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Kurt Sandkuhl · Janis Stirna
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Enterprise Modeling

Tackling Business Challenges with the 4EM Method

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Kurt Sandkuhl
Matthias Wißotzki
University of Rostock
Rostock
Germany

Janis Stirna
Stockholm University
Stockholm
Sweden

Anne Persson
University of Skövde
Skövde
Sweden

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Preface

Methods, techniques, and practices for Enterprise Modeling have been a very important part of our professional lives during more than 15 years. We strongly believe that modeling is a key technique for understanding, capturing, and communicating organizational knowledge—and crucial for successfully mastering change and innovation processes in enterprises.

During the last years—when working on this book—we were involved in at least a dozen of Enterprise Modeling projects with different industrial enterprises or public authorities. In most of these projects it became obvious to us and other project participants that Enterprise Modeling methods and techniques are extremely valuable for understanding the present and preparing for the future—particularly in times of continuous organizational change, which is often caused by an increasing pace of innovation, collaboration with other organizations, new challenges in the market, societal changes, or technology advancements.

The idea for this book emerged from discussions with our students. All of us regularly teach Enterprise Modeling at our respective universities and so far the teaching material for our courses consisted of an early version of a method handbook for the predecessor of the 4EM Enterprise Modeling method described in this book and a collection of lecture notes and slides also including enhancements of the method. Many students asked for additional, more comprehensive course material about the 4EM method, the techniques and practices related to it, and the field of Enterprise Modeling as such. This initiated nearly 2 years of work on this book with quite a few discussions about its scope and required content. Quite quickly we agreed to neither focus on theories and general approaches to Enterprise Modeling nor to try and cover all developments in the field. Instead, we decided to focus on practical advice and to combine a detailed description of 4EM with the real life experiences collected in our projects. The book addresses modeling procedure, modeling language, and modeling practices in an integrated manner. On the same topic, enterprise modeling with 4EM, a German language book is available. At first glance, the content of both books might seem similar. However, this English language edition has been substantially extended and revised as compared to the German book.

When preparing the book we were surprised to learn how few books on Enterprise Modeling methods were published and that even fewer have a focus on how to do Enterprise Modeling in practice. A reason for this might be the large number of books on business process management, process modeling, and process optimization. Process modeling and Enterprise Modeling are often considered as different words for the same subject, but they definitely are not the same for us. Enterprises consist of much more than processes and hence modeling and managing only processes will not provide a complete and holistic understanding of the enterprise, which is required for properly addressing many challenges and problem-solving tasks.

This book would not have become a reality without the support of many people in our private and professional environments. First of all, we would like to thank all colleagues and friends who actively contributed to the development of 4EM and its predecessor, EKD. Since the list of people would be very long and the danger imminent that we would forget someone, we just want to mention Prof. emeritus Janis Bubenko Jr. at the Royal Institute of Technology (Sweden), Prof. Pericles Loucopoulos at Harokopio University of Athens (Greece), and Prof. Colette Rolland at Université Paris 1 Panthéon—Sorbonne (France) who all were part of developing the first versions of what now has developed into the 4EM method.

Furthermore, we would like to thank our colleagues in Jönköping, Riga, Rostock, Skövde, and Stockholm who teach Enterprise Modeling, use 4EM or EKD, and contributed ideas, improvement proposals, and practices in many fruitful discussions and joint modeling sessions. You all know who you are!

Moreover, we would like to thank fellow researchers and practitioners that work in the area of Enterprise Modeling and in recent years have been part of forming an active community under the auspices of the IFIP Working Group 8.1 on Design and Evaluation of Information Systems and more specifically the Working Conference on the Practice of Enterprise Modeling (PoEM). Many ideas presented in this book have been put forward for discussion with our peers at these forums.

Furthermore, we would like to thank Prof. Ulrich Frank at the University of Duisburg-Essen (Germany), Prof. Dimitris Karagiannis at the University of Vienna (Austria), Frank Lillehagen at Commitment AS (Norway), and Prof. John Krogstie at the Norwegian University of Science and Technology for checking the content of Chap. 14.

We acknowledge the support from our research groups and colleagues in Rostock, Skövde, and Stockholm. We are particularly grateful to Ulrike Borchardt, Petra Kegler, Hasan Koc, Birger Lantow, Dirk Stamer, Peggy Sterling, Tino Weichert, and Tino Weigel for their help in creating pictures and with formatting, cross-referencing, proofreading, and establishing the companion Web site.

The last months before finishing the book have been a challenge to our families. We would to thank them for all the support and understanding.

Rostock, Germany — Kurt Sandkuhl
Stockholm, Sweden — Janis Stirna
Skövde, Sweden — Anne Persson
Rostock, Germany — Matthias Wißotzki
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List of Abbreviations

4EM	For enterprise modelling
A4Y	Assessories4You
ARM	Actors and Resources Model
B2B	Business-to-business
B2C	Business-to-consumer
BPEL	Business Process Execution Language
BPM	Business Process Management
BPMN	Business Process Model and Notation
BRM	Business Rules Model
CM	Concepts model
DSL	Domain Specific Language
EA	Enterprise Architecture
EAM	Enterprise Architecture Management
EC	Electronic commerce
EKD	Enterprise Knowledge Development
EM	Enterprise Modelling
F3	From Fuzzy to Formal
GM	Goals Model
GPM	Goal-/problem model
IFEAD	Enterprise architecture development
IT	Information Technology
PoEM	Practice on Enterprise Modeling
SEM	Search engine marketing
SEO	Search engine optimization
SMM	Social media marketing
SRM	Supplier-relationship-management
TC	Technical component
TCRM	Technical Components and Requirements Model
UML	Unified Modeling Language

Contents

Chapter 1
Introduction

Many systems and organizations seem complex and difficult to understand—until you show their elements and structures and reveal relations and dependencies. Enterprises are such complex systems with their different organizational units and people working in the enterprise, with workflows and production processes, products and services offered to different customer groups, supplies and business partners, IT systems and production resources, etc. This book is about Enterprise Modeling, a technique that helps to capture the different elements and structures of an enterprise as well as to visualize the inter-dependencies between the elements. Enterprise Modeling can be used for a multitude of different purposes, like visualizing the current situation, analyzing the reasons for shortcomings or problems, developing strategies for business or IT, optimizing processes, or setting up new cooperations with other enterprises.

Enterprise Modeling offers a practical and flexible set of work procedures, tools, and practices, which can be adapted to the situation at hand and to the purpose in focus. One of the main purposes of this book is to provide a "guide for action," i.e., practical advice for how to address challenges in enterprises which can be solved or supported with Enterprise Modeling. The methods, tools, and practices provided by the book are rooted in experience from many industrial modeling projects, but they also have a solid theoretical foundation from research in the field.

Enterprise Modeling is a structured way of working which captures various perspectives, such as goals, processes, and actors, of an organization or a problem situation in an integrated way. It supports management of the organization by supporting change management, decision making, and planning processes both within the different business functions and for the IT support.

Enterprise Modeling has a strong connection to the discipline of Enterprise Engineering, which aims at providing methods and techniques for an aligned development of all parts of an enterprise, e.g., the business, functional, organizational, and technical aspects. Such an aligned development is far from trivial, since the business environment and the IT in an enterprise continuously change, but the pace of change and the time frames needed to implement changes are different.

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Enterprise Engineering combines concepts from management and organization science, information systems science, and computer science to achieve this goal. The core ideas of enterprise engineering, from the perspective of the CIAO! network (http://ciaonetwork.org/), are defined in the Enterprise Engineering Manifesto (Dietz 2011). The manifesto includes seven postulates aiming at achieving practical relevance and theoretical rigor in enterprise engineering.

In some areas of economics, the term "enterprise" is used for the private sector enterprises only. However, this book's interpretation of Enterprise Modeling is not limited to any specific kind of enterprise. It is applicable to public organizations, industrial enterprise of any domain, privately run businesses, as well as any kind of nonprofit association. The term could as well be "organization modeling" but Enterprise Modeling is more established.

Furthermore, Enterprise Modeling does not always have to consider the complete enterprise, it may focus on those parts of the enterprise or organization that are subject to investigation. The scope of a modeling project is usually defined in the early phases of modeling.

Enterprise Modeling is related to a number of other modeling disciplines, like business modeling, business process modeling, or information modeling. Business process modeling and Enterprise Modeling are similar in that both capture and visualize the relevant business processes with the actors involved and resources needed. However, in Enterprise Modeling business processes are only *one* view of the enterprise and not the predominant one like in business process modeling. Enterprise Modeling can support different modeling purposes, which leads to a greater flexibility of the methods; some application areas of Enterprise Modeling do not require detailed process modeling.

Similarly, information modeling and Enterprise Modeling have some overlap. Information modeling aims at identifying information objects with their attributes, which often is a part of enterprise models as well. Information models are used in information systems or software development and have to be very detailed whereas enterprise models include information objects to capture relationships and dependencies, which usually do not require the same level of detail.

Enterprise Modeling and business modeling are often used as synonyms. Business modeling is in principle a broader term consisting of a wide range of approaches originating in operations research, economics, management studies, and information systems.

In summary, Enterprise Modeling as described in this book has two main characteristics: (1) it focuses on addressing multiple perspectives of an enterprise in an integrated way and (2) it offers a set of practical guidelines for knowledge acquisition, modeling, and analysis. In addition, the stance taken in this book concerning the modeling process is that the quality of models and the effect of modeling are greatly enhanced if a participatory approach to stakeholder involvement is adopted.

1.1 Goal of the Book: Practical Advice

The main goal of this book is to provide practical advice on Enterprise Modeling (EM). The theoretical background to EM also is part of the book, but it is limited to the most relevant concepts. EM is a powerful technique for many application purposes if used in the right way with the right aids and resources. The approach in this book to providing practical advice is to start from common challenges in enterprises and offer a flexible EM method suitable for tackling the challenges.

The practical challenges are common situations that occur in enterprises and have the potential for cost savings or efficiency improvement if managed correctly and are beyond the normal day-to-day activities of running the enterprise. Such challenges are often connected to midterm or long-term enterprise development, e.g., organizational structure development, quality and process improvements, strategic development, as well as innovation processes.

This book offers an EM approach for tackling these challenges. It is flexible in the following ways:

- It does not have a rigid problem solving process. Instead, the way of working (the modeling process) can be adjusted to the situation at hand depending on the enterprise's preferences and on the preferences of the problem solver.
- The modeling language suggested consists of various components for modeling the different perspectives (e.g., goals, business processes, concepts), which—like in a toolbox—can be combined and applied in many different ways.
- All parts of the approach are freely available and not locked behind consultancy secrets.

The practical challenges are discussed in Chap. 2, the modeling language in Chap. 8 and the modeling process in Chap. 9. In addition to giving advice on how to use EM for tackling business challenges, the book also includes advice on areas related to EM, e.g., elicitation techniques, reference models for enterprise architectures, how to do quality validation of models, and how to run EM as a project.

Much of the work presented in the book originates from research projects and has been validated with scientific methods. It has also been successfully applied in a large number of development and/or change management projects in industry and in the public sector. The experiences from these projects provide a solid basis for this book.

When using EM for tackling business challenges, method knowledge alone is not enough. EM activities also require a solid project organization in order to achieve the desired results, i.e., resources need to be secured, roles assigned, and decision structures prepared. We provide recommendations for setting up an adequate project organization in Chap. 9.

1.2 Structure and Content

The aim of this book is to provide practical advice on how to successfully carry out EM, particularly by using the 4EM method for Enterprise Modeling. This aim is also reflected in the structure of the book:

Chapter 2: This chapter will show how EM can help tackling typical business challenges that practitioners face in their daily work. The common characteristics of the challenges and how 4EM should be used to address them are described. The challenges are the need to understand organizational dependencies, find the need for change, improve business processes, align organizational strategy and IT, as well as develop the IT strategy.

Chapter 3 introduces important terms and concepts used throughout this book—models and their purpose, modeling language and modeling process, as well as basic components of an Enterprise Modeling method used in this book.

Chapter 4: One of the central elements in EM is analyzing the actual situation and existing challenges in the enterprise in close cooperation with domain experts, decision makers, and other stakeholders in the enterprise. In this context, elicitation approaches including interviews, observation, document analysis, and participatory modeling sessions are important skills for the modeler. This chapter introduces the most frequently used elicitation approaches.

Chapter 5 focuses on EM tools. Relevant tools do not only include IT-based applications, but also traditional aids, like flip charts and the "plastic wall." Even though IT-based tools are subject to continuous development and improvement, a number of core features can be identified which many modeling tools offer. This chapter will introduce different tool categories including an example for each category.

Chapter 6: An example case used for explaining the 4EM concepts is introduced in this chapter. The case study is about an imaginary company from the retail sector with several subsidiaries and substantial e-Commerce activities.

Chapter 7 introduces the 4EM method by giving an overview to three main parts of the method—a defined work procedure and notation, the participative approach to stakeholder involvement, and the organization of EM activities as projects.

Chapter 8: The 4EM method includes six integrated sub-models addressing different perspectives of the organization. For each sub-model, the purpose of the model, notation, components, an example from the case study, development process for the sub-model is presented.

Chapter 9: For an EM project to succeed, knowledge of the basic elicitation approaches and EM perspectives is necessary, but not sufficient. Establishing an EM project in the organization and carrying out the EM process are equally important aspects. This chapter describes how such a modeling project should be structured and established. This includes the roles within the project team, organizational frame conditions, and typical project phases.

Chapter 10: The success of EM projects also depends on having personnel with the right competences in the project team. This chapter discusses issues of competence supply.

Chapter 11: Organizations usually begin using EM in a project form where an outside vendor and/or consultant provide the method and tool usage competence. If they use EM sufficiently frequently a need to use EM without external support often arises. This chapter discusses the process of how to acquire an EM approach and a tool in order to use it without the support of outsiders. More specifically, this chapter discusses the acquisition and adoption processes as well as organizational structure needed to support EM activities.

Chapter 12: EM projects and the cooperation process between different stakeholder groups sometimes result in organizational change measures which can be implemented without initiating bigger change projects or the introduction of IT support. In such cases, the different models developed might only be used for documentation purposes. However, in the majority of the EM projects, the sub-models will be continuously refined, improved, and transformed; they need to have a high-quality level. This chapter discusses the overall principles of enterprise model quality as well as suggests a number of best practices for improving model quality.

Chapter 13 addresses the two aspects of reuse in EM—developing reusable model fragments (design for reuse) and reusing existing reusable components in building new models (resign with reuse). The main focus of the chapter is on the concept of patterns as the main medium for supporting reuse.

Chapter 14 introduces a selection of EM and business process modeling methods that show similarities to the 4EM method. The purpose of this chapter is neither to provide an exhaustive list of approaches nor is it to include all details and usability aspects of these approaches. The intention is rather to show that 4EM in many aspects is a typical or exemplary modeling language, i.e., it is easy to switch from 4EM to another method, since most concepts and perspectives used in 4EM also are to some extent available in other methods.

Chapter 15: Within the field of EM, substantial work has been spent on defining frameworks and architectures. In comparison to EM methods, frameworks and architectures do not focus on procedures for the actual modeling process, notations, and modeling languages, but they address the modeling domain or the results of the modeling process. Most frameworks were developed within a specific application domain or for an enterprise function and structure this domain and function. This chapter introduces frequently used reference models and discusses their relevance and application potential for enterprise modeling.

Chapter 16 discusses the current research trends and directions for further studies. This includes the connection between EM and information system development, and in particular the field of Requirements Engineering, the area of enterprise architecture management, linking EM and Model Driven Development, and support for mobile and cooperative modeling. The main objective of the chapter is to give advice to the reader on which additional subject area and material could be of interest.

1.3 Reading Recommendations

This book is written for everybody who wants to learn more about EM with specific focus on how to do it in practice and how to teach it. Although the book does not require any prior knowledge about EM, background knowledge in how an enterprise functions and the basics of modeling in general is recommended.

Basic modeling knowledge, like how to develop an information model, is recommendable since abstracting the most important aspects from reality in order to capture these aspects in a model is also at the heart of EM.

General knowledge about structures and processes in organizations helps to understand the method description in this book and applying the method constructs to reality.

More specifically, the book is written for four main target groups:

- Instructors in the field of Enterprise Modeling,
- Students in the areas of information systems, computer science, and business administration,
- Newcomers in the field of Enterprise Modeling, and
- Practitioners looking to extend their competence and to get practical advice for tackling their business problems.

