contact again the vendor in order to trace the cause of the bounced payment.

1. What type of process is the above one: order-to-cash, procure-to-pay, application-to-approval, or issue-to-resolution?
2. Who are the actors in this process? Who are the customers?
3. What are the tasks of this process?
4. What value does the process deliver to its customers?
5. What are the possible outcomes of this process?
6. Taking the perspective of the customer, what performance measures can be attached to this process?
7. What potential issues do you foresee this process might have? What information would you need to collect in order to analyze these issues?
8. What possible changes do you think could be made to this process in order to address the above issues?

Acknowledgment This exercise is adapted from a similar exercise developed by Michael Rosemann, Queensland University of Technology.

Exercise 1.8 Consider the phases of the BPM lifecycle. Which of these phases are not included in a business process re-engineering project?

1.8 Further Readings

Rummler is one of the pioneers of process thinking as an approach to address the shortcomings of purely functional organizations. His work on process thinking was popularized by a book co-authored with Brache: "Improving Performance: How to Manage the White Space on the Organizational Chart" [153]. A paper published two decades later by Rummler & Ramias [154] gives a summary of Rummler's method for structuring organizations around processes.

Two key articles that popularized process thinking as a management concept are those of Hammer [59] and Davenport & Short [31], which were discussed in this chapter. While Rummler's work deals broadly with structuring organizations based on processes, Hammer and Davenport & Short focus on how to redesign individual business processes to improve their performance.

A comprehensive and consolidated treatment of BPM from a business management perspective is provided by Harmon in his book [65]. Harmon's book presents the so-called BPTrends method for BPM. Harmon is also editor of the BPTrends newsletter and portal[5] which features numerous articles and resources related to BPM. A good overview of the field is also provided in books by Becker et al. [17] and by Rosemann & vom Brocke [186, 187].

As mentioned in this chapter, BPM is related to several other fields, including TQM and Six Sigma. Elzinga et al. [43] discuss the relation between BPM and TQM, while the application of Six Sigma techniques to BPM is discussed by Harmon [65, Chapter 12], Laguna & Marklund [85, Chapter 2], and Conger [28].

[5] http://www.bptrends.com.