Newcomers to Enterprise Modeling. Newcomers need to understand what EM is for and where its limits are and that an enterprise should be viewed from different but integrated perspectives in order to fully understand dependencies, how to start an EM activity, and the actual way of modeling relevant facts and using the model for the purpose at hand. The reading recommendation in this case is:

- Start with Chap. 2, which will provide a number of typical examples where EM is useful. There is no need to study all of the content of Sect. 2.1 in detail, but reading at least some Sects. of 2.1 (practical challenges) plus 2.2 and 2.3 is recommended.
- Chapter 3 introduces important terms in EM. You can either go through it at the beginning or use it as reference section for checking the meaning of terms.
- Chapter 4 contains valuable information about how to elicit knowledge from the problem domain by various approaches such as interviewing, observing stakeholders, studying documents, and performing participatory modeling sessions. The content of this section is very important for practical modeling, but it does not strictly originate from Enterprise Modeling, i.e., you might have learned it elsewhere.
- Chapter 6 introduces the case study used for illustrating the modeling techniques. Read at least Sect. 7.1 to get an idea of the case and revisit other parts of Chap. 7 when using the examples in Chap. 8.
- Chapter 7 is important because it shows how the modeling method (Chap. 8), the project organization (Chap. 9), and the participative way of working (Sect. 9.6) complement each other.

- Chapter 8 should be studied in great detail. Here, you will learn the different views of an enterprise, how to capture them, and what questions to ask. For each perspective, you should take some time to inspect the examples.
- Chapter 9 complements the knowledge of "how to model" with knowledge about "how to start" in an enterprise and how to set up modeling projects.

In order to have most use of it, newcomers to the subject should study the remaining sections of the book only after gathering some practical modeling experience first.

Practitioners Practitioners will probably use the book in different ways, depending on the situation of use. On the one hand, the book can be used as reference manual for reading up on subjects of interest to the practitioner. Elicitation approaches, EM methods and perspectives, reference frameworks, or quality assurance are among the subjects covered in chapters that can be studied independently of the other book chapters—if the background knowledge is sufficient.

On the other hand, the book provides instructions on how to approach problem solving for business challenges (some of them outlined in Sect. 2.1). The challenges all include information about the EM perspectives important for tackling the challenges and the tools or subject matter experts needed. With this information, the reader can proceed to Chap. 7, which explains the different elements of a successful EM activity. Afterwards, Chap. 8 is important, where each modeling perspective and its use is presented in a cookbook style, including which questions to ask and what information to look for. Chapter 9 provides information on how to set up an EM project and Chap. 5 provides advice regarding tools available while Chap. 12 discusses aspects of model quality.

Instructors Instructors will find the material in this book suitable for different levels of courses and different study programs. The book serves as a basis for education on Bachelor-, Master-, and PhD-course level. In the following, a proposal for both Bachelor and Master level courses is presented. Additional information, lecture slides, and other teaching material are available on the book's companion website (See http://www.4em-method.com).

For a course on Bachelor level a lecture track in parallel to a lab track with exercises in EM is recommended. The lecture track could consist of the following parts:

- An introductory session about EM and typical application cases based on Chap. 2 and examples from the case study in Chap. 7
- One or two lectures about knowledge elicitation techniques presented in Chap. 4. To what extent this subject has to be addressed depends on whether it is covered elsewhere in the study program.
- One lecture about the basic terminology in EM based on Chap. 3
- 2–3 lectures about the different EM perspectives, how to approach them, and what notation to use. This part should be based on Chaps. 7 and 8

- One lecture about the case study used in the book, or alternatively, the case study used for the lab work. Alternatively the students can be allowed to choose their own case.
- One lecture about the quality characteristics and validation of enterprise models based on Chap. 11
- One lecture about setting up and organizing Enterprise Modeling projects based on Chaps. 9 and 10
- One lecture about how to use the enterprise models produced for process improvement and information system development.

The lab part should primarily consist of performing EM for a given purpose in a sample case using all perspectives. Such a course should be scheduled after fundamentals of business administration and basics of information or process modeling.

On the Master level, method knowledge, knowledge about tools, reference architectures, and quality aspects can be in focus. Chapters 5 and 11–15 can serve as a basis for lectures introducing these subjects and as study material for the students. Most chapters contain recommendations for future readings, which provide starting points for assignments to students.

Students If you intend to study by yourself, you should study the content of the book according to the sequence of its chapters. If the book is used as part of a course or study program, the instructor will provide advice on how to proceed.

Chapter 2
Business Challenges: And How Enterprise Modeling Helps

Enterprises operating in most industrial and service sectors face a number of business challenges that exceed the scope of the daily operations and routine activities. Examples are continuous process improvements for increased efficiency, adjustments of the enterprise strategy to new market demands, changing business models due to new competition, new regulations and bylaws requiring operational changes, or technological innovations leading to changed customer behavior and new processes. In many cases, improving business processes alone is insufficient for addressing problems of this nature. The overall situation of the enterprise has to be taken into account including relations between strategic goals, business rules, work processes, organization structures, products, services, IT infrastructure, etc.

Enterprise Modeling (EM) is a proven instrument for addressing these kinds of organizational challenges. The area of Enterprise Modeling in general is concerned with techniques, methods, and tools for modeling organizations and for finding and preparing potential improvements. This chapter discusses a number of typical business challenges for illustration purposes (Sect. 2.1) and then shows how EM can help addressing them (Sect. 2.2) followed by an overview on practical guidance for modeling (Sect. 2.3).

2.1 Typical Business Challenges

The aim of this chapter is to discuss a number of typical business challenges in order to show how EM can help in tackling them. The following challenges will be discussed:

- Understanding organizational dependencies
- Finding the need for change
- Improving business processes

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- Aligning organizational strategy and IT
- Developing the IT strategy

The challenges will be described in terms of their typical characteristics and put in relation to the EM perspectives with respect to why and to what extent they are needed to understand the problem and to define a solution. Method support for the different perspectives will also be presented in this chapter.

2.1.1 Understanding Organizational Dependencies

Many situations and tasks in enterprises require a clear understanding of the established organizational structures and existing processes, which can be achieved by creating enterprise models to visualize these structures and processes. Such a visualization describes the current situation in the enterprise and helps to clarify relations and dependencies between various parts of the organizational design. Visualizing the current situation usually is the first step towards finding problems (discussed in Sect. 2.1.2.) and improving business processes (see Sect. 2.1.3.), but it can also be applied for other purposes, such as:

- Training new employees and introducing them to the current practices of an enterprise. This activity can benefit from documentation that includes enterprise models. The focus of the documentation will often be on the workflow, e.g., standard operation procedures, and on tasks and responsibilities, e.g., which role or unit in an organization is responsible for what task.
- Planning a new product variant or customer service. In such cases it is important to know the dependencies between new and existing variants of products and services as well as which processes and resources are involved in production.
- Identifying dependencies of the information systems and IT applications in an enterprise and analyzing the IT support for different tasks and work processes. Visualizing these relations is an important input for planning operations and maintenance.
- Setting up the cooperation with a new partner or supplier. In such cases EM is instrumental in showing the business processes that the new partner or supplier will be contributing to and hence what integration activities need to be designed.

The above examples show that visualization of the enterprise may focus on different views of the enterprise, like processes, IT systems, services, or organization structures to serve the specific purpose for the EM activity.

One of the most important features of enterprise models used for visualization purposes is that they have to be easy to understand for the targeted users. This includes a modeling language that is easy to understand and is adequate for the purpose, tool support for easy navigation in the models, as well as a layout of the models supporting illustration of relationships and dependencies.

Furthermore, such models have to reflect the current situation in the enterprise or part of the enterprise under consideration, i.e., accuracy to the required level of

Table 2.1 Features of EM for understanding organizational dependencies

EM for understanding organizational dependencies	
Purpose	Capture and document organizational aspects, such as structures and processes, in an explicit and understandable form
Input required	Scope: which part of the enterprise has to be considered (organization units, processes, divisions, etc.)?
Who should be involved?	Staff knowledgeable about the problem domain from all levels (operations, management, subject matter expert)
Typical outcome	Enterprise model for the part of the enterprise depending on subject and purpose: process, organization structure, IT systems, products
Critical quality issues	Model has to fit the reality (high correctness) Modeling language and the produced models have to be easy to understand for organizational stakeholders (high understandability)
Tool support	Viewing and browsing of models

details is essential. In order to achieve the desired level of accuracy subject matter experts (stakeholders) with deep knowledge of the problem domain should be involved in modeling.

Formality of the models usually is less important since the models are not meant for using them in workflow engines or other execution environments, but only for human audience.

That the purpose of modeling is the visualization is often known from the beginning and the scope of the model is quite clearly defined. More often in such cases, a top-down modeling strategy is applied, i.e., starting with the general structures and processes and elaborating details in increments. Table 2.1 summarizes the characteristics of enterprise models and the modeling process for visualization purposes.

2.1.2 *Finding the Need for Change*

Daily work in most enterprises does not only consist of running routine processes or standard procedures in a "business as usual" fashion; it also includes troubleshooting and as well as identifying the need for and developing improvements. Problems are often related to several areas of the organization, e.g., different processes, products, organization units, and systems. Finding and analyzing them requires an understanding of the dependencies and relationships, which is often difficult because they are hidden in the complexity of the enterprise. In some cases the symptoms of a problem are visible, but the causes remain hidden and require a careful analysis.

EM can help finding such problems or—to be more precise—finding and analyzing them in order to identify their causes and potential solutions. Depending on the visible effects of the problem, different aspects of the enterprise might have to be modeled. Examples are:

- Variations in the quality of products or services could have their cause in different opinions of stakeholders in the organization about what the most important quality aspect is. Even though standard procedures might be defined, the quality will depend on who is involved and maybe even on the sequence of the involvement. This is difficult to detect unless quality priorities are made clear and the different viewpoints are exposed.
- In many enterprises problems in the information flow cause costly operational problems, such as high failure rates in production and delayed deliveries. In such situations, all roles involved in a process should, in principle, get the right information for their task but in reality the information is partially incomplete or inaccurate without the stakeholders being aware of this.
- Process descriptions are interpreted and followed differently at different parts of the same enterprise, which causes deviations in resource use and process efficiency. The differences in executing the same business process can be caused by specific changes at some of the parts of the organization, which makes the existing process descriptions incomplete. Explanations for these deviations will require creating a joint view of the process by all involved sites.
- Organization finds itself in a changing market situation and needs to adjust its business vision and how the vision is implemented. In such cases the business vision is created and the existing business processes and the IT architecture need to be adjusted as well as new components need to be introduced.
- Different interpretations of the same term or business concept can have an effect on how policies and business rules are handled in an enterprise. Clarification of such terms may seem as an easy task on the outset, but connecting this to operational problems often requires a substantial effort.

When dealing with these kinds of “wicked” problems it is important to have a problem solving approach which is not too rigid in its process but allows for adaptation to the situation at hand. Different ways of gathering information about the situation might be needed, e.g., moderated modeling sessions, observations, and interviews. At the same time, different perspectives need to be analyzed in order to identify dependencies between the various aspects of the problem situation. This may entail creating and analyzing a combined process and service view or considering the involved organization units from the perspective of their position in the value chain. One of the key factors for finding the problem is to include those people in the problem solving process who are involved in daily operations of the area in question. Those who are only responsible for operations might not be sufficient because they might only know how things “should be performed” and not how they are really done in practice. Table 2.2 summarizes features of EM for finding the need for change.

Table 2.2 Features of EM for finding the need for change

EM for finding the need for change	
Purpose	Find the needs for changing the organization
Input required	Where is the problem encountered? How does the problem manifests for itself? Who is involved (staff, role, unit, . . .)?
Who should be involved?	Stakeholders familiar with the problem on operational and managerial levels
Typical outcome	Problem analysis in terms of which organization unit, role, process, product, IT system, or information is involved, what are the likely causes, what needs to be done to solve them
Critical quality issues	Model has to include the dependencies between different potential aspects and effects of the problem
Tool support	Capturing different perspective in the same model

2.1.3 Improving Business Processes

Efficient and effective processes are one of the keys to a successful business. If processes do not fulfill this criterion they need to be improved. This is a challenge that many enterprises face and EM is able to support it.

Process improvement projects usually start from an observation that certain activities or workflows in an organization take too much time or resources, that they produce suboptional results, or that they are performed with many ad hoc adjustments and work-arounds created by the involved staff members. Thus, the starting point for process improvements is often given by such observations. However, when defining the scope for the improvement project a wider view should be taken in order to include potential influences from related process and/or departments. The potential improvements will most likely concern more areas than just processes. It is highly likely that business goals, concepts, business rules, and the IT infrastructure will also have to be changed.

Process improvement has to usually involve three different levels that can be supported by EM:

- The strategic level concerns the definition of the objectives from an enterprise perspective to be reached with process improvements. Questions to consider are: is it more important to shorten the time needed for completing the process, to reduce the resources needed, or to increase the number of parallel process executions; should the improvement contribute to increased customer satisfaction or is the priority on standardizing process execution?
- The conceptual level addresses the design of future processes in accordance with the strategic objectives of the organization. This includes aspects like the flow of activities, the personnel involved, the resources needed, interfaces to related

processes, etc. An important aspect is to agree with the subject matter experts and the staff involved on the future process in order to increase acceptance of the process.

- The operational level implements the results from the conceptual level for everyday use in the enterprise. This can be achieved by using workflow environments for process execution or specific IT support. The step from the conceptual level to the operational level often requires refining the processes (e.g., by describing all possible exceptions from the standard process) and adding more details.

EM is well suited for the strategic and the conceptual level. Here, visualizing and defining objectives and processes, creative design of future situations, and agreements between stakeholders are more important than exact technical specifications and "executable" process descriptions. For the operational level, many specific workflow languages and execution environments were developed, which fit better to the purpose of implementing the process. However, these specific workflow tools often have shortcomings in supporting the creative and design part of the process improvement. EM can also be used for more exact operational specifications of the conceptual level, but since it is not meant for process execution, different modeling languages may need to be used.

The typical outcome of a process improvement project in the first stage is an inventory of the most important processes with a short textual description but without detailed specification of the activity flow. The processes to be improved have to be defined in more detail including the sequences of activities, alternative activity flows, actors, and resources involved. The future process descriptions should be captured as visual models and agreed on between the stakeholders involved.

Table 2.3 summarizes the feature of EM for process improment.

Table 2.3 Features of EM for process improvement

EM for process improvement	
Purpose	Improving business processes
Input required	Processes to be improved including the relevant actor dependencies, such as the process owner
Who should be involved?	Management level for defining strategic objectives; process owner and involved staff for designing future processes; operations manager and technical support for process implementation
Typical outcome	Strategic objectives guiding process improvement; future process with roles, resources, and supporting IT; action plan for implementing the change process
Critical quality issues	Fulfillment of strategic objectives; feasibility of future process in practice; acceptance by staff involved; integration with other processes and systems in the organization
Tool support	Modeling of processes at several levels of abstraction, using the process decomposition principle

2.1.4 Aligning Organizational Strategy and IT

Alignment of business and IT is often considered to be a serious challenge in enterprises since the business environment and organizational practices continuously change and in turn so does the IT of an enterprise. The pace of change and the time frame needed to implement the changes are different in both areas. Furthermore, business professionals and IT professionals often have different backgrounds, use different terminology, and set different priorities for development. In this context of multitude of influences and contradicting needs, reaching an agreement about how to set priorities for the enterprise is difficult, because there is no enough understanding of the "other side." EM is able to deal with situations where different stakeholder views and requirements need to be consolidated and consensus achieved. For the purposes of business and IT alignment, the following directions of work are commonly taken:

- Goal modeling and problem modeling involving business and IT professionals in order to create a better understanding for the concerns, limitations, and priorities from a business or an IT perspective. In particular, using a participatory way of working consisting of modeling sessions leads to creating common understanding of dependencies between goals and problems as well as resolution of inconsistencies and conflicts between the goals, the measures for reaching them, as well as the IT requirements and architecture design.
- For the most important future business areas or the most relevant strategic developments, the dependencies between products or services and IT can be modeled as well as the dependencies between the core business processes and IT systems can be visualized. Knowledge about these kinds of dependencies will help to plan the forward development of IT proactively and to influence the priorities that are assigned on the business side.
- In cases when business and IT development is congruent EM is used to elaborate and compare different strategies for achieving the business intentions.

For all of the above purposes it is important to involve business and IT professionals responsible for the areas under consideration and for implementing business or IT changes. This kind of stakeholder involvement increases acceptance of the designed solution and reduces potential tensions during implementation and deployment of the solution.

With respect to the modeling language and the tool to be used, the stakeholders should not be forced to learn new languages or to get acquainted with modeling tools, since this might negatively affect their willingness to participate in the modeling process. Enterprise-wide modeling tools and languages that are already used within the organization should be applied to ensure compatibility with the existing designs and solutions. If the organization does not have experience with EM and/or other model-based ways of working, less formal approaches and easy-to-use tools, like modeling on large plastic sheets, should be preferred. In many cases, the actual models produced will be less important than the process performed and the agreements or advances reached during the process. Table 2.4 summarizes the features of EM for aligning business and IT.

Table 2.4 Features of EM for aligning business and IT

EM for aligning business and IT	
Purpose	To achieve congruence of business and IT
Input required	Business challenges and IT challenges to be coordinated. Existing business visions and designs, existing IT architecture
Who should be involved?	Business and IT professionals responsible for the areas under consideration or for implementing business or IT changes
Typical outcome	Examples: joint understanding of business and IT regarding goals and problems; dependencies between products/services and IT; comparison of different solution alternatives
Critical quality issues	Joint understanding of business and IT professionals regarding problems, goals, and dependencies, integration of models
Tool support	Depending on the actual purpose, e.g., support for requirements management, integration with IS development tools (e.g., CASE or MDD tools)

2.1.5 Developing the IT Strategy

In general, an IT strategy defines the long-term objectives that the IT in an enterprise is supposed to reach in order to contribute to the enterprise strategy as well as the measures and planning for reaching these objectives. Depending on the importance of IT for the enterprise and on the size of the enterprise, an IT strategy can be quite complex and encompass strategic, tactical, and operational parts. EM is well suited to support developing the strategic and tactical levels and can even contribute to the operational level.

On the *strategic level* the organizations formulate the goals to be reached in the long term and the problems to be solved. A prerequisite for this task is to have a clear picture of the current situation of the IT and its support of the enterprise operations. The current state of affairs can be modeled as described in Sect. 2.1.1 "understand organizational dependencies." However, the enterprise application architecture, i.e., the different IT applications and information systems including their interfaces, and the IT infrastructure (servers, networks, locations, etc.) have to be in focus of modeling. This should also include the IT support for the core business processes and functions, e.g., what roles and business processes use which applications or information systems. Based on the knowledge about and the analysis of the current situation the existing problems and aims for the future IT of the organization can be identified and made explicit. This task should include all enterprise stakeholders involved in defining and implementing the strategy. The stakeholders to be involved are the IT Management of the enterprise, representatives of the corporate management, and representatives of the different divisions and business lines in the enterprise. An important input for this process is the overall "corporate" strategy for the enterprise or, alternatively, long-term objectives/challenges of the enterprise from business perspective. If the corporate strategy is not explicitly documented, then modeling it might be a part of the IT development project.

EM supports establishing a common understanding and an agreement among the stakeholders about such business problems and objectives. Strategy development will usually have to include the definition of priorities and solving conflicting intentions and/or implementation alternatives. EM can support this by linking goals and problems to the current situation and among each other. By doing this, it usually becomes clear what problems need to be solved with priority to reach certain goals and, in turn, what IT applications, infrastructure components, business processes, and organization units will be affected. The IT strategy as such will have to be documented in a suitable manner that should include the goal and problem models as well as the parts of the IT and the enterprise that will have to be changed in the future (Table 2.5).

Enterprise Modeling activities on the *tactical level* translate the long-term strategic objectives into midterm planning steps to be implemented. Often, this is prepared as a road-map defining one or several packages of changes in the information system architecture or IT infrastructure. EM is a valuable technique for defining the "to be" situation and the different change packages. This can include defining, for example, the following:

- Initial plans for the required change projects for IT applications and information systems, e.g., introduction of new systems, replacement of existing IT, forward development of custom-made software, integrating of enterprise applications, etc.,
- The necessary changes in business processes and/or new management services and functions to be introduced,
- Changes in the organization structure and role distribution of the IT department.

At this stage not only the decision makers from business areas and IT driving the changes and the experts from business and technical perspective should be involved, but the responsible roles for all affected processes and functions. The aim of the modeling is to reach a common understanding and agreement about the future situation. The enterprise models for the future situation should be more detailed for the tactical planning than for the strategic planning.

If a comprehensive model of the IT architecture exists or was developed for the strategic level, this has (a) to be enriched to accommodate information about planned changes and (b) prepared in several versions showing the planned status at different stages of organizational transition to the desired future state. For this kind of roadmap planning, specialized tools in the category of IT portfolio planning exist.

The *operational part* of an IT strategy has to include very detailed short-term objectives and corresponding plans as well as instructions for their implementation. This usually is a refinement of the tactical planning and, hence, the enterprise models developed for the tactical stage can form the starting point for the operational planning of the implementation. In the same way the operational objectives should be directly contributing to the goals defined in the strategic level. However, for the actual operational planning of day-to-day work the organization should use project management tools in combination with—depending on the planned activity—workflow management tools or software development tools. Tables 2.5 and 2.6 summarize the feature of EM for business and IT alignment.

Table 2.5 Features of EM for IT strategy development, strategic level

EM for developing the strategic level of an IT strategy	
Purpose	Define the long-term objectives for the IT in an enterprise and how to reach them
Input required	Corporate strategy for the enterprise (if defined) or long-term objectives/ challenges of the enterprise from business perspective
Who should be involved?	IT Management of the enterprise; representative of corporate management; representative of different divisions or business lines in the enterprise
Typical outcome	Strategic objectives for the IT in an enterprise and how they contribute to corporate objectives; problems to overcome with respect to strategic objectives; long-term plan of IT changes to be implemented and rough analysis of processes and functions affected
Critical quality issues	Clearly defined realistic and controllable objectives; acceptance by stakeholders; long-term plan for IT changes has to show stages with accepted priority
Tool support	Traditional modeling on paper and plastics for objectives/problem modeling

Table 2.6 Features of EM for IT strategy development, tactical level

EM for developing the tactical level of an IT strategy	
Purpose	Refine the planning and measures defined on the strategic level into midterm planning steps
Input required	Results of the strategic level of IT strategy development
Who should be involved?	Decision makers from business areas and IT driving the changes; experts from business and technical perspective; responsible roles for all affected processes and functions
Typical outcome	Planning of changes in IT applications and information systems; planning of changes in processes and functions affected; update of information system architecture
Critical quality issues	Clearly defined contribution to strategic objectives; feasibility of planned change projects in time, budget, and quality
Tool support	Enterprise modeling tools; enterprise architecture management tools

2.2 How Does EM Help?

Enterprise Modeling helps to tackle the challenges discussed in Sect. 2.1 by offering a flexible but systematic way of working (i.e., a method), tools of different kinds supporting this way of working, and experience-based recommendations for how to do things and how not to do things, so-called practices. This support with methods, tools, and practices provided by EM can be used for a variety of different tasks and situations due to the different perspectives of modeling, which are supported.

The perspectives urge the modeler to look at the enterprise from a specific angle and guide the modeling process in a way that specifically captures and analyzes the specific perspective. All perspectives are equally important because they allow building a holistic view on a problem situation, solutions, and the enterprise as a whole. For specific purposes, one perspective may be guiding the work; hence it might be practical to start modeling with that perspective. The different perspectives at first may seem independent and produce different models—one for each perspective. This is a false impression; all perspectives are mutually dependent on each other and modeled in an integrated way since they all reflect the same modeling subject, i.e., the same enterprise.

The most important perspectives used in EM are the following:

- The goals and problems perspective: future development and daily operations in enterprises should be guided by clearly defined goals, which can be set on general enterprise level or specifically for certain enterprise functions, business areas, or parts. In order to achieve the goals, problems, weakness, threats, and challenges have to be solved. Relationships and dependencies between goals and problems need to be understood.
- The business process perspective: value creation activities, management, and support tasks often are conducted in business processes which have to be continuously improved in order to support the business goals. In many process-oriented enterprises, business processes, and their systematic management are considered the key for efficiency.
- The organization structure perspective: the different organizational functions are provided by organization units forming the organizational structure of the enterprise. Within these units, actors and roles with defined tasks and responsibilities perform the business process.
- The technical components perspectives: both business processes and roles are connected to resources used within the process or for fulfilling the responsibilities. These resources can be IT systems and applications, information resources, or other types of machinery.
- The product perspective: products of enterprises can be physical products produced with enterprise resources or services provided by the enterprise. To visualize and understand the components or parts of these products or services can be essential for understanding the business.
- The concept perspective: when sharing knowledge about dependencies and relationships between processes, roles, products, and services of an enterprise, it is important to use essential terms with exactly the same meaning. Thus, these concepts should be expressed and defined explicitly.
- The business rule perspective: in order to achieve certain business goals or to control the business processes, definition of specific rules to apply often is inevitable. Such business rules also are related to the concept perspective.

Table 2.7 Importance of the different perspectives for the business challenges

Business challenge	Guiding perspective	Complementary perspectives
Understand organizational dependencies	Organization structure	Business processes, products, business rules, technical components
Find the need for change	Goals and problems	Concepts, business processes, organization structure, technical components
Improve business processes	Business processes	Organization structure, business rules, technical components, concepts
Align organizational strategy and IT	Goals and problems	Concepts, business processes, technical components, organization structure
Develop the IT strategy	Technical components	Concepts, business processes, organization structure

Table 2.7 illustrates which of the perspectives introduced above is of highest importance for the different challenges discussed in Sect. 2.1 ("guiding perspective") and which other perspective form important complementary perspectives. This makes clear that it depends on the modeling purpose which guiding perspective has to be used.

Tools for EM support capturing the above perspectives either only for specific perspectives or for an integrated view on all perspectives. Furthermore, different tool categories support the complete EM life cycle from early phases like scoping or project definition to use of models developed for process improvement or information system development.

Many EM activities require a clear objective, participation of several stakeholders from the enterprise, an adequate resource allocation, and a thorough time plan. They should not be performed "on the side" of daily business, but organized and treated as projects. Setting up such projects has many similarities to other kinds of organizational change, system introduction, or development projects, but there also are specifics of EM which have to be taken into account. Thus, support for EM also has to include activities for preparing and organizing EM projects.

2.3 For Enterprise Modeling (4EM): An Example EM Method

During the long history of EM, several hundred methods have been proposed, most of them in a scientific context without ever reaching a level of maturity that is required to be used in practice. Among the established methods, only a few are thoroughly documented and publicly available; many are proprietary knowledge of consultancy firms or system integrators. All perspectives presented in Sect. 2.2 are represented in the most of these methods, but only some methods cover all perspectives. For this book, an EM method was needed which includes all perspectives, is openly available, and has a high maturity. Only introducing EM on a conceptual level, i.e., without a concrete way of working, was not an option since this would lack sufficient practical advice.

We decided to use the 4EM method in this book and to introduce it when discussing the perspectives and the way of working in Chap. 5. The 4EM method is rooted in both academia and practice, but it is not a commercial product. This book does not intend to focus on the method as such; the method is used to illustrate the different perspectives and a systematic way of working with EM. Hence, 4EM serves as a vehicle to transfer this kind of knowledge. Experience shows that it is easy to switch from 4EM to another method, since most concepts and perspectives used in 4EM are also available in other EM methods. Furthermore, in many industrial contexts and enterprises, certain ways of working, and specific modeling languages are already established, i.e., models, tools, and practices exist. In such cases it is important to be able to switch to the existing enterprise standards.

4EM is presented in much detail in Chaps. 6, 8, and 9. More information about the origin of 4EM can be found in Sect. 7.5.

Chapter 3
Terms and Concepts in Enterprise Modeling

In Computer Science and Information Systems, models play an important role for different purposes. This chapter will start by defining and explaining general terms used in the context of modeling. The concept of model is introduced in Sect. 3.1. The term "method" and the constituents of methods are discussed in Sect. 3.2 before investigating the term Enterprise Modeling and Enterprise Modeling method and then presenting the components of enterprise models and ways to represent such models in Sect. 3.3.

3.1 What Are Models and Why to Use Them?

Changes and improvements in enterprises usually have to be based on understanding the existing situation, i.e., the reality in the enterprise under consideration. This reality is complex and can be analyzed from different perspectives, but not all perspectives and not all aspects of reality are required and relevant for solving the problem or completing the task at hand. Modeling generally aims at capturing only the relevant aspects of reality in a representation, called the "model," which can then be used for the intended purposes, such as analysis and development.

Not only are models extremely important in Computer Science and business information systems, but they also have a wide variety of uses in other fields and even in everyday life. A street map, for example, is a model that reflects the reality of a particular town. Depending on its purpose, the emphasis could be on highly detailed information for road users, or it might instead show the cultural and recreational activities available. In architecture, three-dimensional models may for instance be used to show the design of a building, while other models, such as architectural drawings, are used for planning floor layouts. In chemistry, balls and sticks are used to create models of molecules. In mathematics, models are used to accurately describe and gain a better understanding of technical or natural systems. The terms "model" and "modeling" are defined more precisely below.

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_3

3.1.1 Model

> *A model is a generalized representation of a piece of reality, with only relevant real-world properties taken into account during modeling.*

A model is traditionally defined as a generalized representation of reality or a piece of reality, with only relevant real-world properties taken into account during modeling (Kühne 2006). Stachowiak (1973) describes the three main characteristics of a general model as follows:

- Mapping: models are always mappings (representations) of real or abstract originals, which may, in turn, be models themselves.
- Reduction: models contain only those attributes of the corresponding original which are relevant to the modeler and the intended model user.
- Pragmatism: models are not inherently assigned to a specific original. They are utilized by a model-using subject within a particular time frame "and within the constraints of certain conceptual or actual operations."

When abstracting (reducing the level of detail) and mapping a reality in a model, it is important to maintain similarity between the model and the part of reality that was modeled. Here we can distinguish between:

- Structural similarity: the structures represented in the model are retained from reality. When representing an enterprise's organizational structures or product structure, for example, the model should reproduce these structures correctly and as fully as possible.
- Functional similarity: often, reality can be broken down into components or parts based on the tasks which they perform. A model that is intended to represent this functional perspective must accordingly reflect the components and functions of reality.
- Behavioral similarity: if the model is intended to express a behaviour observed in reality, for example, over a particular period of time when events occur, or under particular conditions, similarity between the model and reality must be achieved in this respect.

Among other things, enterprise models are used to describe or capture the "current state"—that is, the current situation or relationships in enterprises or divisions. In doing so, the abovementioned similarity requirements must always be met in order to achieve the most accurate and understandable representations possible. If models describe a desired future situation, i.e., what is known as the "target state," they can be used to guide and assist those involved in the change process.

A model of the "current state" will rarely be an exact replica of the real world. This is due to the modeling characteristics described above—i.e., mapping, reduction and pragmatism, as well as the subjective perception of those that contributed to the model creation. Thus a model is also characterized by a collective perception of the real world that reflects the contributors' frames of reference, experiences, and backgrounds.

3.1.2 Modeling

The process of creating and constructing models is called modeling. Bubenko (1992) defines modeling as follows:

> *"Modeling means essentially to describe a set of abstract or concrete phenomena in a structured and, eventually, in a formal way. Describing, modeling and drawing is a key technique to support human understanding, reasoning and communication."*

Modeling generally results in models. In order to obtain models with relevant content and the desired properties, modelers use a formal model derivation and analysis process (Bubenko 1992), which can often be referred to as a method (see Sect. 3.2). The following aspects should be considered when modeling, regardless of the specific method:

(a) Defining the problem and the purpose of the model: the task, and therefore the problem to be solved, must be clearly defined and should form the basis for defining the purpose of the model.
(b) Delimiting the problem: it is essential to define what is part of the model or problem and what is not. When developing medium or long-term enterprise strategy, for example, detailed planning may potentially be left out.
(c) Identifying important model objects: for example, when modeling an overall structure of an organization the model should only record important objects, such as departments, roles, and locations, and how they interrelate.
(d) Acceptability and users: a model should be tailored to the model users as well as to the problem and purpose. Issues may arise if, for example, the modeler does not know the necessary relationships and designs models that are not accepted by the model users.

3.1.3 Modeling Language

> *The outcome of the modeling process is documented using modeling languages, which can be classified as textual and visual languages. In Enterprise Modeling, visual languages with diagrammatic representations are common.*

In Computer Science and business information systems, the product of the modeling process—i.e., the developed models—are documented using modeling languages. A distinction can be made between textual and visual (or graphic) modeling languages based on the representation format that they use. Like programming languages, textual modeling languages are defined by a grammar. By contrast, visual modeling languages normally use diagrams to represent the model. In these diagrams, geometric shapes (rectangles, circles, ellipses, etc.) connected by lines and arrows are used as graphic symbols. Often, details of how these symbols and connections should be labeled are also specified. Most Enterprise Modeling languages are visual languages. The language for the 4EM method presented in Chapter 8 is a concrete example of this. Visual languages are also used in information technology for other purposes, such as in information modeling using entity relationship diagrams or in software development with UML as the modeling language.

In a modeling language, the underlying abstract syntax defines how the symbols can be used and interconnected. In addition to syntax, modeling languages also have semantics, although a distinction must be made between formal and informal modeling languages. Formal modeling languages have precisely defined semantics, known as operational semantics. In informal modeling languages, however, the semantics is only colloquially defined or indirectly provided through an established practical application. The advantage to formal modeling languages is that syntactic and semantic errors can be detected with tool-based checking algorithms, or even prevented during modeling. This allows these models to be transformed into other modeling languages more easily and often without a loss of semantics, which would for example allow enterprise models to be used in the software development process.

3.2 What Is a Method?

> *A method describes the approach to Enterprise Modeling by formulating a set of underlying principles as well as detailed and systematic work procedures.*

Methods are used to concretely define the modeling approach. However, the term "method" does not have a standard definition in business information systems literature and textbooks. A method, in the most general sense, is used to describe problem solution approaches. These approaches give rise to detailed and systematic procedures that describe how and according to what principles a specified goal can be achieved.

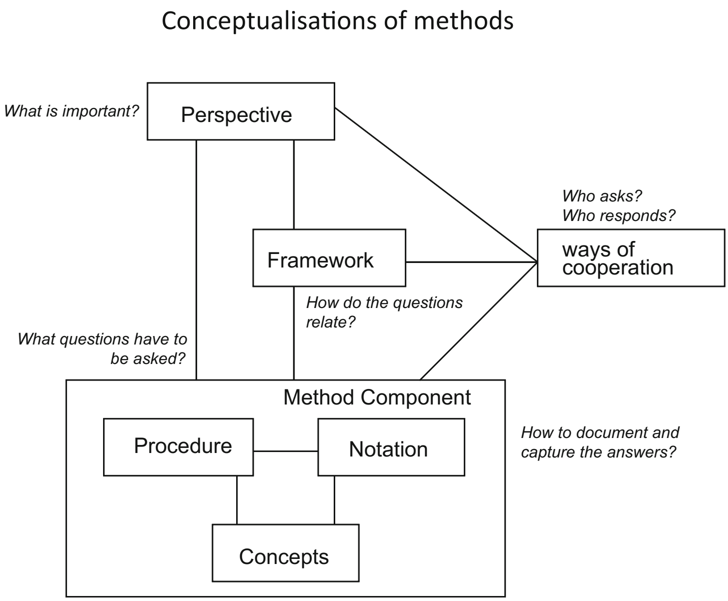

Fig. 3.1 Method components according to Goldkuhl et al. (1998)

The term "method" can be refined for the purposes of Enterprise Modeling. This book will do so, based on the work of Goldkuhl et al. (1998). In their definition, Goldkuhl et al. state that a method provides instructions for working, i.e., a method provides a guideline with steps that must be executed in order to achieve predetermined goals in various situations. A comprehensive method description should describe the perspective, framework, cooperation principles, and all method components. Figure 3.1 illustrates how these method components are related, and all parts are explained briefly below.

Method components: concrete instructions for the modeler can be found in the method components, of which a method must contain at least one. A method component should consist of concepts, a procedure, and a notation. The concepts specify what aspects of reality are regarded as relevant in the modeling process, i.e., what is important and what the modeler must look out for in order to capture it in a model. These relevant concepts should be named in the method component and explained if necessary. In a method component for process modeling, for example, processes, external processes, and information sets will be relevant. These concepts and their differences should be explained in the method component. The procedure describes in concrete terms how to identify the relevant concepts in a method component and represent these in a model. It may also cover prerequisites and resources. The notation specifies how the result of the procedure should be documented. As a rule, this must provide appropriate expressions for each concept and for the potential relationships between them. In graphic notations, these are the symbols to be used.

Framework: the method framework describes the relationships between the individual method components, i.e., which components are to be used and under what conditions, as well as how and with which subsequent component or components the results are to be used. In a lot of methods, the sequence of the method components is always the same, which is why the framework is not described separately, but implicitly provided by the description of the method components.

Forms of cooperation: many modeling tasks require a range of specialist skills or cooperation between different roles. These necessary skills and roles must be described, along with the division of responsibilities between the roles and the form of cooperation. The cooperation form also includes who will take responsibility for each task or method component, and how the collaboration will be organized. Two main role categories can often be distinguished: method experts and stakeholders knowledgeable in the facts to be modeled.

Perspective: every method describes the procedure for the modeling process from a particular perspective, which influences what is considered important when representing reality in a model. One Enterprise Modeling method, for example, might make the perspective of business goals and intensions its focus, while another Enterprise Modeling method works from the perspective of processes and structures. Many existing methods do not explicitly describe what perspective is used, but it is implicitly clear from the framework or method components. If the perspective is explicitly described, it contains the values, principles, and categories underlying the method and in essence delimiting what aspects of the problem domain should be modeled. This means that a perspective forms the conceptual and value basis of the method.

3.3 What Is Enterprise Modeling?

The start of this Sect. 3.3.1 briefly introduces various definitions of the term to raise awareness of different views on Enterprise Modeling found in the literature on the subject. Afterwards, the fundamental types of representation that can be used for the models produced by Enterprise Modeling (Sect. 3.3.2) and the elements that make up an enterprise model (Sect. 3.3.3) are described.

3.3.1 Definitions of the Term "Enterprise Modeling"

A variety of definitions regarding the discipline of Enterprise Modeling can be found in the literature. The lack of a standard, generally accepted definition is due to differing viewpoints as to how formal enterprise models should be and for what purposes they can be used. This can be illustrated by two examples from knowledge representation in computer science and industrial organization.

The following definition, proposed by Vernadat in 2002, has its roots in industrial organization and the field of enterprise engineering:

> "Enterprise modeling is the art of externalizing knowledge which adds value to the enterprise or needs to be shared. It consists of making models of the structure, behavior and organization of the enterprise." (Vernadat 2002)

Vernadat advocates an industrial approach, in that he regards an enterprise as being similar to a product and thus divides it into modules and components, just as more complex products are handled. The models that are produced in Enterprise Modeling display the externalized knowledge structure of an enterprise, but are usually only a snapshot and are therefore only valid for a short time. The participants in an Enterprise Modeling activity should be able to use these models to plan the enterprise's future situation or to allow new processes or structures to be designed, e.g., using sub-models for this purpose. They are essentially intended for use by the managers and employees in the enterprise. In other words, processing or execution by computer is not a priority.

In contrast to Fox and Gruninger (1998) advocate a different view of what Enterprise Modeling is:

> "An enterprise model is a computational representation of the structure, activities, processes, information, resources, people, behavior, goals and constraints of a business, government, or other enterprise. It can be both descriptive and definitional—spanning what is and what should be. The role of an enterprise model is to achieve model-driven enterprise design, analysis and operation." (Fox and Gruninger 1998)

In this approach to creating enterprise models, complete formal definitions of the information contained in each perspective are produced in the form of rule sets. These are very well suited to computer-based enterprise model representation. The major benefit to this approach is that the enterprise model is formally described with a focus on executability and completeness, and thus allows already modeled components to be reused. For this reason, such enterprise models are used more in the context of knowledge representation and artificial intelligence, as the high degree of formalization is not entirely suitable for communication with executives or other decision makers.

The understanding of Enterprise Modeling in this book is based on the definition given in (Bubenko et al. 2001) as follows:

> Enterprise Modeling (EM) is the process of creating an integrated enterprise model which captures the aspects of the enterprise required for the modeling purpose at hand. An enterprise in this context can be a private company, government department, academic institution, other kind of organization, or part thereof. An enterprise model consists of a number of related sub-models, each focusing on a particular aspect of the enterprise, e.g., processes, business rules, concepts/information, vision/goals, and actors. An enterprise model describes the current or future state of an enterprise and contains the commonly shared enterprise knowledge of the stakeholders involved in the modeling process.

The emphasis in this book is on enterprise models to help managers and other stakeholders in the enterprise to further develop the enterprise and/or solve existing problems. Formalization in the sense of using a modeling language to represent the model is a part of the 4EM approach, but executability or the ability to transform models into other notations is not the primary concern.

3.3.2 Enterprise Model Representations

Enterprise models can generally be presented in a variety of ways. Allweyer (2010) proposed a classification of these, which is explained in this section. This classification distinguishes four types of description technique for models, according to (Allweyer 2010):

(a) Textual description
(b) Tabular representation
(c) Graphic representation without the use of a specific notation
(d) Graphic models with of a defined notation

Structured text descriptions using natural language are the simplest means of documentation, and also highly flexible as there are no restrictions as to what terminology and formulations may be used. However, complex facts quickly become confusing with this approach, and the individuality of description shows the greatest variation between authors. Furthermore, neither automated processing nor analysis of the descriptions is possible. Figure 3.2 shows an example in which only a structure divided into goals, business processes, and stakeholders is predefined. In practice, this type of textual representation is used in Enterprise Modeling:

- To create a very rough overview of the most important processes and structures in the enterprise before starting the actual modeling process, such as when defining the limits of the modeling project, or
- When enterprise models have reached a level of detail where further refinement using semiformal or formal modeling languages is no longer practical, and the tasks, duties, or functions can be better described in a textual format.

Tabular representations, the second form of structured description, are also easy to create and understand. Furthermore, this representation provides basic options for comparing and analyzing tables. When tabular representations are highly formalized and use particular predetermined terms, for example, it is possible for the information they contain to be processed automatically. However, there also are

Goals:
The managenent has defined the overall goal of reaching an increase in revenues of 15% during this year. Furthermore, reduction of costs of operations by 10% is considered another important goal for the enterprise. Several proposals were considered to reach this objective. One option would be to invest in more efficient production machinery, but the required investments are financially not affordable for the enterprise. Thus another option was selected: to avoid or reduce costs of repairs by improved maintenance. […]
Business Processes:
Two sales persons are working in the shop. Their main task is to take care of the customers and support them by giving advice in selecting the right products. After selecting a product, the customer has the option to choose the standard version of the product or to add engravings. In case the standard product is selected, the payment process is initiated; the products are taken from the shop-internal stock and handed over to the customer. […]
Organization Structure:
The enterprise has four departments: marketing, shop, IT and production. Each of these departments has two employees with dedicated tasks. Example: In the shop are two employees who take care of the sales process. […]

Fig. 3.2 Example for the textual description of an enterprise model part

problems with using tabular representations to describe complex facts, as in the case of multi-nested structures or iterations on different levels. Tables can be created with office tools, and are generally clearer than purely textual description formats. Table 3.1 shows an example of a tabular representation. Similarly to textual descriptions, tabular representations can be used in the early phases of modeling to create initial overviews or to supplement detailed refinements.

The third option is graphic representation without the use of a formal notation. Here, models are represented using graphic elements, and how they are arranged or connected is meant to convey certain semantic meaning. These descriptions are easy to create and are a good documentation method for creative modeling workshops in particular. The high level of clarity can be further improved with the help of graphics applications such as mind map programs, but the inconsistent representation and the depiction of complex facts are again problematic, for example, when comparing and evaluating the descriptions. Figure 3.3 shows an example of a graphic representation without formal notation. Arrows and rectangles in this figure have no formal meaning and are used to represent both activities (e.g., “maintaining online presence”) and stakeholders (e.g., “customer”). Hence, such drawings are difficult to use in a broader audience because those that were not part of the initial modeling activity might interpret it differently. Graphic representations of this kind can be created with drawing tools, as described in Sect. 5.2.1. This way of informal documentation of models is not recommended because it leaves room for misinterpretation. In addition, stakeholders might get used to modeling without even a minimal set of rules, which might later cause problems when a more formal modeling method is used.

Table 3.1 Example of the tabular representation of an enterprise model part

Goals	
1. Increase revenue by 15 % in the current year	
2. Increase sales by innovation measures	2.1 Develop new product variants
	2.2 Shorten time to market
	2.3 Improve service offers
3. Reduce operative costs by 10 %	3.1 Reduce repair costs for machinery
	3.2 Establish long-term contract with logistics service providers
4. Optimize production	4.1 Reduce production time
. . .	
Business Processes	
1. Maintenance of website	1.1 Keep E-Shop up to date
	1.2 Insert new content
	1.3 Remove errors on website
2. Product catalog search	
3. Online orders	
. . .	
13. Produce standard product	13.1 Check quality of supplies

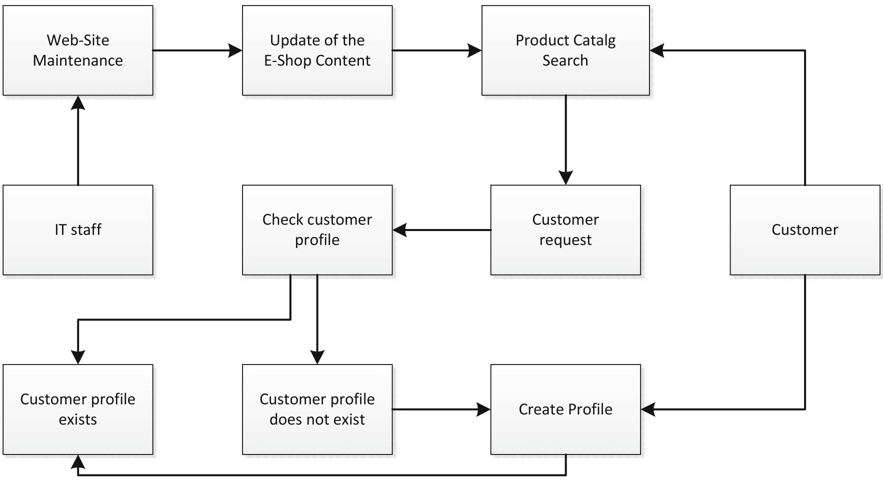

Fig. 3.3 Example of a graphical representation without use of a formal notation

The fourth representation type is graphic representation with a more formal notation. This representation format uses a predetermined language and notation to structure facts. The language may contain both graphic and textual elements. Formal definition of the language and notation has a number of advantages that particularly come into play in extensive modeling projects and when modeling complex facts:

(a) Models can be used for communication among stakeholders and developers
(b) The models can be checked to ensure that the language and notation are correct, which helps to avoid errors in the models.
(c) Computer-aided comparison of different models is possible, e.g., between models of the current situation and the target situation, or between different enterprises or divisions.
(d) The information contained in the model can be reused, for instance, in computer-based information systems and to develop software solutions.
(e) Depending on the model purpose as well as the language and notation, it is also possible to simulate the sequences recorded in the model or to manage workflows.

Furthermore, avoiding the use of natural language helps minimizing ambiguity, which in turn reduces misunderstandings caused by varying perceptions and conceptual and cultural differences, which often occur when people communicate.

Figure 3.4 shows an example of a graphic representation with formal notation. In this case, the notation corresponds to the 4EM method presented in this book. In principle, simple drawing tools (Sect. 5.2.1) can be used to create descriptions of this type; however, it is more beneficial to use modeling environments (Sect. 5.2.2) that provide support specifically for the language and notation used. The best way of uniformly representing and evaluating more complex facts is using graphic representations with formal notation. A disadvantage to this is that everyone involved in the modeling process must be taught the selected language and how to interpret it. From an EM perspective, we recommend simple and easy to learn notations. As we will discuss this in Chap. 9, during a modeling session it is the responsibility of the modeling facilitator to make sure the notation of the method is followed. This reduces the need to train the modeling participants in modeling before the workshop and they can learn from their hands-on experience.

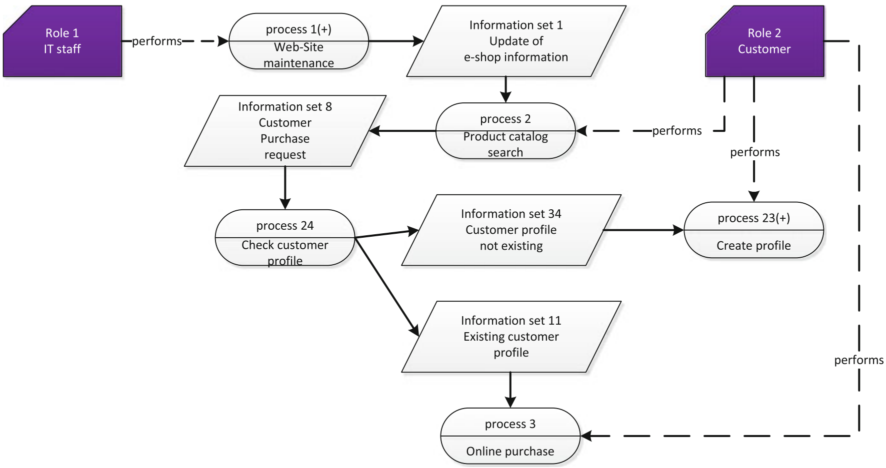

Fig. 3.4 Example of a graphical representation using a more formal notation

3.3.3 Components of Enterprise Models

The terms "model" and "modeling language" have already been covered in Sect. 3.1. To describe a visual modeling language in the context of an Enterprise Modeling method, as is the case in Chap. 8 of this book, terms for the parts that make up such visual models must also be introduced. A visual model consists of symbols, mostly in the form of geometric shapes such as rectangles and ellipses, and the lines connecting them, such as arrows. The symbols are referred to as model components (or components, for short), and the connections as relationships. Together, model components and relationships are known as model elements.

These are distinguished by model component or relationship type, depending on the types provided in the modeling language that is used. Every model component thus has a specific type—the model component type (or component type, for short)—and every relationship has a specific relationship type. Together, model component types and relationship types are referred to as elements of the modeling language. The component types that can be connected with which relationship type must be defined. In modeling languages, this is done with rules and integrity or consistency conditions.

The terms "model component," "component type," "relationship," and "relationship type" mentioned earlier will be described in more detail below.

Model Component Type (Component Type)

- A (model) component type identifies a set of model components of the same type or sort.
- In visual modeling languages, a component type is represented in a predefined way, often by a specific graphical symbol. The symbol is commonly a geometric shape in a certain color and, if applicable, with a specific line type.
- Each component type has a predefined set of attributes to record information about the model components belonging to the component type. In the simplest case, there is only one attribute: the name of the respective model component.
- The component types that may be used are defined in the modeling language.

Examples of component types commonly used in Enterprise Modeling are goal, process, role, organizational unit, resource, and IT system.

Model Component

- In an enterprise model, each model component represents an element of the reality in the modeled enterprise.
- Each model component has a specific type, and uses the representation and attributes defined by the component type.

Examples of model components might be "collect customer data" for the component type "process," or "purchasing department" for the component type "organizational unit."

Relationship Type

- A relationship type identifies a set of relationships or connections of the same type.
- The component type(s) from and to which the relationships may lead is defined for every relationship type.
- In visual modeling languages, a relationship type is represented by a predefined graphic element. This element is commonly a line of a particular type (solid, dashed, dotted, etc.) in a certain color and, if applicable, with predefined line caps.
- Each relationship type may have a predefined set of attributes to record information about the relationships belonging to the relationship type. The individual relationships in a model generally take the name of the relationship type. Unlike model components, they are not given an individual name.
- The relationship types that may be used are defined in the modeling language.

Examples of relationship types frequently used in Enterprise Modeling are "responsible_for" as the relationship between a role and process, or "supports" as the relationship between two business goals.

Relationship

- In an enterprise model, each relationship represents a connection between two elements of the modeled enterprise's reality, which are represented as model components.
- Each relationship has a specific type and uses the representation and attributes defined by the relationship type.

An example of a relationship might be that the model components "purchasing department" and "collect customer data" are linked by the relationship "responsible_for," i.e., the purchasing department is responsible for collecting customer data.

3.3.3.1 Views and Levels

Enterprise models for extensive modeling projects or complex processes may consist of a large number of model elements, making them unclear or difficult to display. To allow the complexity of the representation to be reduced, many modeling languages support views and levels.

Views do not change the actual enterprise model, but rather define what parts of the model are displayed at particular time. A view contains only those model elements that have been specified for inclusion in the view definition. The component types and relationship types that the view should contain generally define a view. If for example the "process view" for an enterprise model contains only the model's processes and their relationships, the roles responsible for them, and the IT systems used, then the component types "process," "role," and "IT system" and the

Table 3.2 View concepts of different modeling approaches

Modeling approach	Views	Recommended literature
ARIS	Organization, function, data, control, service view	Scheer and Nüttgens (2000)
According to Weske	Function, information, organization, IT	Weske (2012)
PICTURE	Organization, business object, process, resource	Becker et al. (2007)
4EM	Goal/problem, business process, business rules, actors and resources, technical components, concept	Sect. 8.2

relationship types allocated to "process" are a part of this view, but other model component types or relationship types are not.

The specific views available are predetermined in most modeling languages or methods. The Table 3.2 shows a few examples and that the number of defined views can vary significantly, and that although certain views are common, the naming for these views can differ, e.g., the process, workflow, or business process view (see Table 3.2).

Working with views is to large extent determined by functionality of the modeling tool. For example, some tools support user-defined views based on queries, such as show all processes that the purchasing department is responsible for.

Levels are used to allow model components to be refined. This means that if the parts or decomposition structure of a model component need to be refined for modeling purposes, the model component can be refined elsewhere in the enterprise model, on the subjacent refinement level. The existence of a refinement is generally recognizable from the representation of the model component in the upper level, such as the symbol labeling. The model component and refinement are clearly associated with each other, for example, by an identifier. All relationships to the model component in the upper level must also exist in the refinement level and be clearly related to the model components in the refinement level. Refinements of model components are often presented as sub-models.

3.3.3.2 Stakeholders and Modeling Activities

An Enterprise Modeling project usually consists of numerous steps including modeling activities. By modeling activities we mean all activities involved in constructing or developing models, such as moderated modeling sessions, workshops, creating models based on data by analysis activities (interviews, document analysis, etc.). There are many different actors involved in the modeling process. All those that have direct or indirect interest in modeling or the results are regarded as stakeholders. Stakeholders also are those that have no decision-making role in the course of a modeling activity or who do not have relevant information, but may still contribute to the project result, for example, with experience in similar projects. Stakeholders can be divided into two main groups: internal and external stakeholders. External stakeholders include customers, partners, subcontractors, legislators, and shareholders of the enterprise. The employees, project team, the departments concerned, managers, and executives are part of the internal stakeholder group.

Stakeholder relation to a project or its outcome is not always overt. There can also be so-called indirect or hidden stakeholders. They may, for instance, be members of the management hierarchy with some interest in the project outcome and who could be positively or negatively affected by it. The critical factor for the success of Enterprise Modeling and the resulting change initiatives is to involve all relevant stakeholders in the project. Identifying relevant stakeholder groups is a key activity during the preparatory stages of modeling discussed in more detail in Chap. 9.

3.3.4 Enterprise Modeling Method

The term modeling method and modeling language is sometimes in practice used as synonyms, which can be confusing. Furthermore, the modeling language itself is not enough to achieve the goals of Enterprise Modeling. The user of a modeling language needs guidance for *how* to use the modeling language in a practical context.

In this book the term Enterprise Modeling method has a specific meaning in that it has two components (Fig. 3.5):

1. The Enterprise Modeling language, with a defined syntax, semantics, and notation, i.e., the building blocks of an enterprise model. The language of the 4EM method is described in Chap. 8.
2. The Enterprise Modeling process, with a set of recommended elicitation approaches (Chap. 4), a set of tools (Chap. 5), and a project approach (Chap. 9).

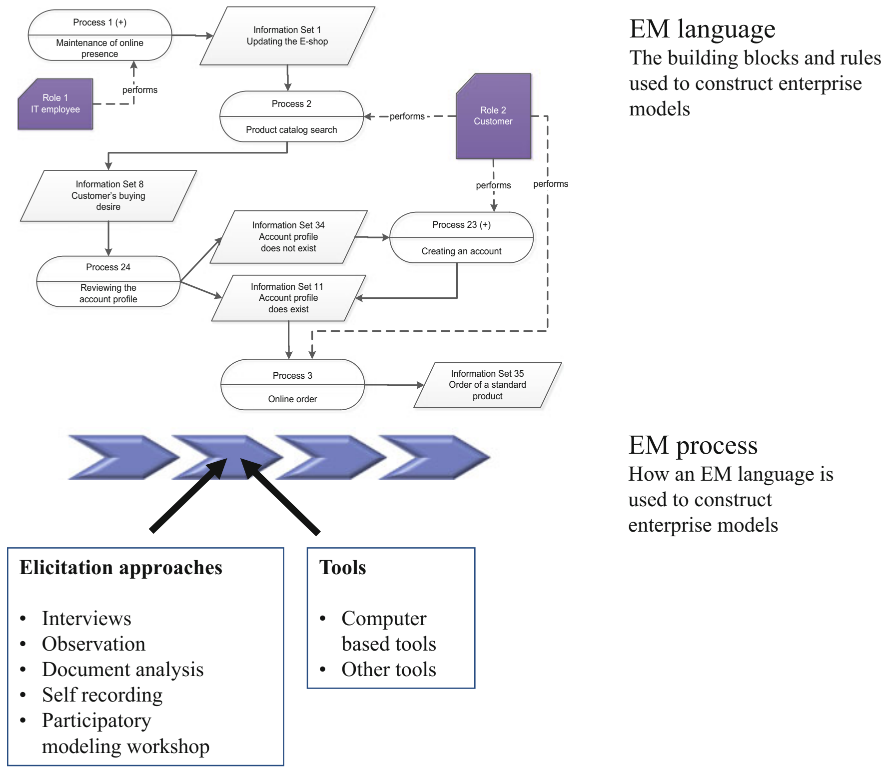

Fig. 3.5 Components of an Enterprise Modeling method

Chapter 4
Elicitation Approaches in Enterprise Modeling

One of the key tasks in Enterprise Modeling is to analyze the current situation and existing challenges in the enterprise with the active participation of domain experts and decision makers. In this respect, elicitation approaches such as interviews, observations, participatory modeling workshops, or document analysis are fundamental instruments.

Starting with an overview of the most important elicitation approaches in Enterprise Modeling (Sect. 4.1) and some advice on preparing for elicitation (Sect. 4.2), the chapter introduces selected elicitation approaches (Sect. 4.3) and in particular participatory modeling workshops, which is the main recommended approach in most cases, particularly in the 4EM method (Chap. 8), although it should be complemented with preparatory interviews. The chapter introduces the basic principles of these approaches and provides resources such as guidelines and checklists for practical use.

4.1 Overview of Elicitation Approaches

Enterprise models represent the situation within the enterprise in question, both in terms of the current state and the future state of affairs. This is only possible if the modeler is able to correctly and fully obtain/elicit relevant knowledge from within the enterprise. Elicitation approaches are essential for this purpose.

One of the key tasks in Enterprise Modeling is to identify and gather knowledge relevant to the purpose of EM from within the enterprise. To obtain the most accurate view of the situation, current or future, a variety of elicitation approaches can be used.

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_4

One important aspect to be considered in the context of knowledge elicitation is whether or not the models created through EM capture the one and only truth about the problem at hand. We claim that they do not. They can only capture the version of the truth that is the negotiated view of the individual stakeholders involved.

Why is this important to keep in mind? Because this will, among other things, prevent the modeling expert or modeling practitioner from framing the problem too narrowly or from stopping analysis too soon. Moreover, it helps her/him to realize that more than one person needs to represent a certain stakeholder perspective in the analysis since there can be different opinions about the current and future situation among individuals in a stakeholder group.

Elicitation approaches make it possible to obtain knowledge from different stakeholders about the aspects and parts of an enterprise's situation important for the given modeling purposes. Enterprise employees from various stakeholder groups are often the most important sources of knowledge. The term "stakeholders" generally encapsulates all groups of individuals, both internal and external to the organization, who are involved in its current activities or who affect or will be directly or indirectly affected by future changes. The approaches covered in this chapter are interviews, observations, document analysis, work diary, and participatory modeling workshops.

Table 4.1 summarizes, for the most important elicitation approaches, the appropriate situations in Enterprise Modeling where they can be used. It also shows where in this book each approach is covered.

Table 4.1 Overview of elicitation approaches in Enterprise Modeling

Elicitation approach	Discussed in section	Appropriate situation in enterprise modeling
Interview	4.3.1	The most important approach when preparing for a participatory modeling workshop Used as an alternative to participatory modeling workshops when the organizational culture or situation does not allow for open discussions in a group setting
Observation	4.3.2	When more detailed analysis of physically observable current situation is needed and participatory modeling workshops and/or interviews reveal no clear or complete view or result in contradictory information
Document analysis	4.3.3	Preparation of the EM project or as a first step in modeling in order to create a model skeleton
Work diary	4.3.4	Capturing more precise information about durations of tasks, volumes or amount of resources, or other quantitative information; often used as complement to other elicitation approaches
Participatory modeling workshop	4.3.5	Facilitated modeling with a group of stakeholders of current and future situation, if participation is crucial for quality, implementability, and acceptance of models Particularly useful • When an agreement and a joint view of all stakeholders is important • If problems and solutions can only be completely covered and understood if all stakeholders participate in the discussion or development

4.2 Preparing for Elicitation Activities

Before starting elicitation activities, the purpose of the activities should be defined, the necessary resources secured, the affected stakeholders informed, and their participation ensured.

All forms of elicitation activities should be carefully prepared. They tie up resources and cost money. Good preparation helps to achieve the goals of this "investment" and to increase the efficiency and effectiveness of Enterprise Modeling.

Before starting any elicitation activity, its purpose and scope should be precisely defined and agreed between those performing the analysis and those in the organization who commissioned it. The aspects and concepts that are important must be derived from the purpose of the activity.

The scope makes it possible to delimit which parts of the enterprise should be included and which should not. The purpose and scope together form the basis for planning the activities to be carried out, determining the specialists and employees to be involved, and estimating the cost.

In addition, it is important to ensure that the knowledge elicitation activities are approved and supported by enterprise managers—not only the executives that commissioned the overall project, but also the managers of the subordinate organizational units in which enterprise knowledge will be gathered. It is important to ensure that the employees or specialists concerned are allowed time to participate in interviews or workshops, that the necessary information or documents are made available, and that access to the appropriate organizational units and employees is secured for observations.

In addition to managers, the employees involved in or are affected by the knowledge elicitation should be involved at an early stage. Comprehensive information about planned activities should be provided to ensure that attitudes towards them are as supportive as possible, and to avoid, if at all possible, hostile attitudes. The significance of the overall project to the enterprise, the purpose of the activities, the intended schedule, which activities are planned and who will be involved or affected by them, how and in what context the collected information is to be used—all of this should be announced before the start of the activities. The key objective here is to ensure that the stakeholders and persons affected have an open attitude towards the activities to be carried out, because this will positively impact the quality and relevance of the knowledge gathered.

The following checklist summarizes the most important points in preparing for knowledge elicitation activities. More detail about preparing for participatory modeling workshops is provided in Chap. 9.

1. Define (as precisely as possible) and agree on the purpose and scope of the investigation between those performing it and those who commissioned it.
2. Obtain approval and support from the relevant managers in the enterprise.
   - Involve all affected organizational units and don't forget to involve external stakeholders if needed.
   - Agree sufficient time and resources.
   - Obtain access to existing relevant documentation.
3. Involve those affected within the enterprise at an early stage
   - Provide information about the purpose of the activities.
   - Announce the schedule and which activities are planned.
   - Communicate who will be involved or affected and why.
   - Provide information regarding how and in what context the collected information will be used.

4.3 Selected Elicitation Approaches in More Detail

An overview of the most important knowledge elicitation approaches has already been provided in Sect. 4.1. This section supplements the overview by describing selected approaches in more detail.

4.3.1 Interviews

> *Interviews are used to systematically gather information for a defined investigative purpose. Individuals or a group of individuals are asked a series of purposeful questions so that the answers can be documented and evaluated.*

In Enterprise Modeling, interviews are among the most commonly used approaches to gathering knowledge about the enterprise, for example, particular procedures, organizational structures, products, and resources. The various interview formats are summarized in Table 4.2 and explained in the rest of this section. The following elicitation approaches are discussed: face-to-face interviews, telephone interviews, group interviews, written surveys, and computer-based survey processes.

In face-to-face and telephone interviews, the interviewer can provide assistance by clarifying questions and answer options. Interviews are relatively quick to conduct, even though they require some preparation, and the interviewer can decide during the interview whether and when to follow-up a point in more detail. This is

Table 4.2 Interview types, according to (Frankfort-Nachmias and Nachmias 2007)

	Interview format			
Medium	Written surveys on paper	Written: computer, e-mail, Internet	Oral; face-to-face	Face-to-face, phone
Definition of questions	Structured interview	Semi-structured interview		Open interview
Definition of answers	Predefined answers (multiple choice)		Free-form answers	
Participants	Single participant		Group	

an advantage over written surveys as it allows a closer examination of individual answers to obtain a more comprehensive view of the interviewee's previous response. An interview that is conducted with the support of an interview guide is called a semi-structured interview. The characteristic feature of semi-structured interviews is that the interview is based on a guide containing open questions that the interviewee can answer freely. The guide merely helps the interviewer not to overlook significant aspects. Structured interviews have a defined set of questions, which the interviewer is supposed to follow rigorously. The advantage of a structured interview is that it provides comparable data. Comparability is achieved by the ability to record information directly during the conversation, which ensures that it is not distorted and can be understood by parties who were not involved in the interview.

A group interview is a particular form of interview where several participants are asked about a subject. It often takes place in the form of a conversation and is led by an interviewer or moderator. Group interviews make it possible to gather individual opinions, which are expressed more spontaneously and with less control through discussion with the other participants. This allows contrary viewpoints to be identified, which may then need to be examined or investigated in individual interviews.

With written and computer-based surveys, addressees fill out a questionnaire which may be accompanied by explanations and contain instructions on the order of completion. It should be kept in mind, however, that there is no guarantee that the addressee will fill out the questionnaire by themselves or alone, or that they will follow the instructions and order of the questionnaire. In principle, questionnaires of this kind may contain multiple-choice questions with preset answer options as well as open-ended questions. However, multiple-choice questions are uncommon when written surveys are used to investigate the current situation in the enterprise. Graphics and diagrams can also be incorporated in addition to the questions in order to better articulate the problem. One benefit to a written questionnaire is that the interviewee has more time to answer, which can have a very positive effect on the quality of the answers. They also allow a large number of individuals to be reached, as the surveys can be distributed through a wide variety of channels such as via Internet portals, by post.

Selecting the interview as the main approach to elicit knowledge to be incorporated in enterprise models may seem to be the easiest choice at first. However, there are good arguments that the main approach should be participatory modeling workshops, complemented by preparatory interviews. This point of view is further discussed in Sect. 4.3.5.

4.3.2 Observations

Observation is used to systematically record and document the behavior of individuals or small groups and the procedures in organizational units in the normal operational context.

Observation makes it possible to collect data and analyze procedures that may be otherwise difficult or impossible to identify. This might concern unconscious, incidental, or routine behavior that is difficult to investigate through other approaches. An important aspect of observation is that the procedures and behavior of interest are studied in the normal operational context, i.e., during normal working hours on an ordinary day at the enterprise. Frankfort-Nachmias and Nachmias (2007) have set out the following points that must apply to every observation:

- The observation must serve a clear purpose (in this case, analysis of an enterprise).
- The start, course, and end must be planned, i.e., not left to chance.
- The results of the observation must be systematically recorded according to predetermined criteria.

Observation can be utilized in a variety of forms. A distinction is made between participatory and nonparticipatory observation on the one hand, and between structured and unstructured observation in terms of the recording method on the other.

Nonparticipatory observations make use of observers who record and document employees' activities with their knowledge and consent, but do not take part in these activities themselves. In concrete terms, an observer could observe the activities of an entire organizational unit or an operational function, such as the work in a warehouse or the incoming goods department. The observer finds a place from which she/he can see and hear everything, but without disturbing the work. Another version would be to observe a single person in the enterprise as he/she carries out their operational tasks. Here, the observer would shadow the person under observation for a particular period of time in order to record their range of tasks and activities. This could for instance be used to document important practices that the observed individual carries out unconsciously. However, the act of observation generally produces the effect that the behavior to be observed is altered by the mere presence of the observer. “If people are aware that they are being observed, they automatically regulate their behavior” (Nerdinger 2008). This fact must be taken into account when evaluating the results of an observation, but is not generally an argument against the use of observation to supplement interviews, for example.

With participatory observation, the observer not only observes what is happening but also asks questions about it. This approach makes it possible to capture some of the tacit knowledge and to collect explanations, for example, about why certain things happen in a certain order or a certain manner.

Observation can also take place in a structured or unstructured form. Structured observation is carried out following precise rules with respect to what is recorded about the subject under observation, as well as when, where, and how. For example, if carrying out structured nonparticipatory observation, details of who is observed, for which period of time and during which activities, and how the information is recorded will be predetermined. Unstructured observation is unsuitable for Enterprise Modeling because this type of observation is used to formulate hypotheses, which are then verified in a hypothesis-testing process. This is not the purpose of Enterprise Modeling. It is to describe an enterprise, in its current or future state, in a model.

4.3.3 Document Analysis

In document analysis, electronic or printed information is viewed and analyzed to obtain relevant findings for the purpose of modeling.

Document analysis often provides a valuable contribution to Enterprise Modeling as it offers the opportunity to gain a relatively quick insight into the structures, tasks, processes, and communicative relationships in the investigated enterprise. Available documents that may be potentially relevant to the purpose of modeling are analyzed, and relevant enterprise knowledge extracted from them. These documents could include organizational handbooks, standard operation procedures, quality manuals, legislation, organizational charts, service regulations, job descriptions, or flowcharts.

Document analysis is generally a good starting point for an Enterprise Modeling project, but it can also provide important reference points for preparing, supplementing, or developing further investigations during the course of an ongoing modeling project. At the start of the project, potentially relevant documents should be requested from the enterprise by the modeling team. The documents provided are then evaluated, checked for contradictions, and filed for later use in the modeling process. Important findings should be documented separately.

Ambiguities, outstanding questions, and contradictions are either resolved with the client in advance or studied during further analysis and information gathering activities.

During document analysis, it is important to be aware that the information represented therein may not be up to date, and must therefore be checked by performing at least random checks with other knowledge elicitation approaches.

An example of document analysis with a slightly odd modeling purpose can be found in a project reported by Persson (1997). Textual requirements specifications were analyzed and the enterprise knowledge contained therein presented in the form of process models, actor models, goal models, concept models, and requirements models. This was done in order to identify missing or contradictory information in the requirements specification. The models revealed numerous unclear aspects of the requirements specification. This indicates that Enterprise Modeling also can contribute to reviewing of requirements specifications.

4.3.4 Self-Recording

> *Self-recording is a knowledge elicitation approach where individuals enter information in preprepared forms during a specified period of time.*

Self-recording can be used to collect information about tasks, activities, time, and volumes. The involved stakeholders note the requested information themselves. Self-recording can be free-form, i.e., the stakeholders describe their field of work in their own words, without a predetermined structure. It can also be structured, where both the facts to be recorded and a form on which to do so are specified. As the information gathered from free-form self-recording takes considerable effort to evaluate, structured self-recording prevails in practice. This requires more preparatory work, but the prestructured information is easier to evaluate, and the information collected is also, in general, more complete.

To ensure that all participants collect the necessary information systematically and with comparable content, forms should be prepared and distributed to all the stakeholders involved, along with appropriate instructions for completion. For example, selected stakeholders who perform a particular role in the process at hand but who work at different departments or related organizations may record all the activities they perform by noting these down at the end of a task/time period along with details of the time and order. This would allow different sites or departments to be compared with the aim of standardization.

Because the information is recorded without any monitoring by an observer, it is necessary to check its plausibility. In addition to tasks, working hours, and volumes, communicative relationships can also be determined. For self-recording, the logging period should be clearly defined, and the method by which the collected information will be evaluated should also be taken into account when creating the forms.

4.3.5 The Participatory Modeling Workshop

In participatory modeling, a group of stakeholders of the problem at hand and modeling experts create enterprise models together. Each workshop has a specific goal and is facilitated by the modeling experts.

The elicitation approaches presented in the preceding sections aim above all to collect information that contributes to an understanding of the current situation in the enterprise or of the future aims. This information is then used to create enterprise models, but these are not actually developed during information gathering.

The participatory modeling workshop, on the other hand, is a knowledge elicitation approach where the elicited information is immediately discussed and incorporated into an enterprise model (or discarded, if not relevant).

A modeling workshop can consist of one or more modeling sessions of 1–3 h, each of which with its own specific goal, outline, and process. For instance, one session could focus on modeling the challenges of the enterprise related to a certain problem and the next on modeling the goals for the future state while a third session could model activities to achieve the goals.

Particular attention is paid to participatory modeling in this book since the approach has proven to be particularly beneficial as an integral part of the 4EM method, the example Enterprise Modeling method described in this book (Chaps. 7–9). More on the arguments for adopting the participatory approach to modeling is included in Chap. 7. The use of the participatory approach in the context of a modeling project is discussed in Chap. 9.

As the stakeholders concerned with a certain problem in an enterprise generally have the best knowledge of or ability to judge the current situation and potential avenues for improvements, their active involvement in modeling both the current situation and future improvements is particularly valuable.

Participatory modeling aims to make these stakeholders active participants in model development and to achieve consensus between them regarding all modeling decisions, or at least to gain acceptance of the models created. Instead of merely acting as sources of information, the participants become active creators, which should result in the participants regarding the created models as their own achievement, and not something developed by outsiders.

The participatory approach encourages participants to introduce their "own" modeling contributions, which are negotiated with the group of participants and then incorporated into an overall model that is accepted by the group. In addition to increasing the acceptance of the models among those involved, a further advantage of this approach is that models depicting design decisions about the future state of enterprise affairs are developed by the participants themselves, and can therefore be accepted and implemented more quickly.

Participatory modeling workshops involve a moderator. During the workshops, the moderator should ensure that the participants' attention remains focused on actually solving the problem at hand. Activities such as training in a particular modeling language are therefore not advisable, particularly in the early stages of modeling.

Two groups of actors can be distinguished in participatory modeling: domain experts and modeling experts:

- Domain experts have the necessary knowledge of the enterprise in question or domain and application context for the modeling purpose. These subject matter specialists know the organizational structure, business processes, responsibilities, regulations, or problems in the enterprise. This means that any member of staff, from an ordinary worker to executives and enterprise stakeholders, may be a potential domain expert.
- Modeling experts have knowledge and experience of the Enterprise Modeling method used. They know both the model creation guidelines and the problem that the model is intended to solve. They are also experts in preparing and conducting moderated modeling workshops. Often, the method experts are engaged from outside the enterprise, not internally.

The modeling experts are also tasked with planning the entire modeling project and agreeing on concrete modeling workshops or other preparatory analysis and information gathering activities with the commissioning party in the enterprise. Among other things, the modeling experts are also responsible for selecting an approach that is suited to the modeling purpose, and for ensuring that the resources provided are used in such a way that the project achieves the agreed goals within the allotted time.

In both groups, it is possible to single out several roles that can be involved in modeling workshops. In the modeling expert group, these are:

- Moderator (or facilitator): moderates the workshop and is responsible for ensuring that the selected Enterprise Modeling method is correctly implemented. A workshop may have multiple moderators who take turns during the workshop and focus on different aspects. Large projects in particular may have several moderators in the same group of modeling experts, but one of these must then be designated as the leader to clarify who is responsible for the overall success.
- Tool operator: digitalizes the model developed during the workshop and assists the facilitator with moderating. This assistance may involve active listening or putting forward supplementary questions regarding information or relationships between the modeling elements.

- Minute taker: takes additional notes during the moderated workshops, which are used afterwards to document the decisions made or record the reasons for particular agreements between the participants.

Together, the modeling expert group is tasked with ensuring the quality of the modeling process in each modeling session and the quality of the model itself (Fig. 4.1).

The domain expert group should generally include representatives from different departments and domains, completely covering the enterprise and domain knowledge required for the modeling purpose. The domain experts are responsible for ensuring that the model content is technically correct and valid for solving the actual problem.

A facilitator should meet various requirements (see also Moody and Shanks 2003):

- Method expertise: confident and unobtrusive use of the most important moderation techniques
- Flexibility: workshops not planned too rigidly
- Social sensitivity: a real instinct for when to hold back or intervene in discussions and critical situations
- A natural style: no painstakingly studied and assumed behavior

The facilitator may come from outside as an external consultant, or from within the enterprise in question. The advantage of an internal facilitator is that they will be familiar with the enterprise and the organizational unit under examination. However, an in-house facilitator is not independent of internal authority structures and objectives, which can make an unobtrusive style of workshop facilitation more difficult. By contrast, a facilitator brought in as an external consultant is impartial to enterprise goals and can bring new ideas and opinions to the enterprise from an outside perspective.

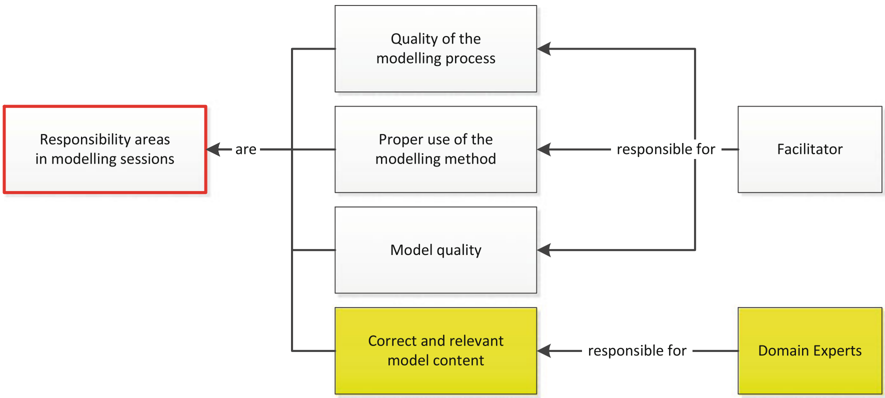

Fig. 4.1 Responsibilities in a modeling session (Persson 2008)

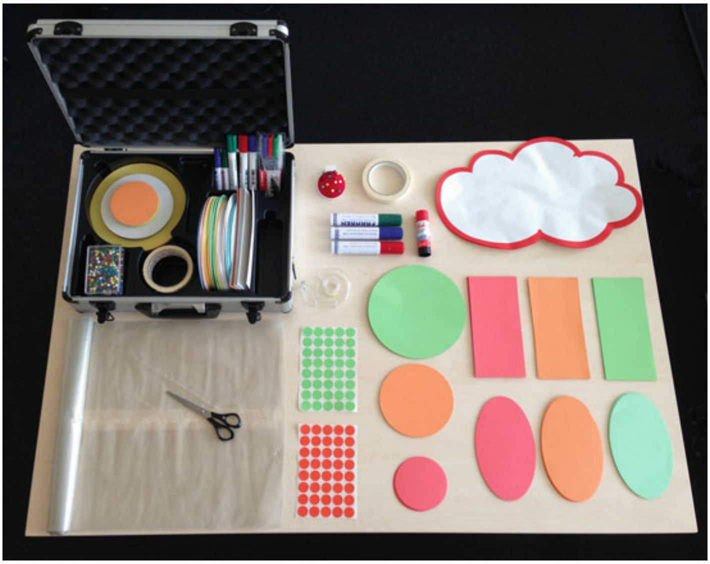

Fig. 4.2 Resources for participatory modeling workshops

The advantages of a moderated workshop (as opposed to interviewing participants individually, for example) are that information from across the entire range of necessary topics can be obtained in a single event, and agreed among the participants. There are also potential benefits even if the work does not involve clearly distinct topics, as many different perspectives can be contributed and the various participants can generally draw on different individual experiences.

Prior to a workshop, its goals and topics should be clearly defined and the necessary participants identified and invited. The facilitator must prepare the structure of the workshop and its sessions, i.e., plan the desired order of events so that this can be used as a basis for moderation. See Chap. 9 for more detail about preparing for the modeling workshop.

At the start of the workshop, the facilitator introduces the theme and objectives. During the workshop, it is useful to use a range of resources to facilitate moderation and participation (Fig. 4.2). Examples include pin boards, flipcharts, moderation paper, pens, moderation cards, pins, PC, or beamer and screens. There should be sufficient resources available to ensure there is no need for interruptions during the workshop.

The participatory modeling workshop may include the following sub-steps or tasks, which are carried out according to the structure planned in advance by the moderator:

1. Card questions

   All participants simultaneously write down on a card their answers or ideas regarding *a specific question* asked by the moderator. The cards are collected and the results are displayed on a plastic wall (see Sect. 5.1.1) in a structured manner. The moderator can evaluate the resulting content with the group, and add to it if necessary.
2. Brainstorming with cards

   The participants are given a specific number of cards by the moderator. The more cards, the more creative the participants can be. On these cards, the participants should then write down their *thoughts and issues* regarding the defined questions, using short sentences.
3. Creating clusters

   The resulting cards are discussed one at a time by the group and divided into particular subtopics or problem areas, also known as "clusters." Individual questions or problems that are mentioned more frequently in the clusters should be marked and weighted. When clustering is complete, the facilitator can decide with the group whether any additions are necessary if particular aspects or criteria have been disregarded.
4. Grouping clusters

   With the help of the group, the facilitator groups the individual clusters by assigning headings to them.
5. Ordering clusters

   A table is produced listing the individual clusters according to their weighting. This table is used to sort clusters by importance or urgency.
6. Breaking out into subgroups

   The participants are divided into subgroups, each of which deals with a cluster. The concrete tasks involved in this work depend on the goal and topic of the workshop. The results obtained are presented by each subgroup to the other subgroups.
7. Evaluation

   The working group results are presented by the group participants. Open questions and further steps are discussed and agreed with all workshop participants.

Chapter 5
Enterprise Modeling Tools

This chapter focuses on EM tools for the use in EM projects supporting basic analysis techniques (discussed in Chap. 4) and development of the different modeling perspectives and sub-models of the enterprise model (presented in Chap. 8). The tools used to support EM do not include only IT-based applications for documenting models. Traditional aids, like flip charts, the "plastic wall," and paper-based modeling, are also used during modeling workshops.

Computerized modeling tools are subject to continuous development and improvement and the objective of this chapter is not to advocate any specific tool or vendor. Instead we will discuss a number of useful core features that are offered by many modeling tools. We will introduce different tool categories including examples for each category. The last section of this chapter discusses the issues of EM tool adoption in organizations, which becomes important once an organization decides to use EM in a more institutionalized way, without relying on external experts for support.

5.1 Basic Tools

In this section we will discuss EM tools needed to support the creative process of the modeling workshop. Regardless of the purpose of modeling, the models need to be documented for further work or at least for the workshop minutes and capturing the results achieved.

There are two basic approaches to capturing models during an EM workshop:

– Using simple tools such as the "plastic wall" or paper flipcharts, or
– Using a beamer and computerized tool for modeling or drawing.

This choice depends on a number of factors and objectives of the modeling workshop, which we will discuss in the following two sections.

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5.1.1 Simple Tools and The "Plastic Wall"

The so-called "plastic wall" approach means that models are documented on large plastic sheets using colored paper cards. The "plastic wall" (for an example see Fig. 5.1) is then viewed as the official "minutes" of the modeling session. The advantages of this approach are that the plastic wall can be set up in almost any room with a sufficiently large and flat wall and that it allows the modeling participants to view the model independently of the tool operator or other external support. The participants can come closer to the model to view certain details, point at them, or engage others in a discussion. They can also improve the model without disturbing each other, if the modeling situation requires so (see Fig. 5.1). Furthermore, all actions of the modeling facilitators are visible and understandable. Compared to a computerized tool, the plastic wall often has advantages in creative modeling situations: with a computerized tool the facilitator or tool operators often need to perform "housekeeping" actions such as saving, changing font size, line size, adding more pages to the drawing, etc., which shifts people's attention and disrupts the creative flow of the workshop. However, after the modeling seminar, models on the plastic sheets should be documented with a computerized tool.

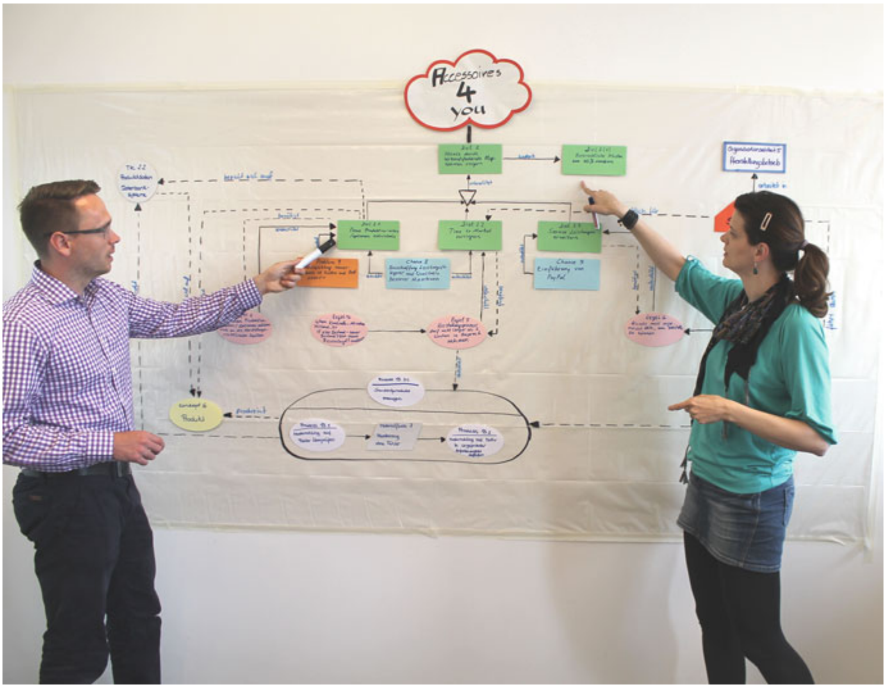

Fig. 5.1 Using the "plastic wall"—everyone is involved in modeling

The "plastic wall" approach is more suitable when

- The purpose of the workshop is to *innovate*—to create and capture new knowledge and to document it in the model form.
- The modeling workshop takes place at a location where using a beamer is impractical, e.g., due to travel plans or layout or the room.
- Many participants shall be involved and be able to contribute to the model at the same time.
- Different alternative options need to be discussed and explored in modeling.

In the context of using the "plastic wall," we would like to point out two common misconceptions:

- There are some people who see this as somewhat unserious way of working. Perhaps due to the fact that many organizations have invested large amounts in equipping their meeting rooms with several beamers, smart boards, multiple displays, and other hardware and, hence, are eager to use this equipment. In our experience, the inclusive nature of modeling with the "plastic wall" outweighs the drawback of needing to document the model in the tool afterwards. Furthermore, the advanced features of the computing equipment often serve as distractors from the problem solving and modeling tasks at hand.
- There are brainstorming and business planning approaches using large paper or plastic sheets for capturing ideas or documenting the discussion. They share some similarities with participatory EM and 4EM and as a result some participants may approach the 4EM workshop with some skepticism thinking that it is just another idea generation session. To avoid this, the facilitators should point out the main differences, e.g., the modeling notation, the specific way of working (e.g., the consensus-driven discussion, focus on concrete actions), and the role of the modeling facilitator.

5.1.2 Using a Beamer to Support the Modeling Session

The "plastic wall" wall is more suitable for capturing the initial version of a model, i.e., innovate and creative modeling activities, but once the model has grown and been discussed for some time, e.g., at the second modeling session, the changes need to be introduced in a model that is documented with a computerized tool. Between the modeling sessions there might also be the need to produce reports or presentations slides, which also requires that the model is documented electronically. Hence, once the models reach the level of completeness where mostly refinements need to be done, the modeling workshop should be supported by a beamer and computerized tool.

In this case, at the modeling seminar there should be two persons driving the process—facilitator driving the discussion and tool operator (or assistant facilitator) focusing on supporting the discussion by displaying the right part of the model at the right time and introducing changes suggested during the meeting. The effort and skill that it takes to perform these tasks efficiently should not be underestimated. It is highly recommended that the facilitator and tool operator rehearse their

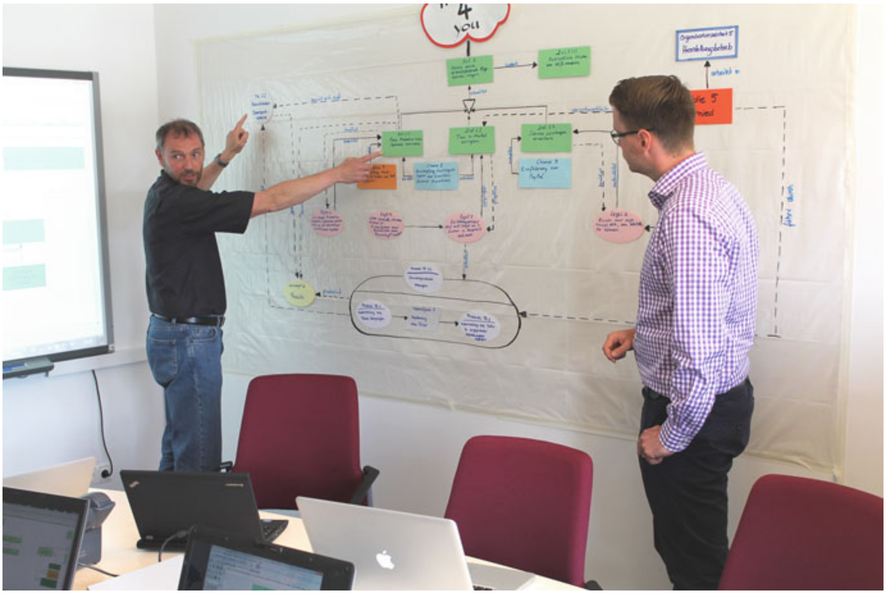

Fig. 5.2 A modeling session focusing on model refinement

presentation of the model in advance; they may also need to prepare the models for presentation purposes by adjusting text size and colors.

Figure 5.2 shows a situation of a modeling session using a beamer and a computerized modeling tool. On the right-hand side we can see a plastic wall model with the initial model that set the overall objective of the modeling engagement. A small portion of the computerized model is shown on the left-hand side. Displaying both models side by side helps clarifying the way of transforming the model on plastic into the computerized model and supports the shift to the computerized model version. In this particular case the initial model consists of less than 20 model elements, but once applied to the whole problem domain in the organization, the model exceeded 100 elements. In this case using the "plastic wall" approach for the whole problem domain would have been impractical.

In summary, using a beamer and a computerized tool is suitable when:

- The purpose of the modeling workshop is to *review* and/or *refine* existing models
- The new model is to be created by *reusing* fragments of existing models and/or integrating patterns.

5.2 IT Tools

IT tools and computerized tools provide an important support for various activities in EM, in principle aiming at covering all modeling phases. These tools can roughly be categorized into simple drawing tools and advanced tools, such as fully developed modeling environments. This section will briefly introduce both categories.

5.2.1 Simple Drawing Tools

Enterprise Modeling has historically evolved independently from tools. This can perhaps be explained by the fact that many contributors to the EM area were practitioners focusing on real application projects. Hence, they got accustomed to using whatever tools they already had. In addition, the advances in EM during the first part of the 1990s were more rapid than the advances in CASE tool and meta-tool development, particularly with respect to support for various modeling approaches and method customization. The EM projects of those days were of small to medium size with simple documentation requirements, which did not require a model repository. As a result the EM community of practitioners widely adopted simple drawing tools such as iGrafx Flowcharter™ and Microsoft Visio™.

This choice was motivated by the following requirements to EM tools:

- The need to integrate with Microsoft Office™ software, such as Word for including models in reports, and Microsoft PowerPoint™ for inclusion of models in presentations.
- The need to print out models in large formats. If only A4 format is available for printing, these types of tools allow distributing it over a number of pages that can then be glued together thus forming a large model.
- The need to export models to popular graphical formats in order to present them on the web. More advanced modern tools offer significant automation possibilities for web-based model presentation.
- The need to create new graphical symbols for certain modeling components. Simple drawing tools support this functionality, which is an easy way to provide minimal support for a modeling method.

Requirements to EM tools that have become significant as the field of EM becomes more mature are:

- Model repository support. For simple projects this is not crucial, but if an organization wants to institutionalize EM then a repository is needed.
- Model export and presentation in web-based format, for example, for presentation on the corporate intranet in order to communicate business processes among the employees.
- Model analysis and quality checking, e.g., by creating user-defined views of the model or executing queries over the content of the modeling components.
- Model maintenance over time, which in essence, can be called as keeping models “alive,” i.e., up to date and relevant for the users.
- Model reuse, e.g., by defining reusable model chunks and/or patterns.
- Model execution and integration with other applications allowing these applications to be configured by models.

Most of the above requirements are cumbersome to fulfill with tools like Microsoft Visio™ or iGrafx FlowCharter™ and if these requirements are relevant for the organization, then a more advanced modeling tool is needed.

5.2.2 Advanced Tools

The decision of whether EM is dependent on a number of factors. The use of modeling environments is recommended

- If models are intended to be maintained and/or reused for a prolonged period,
- When several people at different locations are involved in a modeling project,
- If parts of the model must be reused or integrated into other models, or
- When the correct use of modeling languages or compliance with standards must be guaranteed.

This section covers typical modeling environment functions, which can vary greatly between commercially available tools depending on their focus or target group.

Besides actually allowing models to be created and edited, the functionality of a modeling environment may also include the following functional components:

- (Multiple) modeling language support
- Modeling view and level concepts
- Model storage (in repositories if applicable)
- Modeling method support, e.g., modeling process guidance
- Tool customization and extensibility
- Model analysis and manipulation.

A brief description of these functional areas is provided below. Additional basic tool functions that are not exclusive to modeling environments, such as user and rights management, help functions, or license management, are not included in the following outline.

5.2.2.1 Modeling Language Support

The modeling language defines what (mostly graphic) elements are allowed when modeling, what relationships are permitted between these elements, and what meaning they and their attributes have. The modeling tool should then ensure that the rules and guidelines provided by the language are obeyed. Most commercially available modeling environments focus on a single modeling language, which means that only models in that modeling language are possible. A few tools support multiple modeling languages or the development of a new dedicated modeling language. This process is known as meta-modeling and tools supporting this functionality as meta-tools. In this situation, “multiple modeling languages” does not mean that different languages can be used in the same model, but that the tool allows models to be created in a choice of different languages.

5.2.2.2 Model Creation and Editing

The most important functional area for any modeling tool is model creation and editing. This is where the graphic modeling elements and inter-element relationships available in the selected modeling language are provided by the tool and can be edited using standard graphic tool and editor functions. These include creating, organizing, interconnecting via relationships, manipulating, deleting, defining properties (labels, attributes), and so forth. To this end, most modeling environments provide a graphic user interface with text input fields for properties. Many tools facilitate model creation by automating recurring tasks, for instance, laying out the model according to a predetermined pattern or automatically formatting labels of modeling components. Some tools also provide context-sensitive functions such as only offering the relationship types allowed by the modeling language when creating a relationship between two modeling elements.

5.2.2.3 Views and Levels

Views and levels is an area of tool functionality for structuring large and complex models. They also simplify the use of such models and facilitate model navigation. Views help to reduce complexity by including only the specific aspects required, rather than the entire model. For example the “process view” for a model that contains processes, organizational structures, products, and IT systems would only show the model’s processes and the information relevant to them and hide the other elements of the model. Many modeling environments offer views as part of their functionality. However, the specific views available will generally depend not only on how aspects of an enterprise can be depicted in the modeling language, but also on what method is used. The EM perspectives presented in Chap. 4 can also be used as views. In addition to these thematic views, some tools also use the view concept to define sections of the enterprise based on the organizational structure. In this case, a view might contain only one particular organizational unit, or one particular process that passes through several organizational units.

Levels are used in modeling tools to allow certain modeling elements to be refined and to manage the representation of refinement levels. In process modeling, for example, an overall business process is often modeled first as a sequence of individual activities to be carried out, without immediately splitting these activities into sub-activities. In a further step, which would equate to an additional level for the purpose of refining the individual activities, the actions to be carried out as part of these individual activities are described. The number of refinement levels is unlimited in principle, but may be restricted by some tools. A similar type of refinement can also take place when modeling product structures and services.

5.2.2.4 Model Storage and Repository

Every modeling environment's functionality must include storing the models that have been created. There are differences in the method of storage. The most common form is to save the models as files in the computer's file system—an approach that is common in office applications and drawing tools. This form of storage generally assumes that a model will only be edited by one person at a time. In terms of storage format, it is common to find proprietary formats that are specific to the tool manufacturer and often have an unknown type of storage structure. The simple drawing tools used for EM typically support this way of model storage.

When working on extensive modeling projects with more than one modeler, it is advisable to make use of the additional storage support offered by some modeling environments in the form of model repository. Here, individual models are not stored in the file system, but in a type of database through which access to individual model or its parts is coordinated. This means that more than one person can work on the same model as long as they do not simultaneously edit the same model elements. Sub-models or model views are frequently defined for this purpose, with each sub-model or view only available to one user at a time. Some repository solutions also allow storing different model versions, which means that, if necessary, previous versions can be opened or the differences between versions can be displayed.

In addition to storing models in file systems or repositories, some tool environments also offer cloud storage, which is provided as an Internet-based service and does not involve the user knowing the exact storage location.

5.2.2.5 Method Support

The modeling method specifies what steps should be carried out when creating a model, and how the aspects of an enterprise that are relevant to modeling can be identified and captured in model elements. Some modeling tools are tailored to a particular modeling method, which means that they support not only the modeling language, but also the steps prescribed by the modeling method. This often becomes evident when the method prescribes a sequence for modeling different views of the enterprise, such as modeling business processes first, followed by modeling organizational structures and then modeling information structures. Needless to say, using a tool designed for a specific method requires detailed knowledge of the method concerned. This should be taken into consideration before selecting such a tool.

5.2.2.6 Customization and Extensibility

Many tool environments allow basic adjustments to be made to the tool during installation, e.g., for all employees in an organization, as well as allowing individual settings to be altered for each modeler. Typical customization options include showing or hiding particular menus, defaults for the font and size of text in model elements, toolbar or information positioning, default file or repository location and autosave settings, color choices for certain interface elements and inclusion of the company logo, and defaults for both the modeling language and the modeling method (if applicable).

Only a few tools offer the ability to extend modeling environments, for example, by adding internally developed functions for importing or exporting data, as this requires a built-in scripting language for coding such extensions or a programming interface and the disclosure of storage structures. Tool extension options are primarily used by large enterprises that utilize modeling environments on a permanent basis to support IT management, or that conduct long-term modeling projects.

5.2.2.7 Model Analysis and Manipulation

Model analysis is an area of modeling tool functionality with content and scope that is highly dependent on the modeling language. With semiformal languages, it is often only possible to analyze compliance with fundamental composition and design rules, which might include rules for which elements can be connected and what relationships can link them, or which elements can follow certain others. However, formal modeling languages allow further analysis, making it possible to check the resulting models for modeling language errors, identify refinement errors on different modeling levels, and test a model's completeness or translatability to other notations. Modeling languages that capture data or material flows also allow the represented flows to be checked for correctness and consistency. In models with control structures, it is possible to determine whether deadlocks may occur when executing the model or to check if some parts of the model cannot be reached during execution, meaning that they have been incorrectly modeled.

Model manipulation functions often relate to the entire model or all elements of a particular type as defined by the modeling language. Examples of manipulation functions include adjusting the model layout according to predefined rules, transforming the model into another modeling language, creating other model presentation formats, or manipulating attributes for all elements of the same type.

5.3 Selecting Tools

The practical aspects of tool acquisition are often neglected and as a result tools are acquired and used in haphazard manner. This has created many problems, particularly for inexperienced companies that have tried to use EM tools, perhaps assuming that the tool will be "magically" responsible for performing the analysis and suggesting a suitable solution to their business problem. Many tools have been purchased but insufficiently used. The purchases made without a proper analysis and planning have led to a situation that the tools purchased do not meet the expectations of the company that bought it. As a result, they turn into "shelf-ware," and companies keep looking for new tools. In most cases the negative experiences concerning tools are caused by the lack of proper understanding of how to use the EM tools and how to introduce them in an organization. Furthermore, novices in EM might even be unaware of their lack of knowledge and skill in EM methods and tool usage. Hence, sufficient understanding of EM is particularly important in the stages of acquiring EM methods and tools.

Exactly which types of tools and which software packages are useful is determined by (1) the organization's intentions (e.g., will the models be kept "alive"), (2) situational properties (e.g., the presence of skillful tool operators, availability of resources), and (3) the specific functions that the tool should serve—tool requirements. More about how to select and introduce EM tools in organizations is available in (Stirna 2001). The remainder of this section outlines an EM tool acquisition strategy.

The proposed tool acquisition process consists of three main phases—assessing the organization, choosing the EM tool acquisition strategy, and following the chosen strategy (see Fig. 5.3).

5.3.1 Phase1: Assess the Organization

Determine organization's objectives for EM. At this stage intentional factors are assessed and organization's EM process reviewed. Intentional factors are those generic objectives of the user organization that can be used to determine the most appropriate EM tool acquisition strategy. The following intentional factors should be assessed:

- *Modeling without external consultants.* This intentional factor reflects the organization's intention to develop its own EM competency and to use EM without help from outside EM consultants.
- *Keep models alive.* This intentional factor reflects the organization's intention to constantly update enterprise models, to disseminate them on the corporate intranet, as well as to use modeling as a part of standard business development and execution processes in the organization.

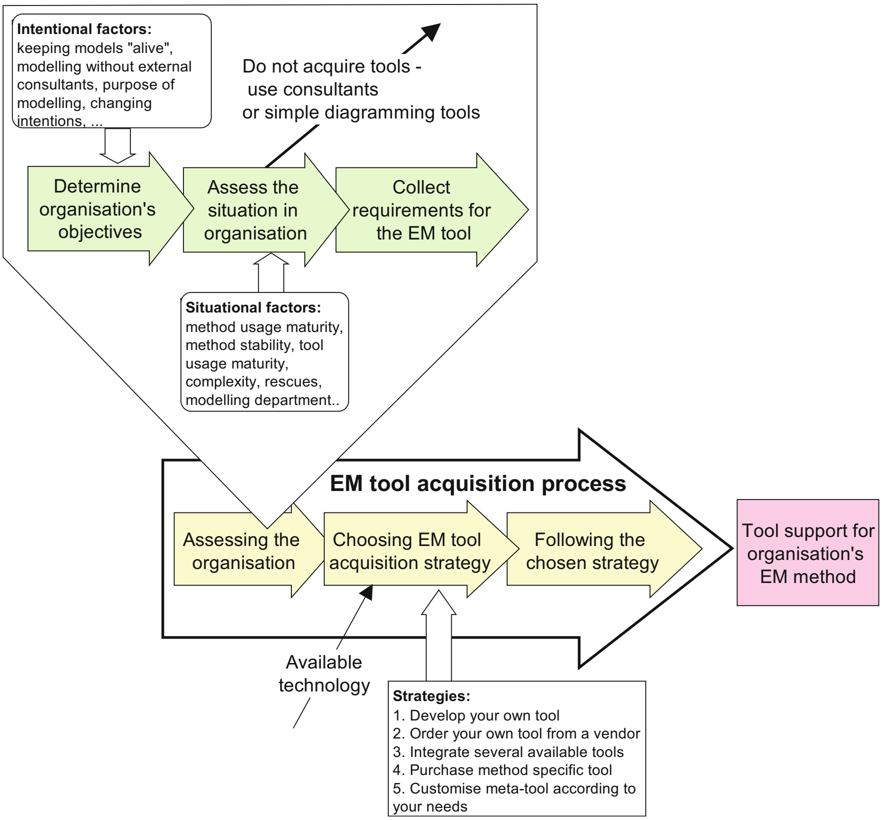

Fig. 5.3 Overview of the EM tool acquisition process

- *Changing intentions*. The organization has to be aware of how often the EM tool-related intentions change and what the rationale for the change is. In reality practical and impractical arguments are often mixed, but nevertheless the organization should assess the potential for future changes.
- *Purpose of Enterprise Modeling*. This intentional factor determines what kind of tool the organization needs to acquire (e.g., developing and configuring IT, disseminating best practices on the intranet). It determines the requirements for the EM tool.

Assess the situation in the organization focusing on a number of situational factors. Situational factors "are those properties of the problem situation that can be used to determine the most appropriate problem solving strategy. This includes those properties that can have an impact on the type of uncertain effects which may occur and their adverse consequences" (Euromethod 1996). The following situational factors should be assessed:

- *Method usage maturity*—determines how experienced and prepared (in terms of competencies and skills, work processes, and roles) the organization is to work with modeling methods of this kind;
- *Method stability*—determines how frequently new versions of the modeling method will be introduced;
- *Tool usage maturity*—determines the organization's experiences and ability to use computer-based tools for supporting modeling methods;
- *Tool development maturity*—determines the organization's ability to develop computer-based EM tools. This situational factor should be taken into account only if the organization has the intention to develop new EM tools.
- *Complexity of the envisioned EM projects*—indicates the kinds of problems that will be addressed by EM, the variety of tasks to be performed, and results expected from the project;
- *Project resources* such as time, competent personnel, and money are the critical success factors of any EM project and therefore should be considered in EM tool acquisition process.

Elicit and prioritize requirements for the EM tool. These requirements include a number of interrelated categories, such as EM support requirements, customizability and extendibility requirements, requirements for the modeling repository, modeling data visualization requirements, reporting and querying requirements, collaborative work requirements, requirements for integration with other tools and information systems, as well as nonfunctional requirements.

5.3.2 Phase 2: Choose EM Tool Acquisition Strategy

At this stage the candidate EM tool acquisition strategies are assessed and the most suitable chosen and then followed. These generic EM tool acquisition strategies were elaborated on the basis of CASE tool adoption strategies defined by Bubenko (1988). The following set of EM tool acquisition alternatives should be considered:

- Outsource the EM tool-related tasks to an external consultant, or
- Use a simple diagramming tool for documenting the modeling results, or
- Acquire an EM tool within the organization, by following one of the EM tool acquisition strategies:

  1. Develop your own EM tool-set
  2. Order your own EM tool-set from a tool vendor
  3. Integrate several available EM and CASE tools
  4. Purchase a method specific tool
  5. Customize meta-tool into an EM tool.

5.3.3 Phase 3: Follow the Chosen EM Tool Acquisition Strategy

At this stage the newly acquired tool is tested in the organizational setting, usually in a pilot project, in order to validate its suitability. If the EM tool proves to be useful, the organization should decide on its institutionalization strategy. Besides procurement of the EM tool itself, the organization should also have the competency to work with it. Our position is that without the necessary EM competency it is more rational to hire a consultant who provides the tool support. Competency issues of EM projects are discussed in Chap. 10 and the issues related to adopting EM within an organization in Chap. 11.

Chapter 6
E-Commerce Case Study

This chapter discusses different aspects of a small business, which will serve as case study in this book. The case will be used for demonstrating and explaining various aspects of the 4EM method. The case is based on an imaginary company called "Accessories 4 you" (A4Y). A4Y is an e-commerce company specialized in accessories and jewelry with individual engravings. Sales and distribution of the products primarily are based on the company's e-Shop ("online shop"), but A4Y also runs a conventional shop that offers services such as personal guidance, product demonstrations, and direct sales.

The content of the chapter is the description of the current situation (as-is situation) of the case study company, which includes the established processes and organization structures. In order to prepare the company for future market challenges and organizational changes, first the current situation should be modeled and used to identify problems, opportunities, and change needs. Afterwards, the future situation (to-be situation) has to be designed and modeled. As-is and to-be models are presented in Chap. 8 in order to illustrate how EM can be used in a change management situation.

The introduction of the case study company A4Y is divided into two parts: Sect. 6.1 describes the as-is situation of the company's primary processes, i.e., the processes directly related to production and distribution (e.g., inbound and outbound logistics, operations, customer services, marketing and distribution). Section 6.2 describes the current situation of the supporting processes (e.g., procurement, human resource management, and technology development).

6.1 Primary Business Processes

A4Y is an e-commerce enterprise specializing in sales of accessories and jewelry with individual engravings. Marketing, sales, and distribution of the products are mainly realized using the e-shop (online shop) of the enterprise. The enterprise has

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a branch office colocated with a conventional shop in which the customers can get personal advice and purchase products of A4Y. All products of the enterprise are manufactured at the facilities of the enterprise. On request the products can be provided with an individual engraving. The branch office receives all orders made via the e-shop and prepares them for delivery. The deliveries of products are carried out by an external shipping service provider. If the branch office receives an order for a product with an engraving, the engraving text is forwarded to the manufacturing unit. Subsequently, the selected product is engraved with the text in the manufacturing unit and is shipped directly from this location by the shipping service provider.

In the following the primary processes of A4Y are described, which include the activities of inbound logistics, operations, marketing and sales, outbound logistics, as well as customer services.

Inbound Logistics The activities of the inbound logistics are reception, storage, and distribution of working funds required to manufacture products or create services. The inbound logistics is mainly focused on the physical inputs that are supplied to the enterprise, e.g., individual parts for the production of accessories. The following activities are part of the inbound logistics: conducting a comparison of deliveries, unloading of incoming goods, completeness check of goods according to the freight documents, ascertainment of possible damage in transit, unpacking of goods, repacking goods in storage means, incoming goods inspection (e.g., quantity, quality, meeting deadlines). The inspection of incoming goods of the physical inputs belongs to the inbound logistics as already mentioned. The inspection takes place at random for goods with a value of less than 100 €. Each item with a higher value is controlled without exception. If a defect in the delivered goods is discovered, it has to be reported immediately to the general manager upon the receipt of goods. The general manager reports this defect to the supplier and orders a new delivery as replacement of the defect goods. All goods with no defect are registered into the stock system of the inbound logistics.

Operations The operations of A4Y include manufacturing processes of final goods carried out at the manufacturing unit which is in close vicinity to the office of the enterprise. A manufacturing process is triggered by a manufacturing order created in the branch office or e-shop. The manufacturing order is placed if a customer would like to have a product with an engraving. Furthermore, a manufacturing order is issued by the branch office if the quantity of standard goods in stock of the branch office is less than the defined minimum. The generic term "manufacturing process" contains several subprocesses that have to be conducted in order to manufacture a product. In the first step a sample blank is embossed or laser-engraved if a manufacturing order for the production of standard goods exists. The sample blank is checked for faults in the next subprocess. If the sample blank is faulty, a manufacturing order for this product has to be placed again. Currently, the number of sample blanks with faults is increasing. Potential countermeasures would be to increase the maintenance efforts for the production machinery or to acquire new production equipment. The general management did not decide yet, which countermeasure to implement. Currently, there is a tendency of the management to increase the maintenance efforts, as the acquisition of new production equipment is quite costly and probably not a viable option for the company.

If the sample blank does not have any faults, it can be used to produce standard products according to this sample blank. Depending on the sample blank, these standard products can also be decorated with a motif. The quantity to be produced depends on the production orders. For standard products which are frequently ordered by customers, A4Y produces more items than actually ordered and puts them into stock in order to be prepared for larger orders and for manufacturing orders including engravings. The management defined as a rule that manufacturing of standard products with engravings must not take more than two weeks. If a manufacturing order arrives which includes engraving a text, the manufacturing unit first has to check whether it is technically possible to produce the engraving. For this purpose manufacturing guidelines have been developed. These guidelines contain restrictions regarding the maximum number of symbols, the permitted fonts, and the size of the engraved text. The standard product is only engraved with the customer's text if these guidelines can be followed. If the guidelines are violated, the order or the text to be engraved has to be modified. Such a change requires the agreement of the customer and the general manager. When the engraving is finished, the product is prepared for delivery and handed over to the external shipping service provider.

Furthermore, the general management defined as a long-term goal to reduce the operating costs by approximately 15 % and as short-term goal to increase profits by 10 % this year. In order to reach these two goals, an organizational change process has to be initiated, which will have to include decisions about investments in new product variations and about measures to cut costs.

Marketing and Distribution The distribution of products currently is carried out by external shipping service providers. A4Y has to hand in the goods to be delivered at a branch office of a shipping service provider. The general management wants to improve the situation by negotiating a long-term contract with one of the shipping service providers. The contract is supposed to include that the shipping service provider in the future will collect the goods to be delivered at A4Y's branch office two or three times a week. Such a contract is expected to contribute to cost reduction because shipping service providers offer better conditions and lower prices for long-term agreements with a certain shipping volume. Furthermore, it will save time for A4Y if the goods are collected by the provider instead of having to hand them in.

In marketing, two main processes have to be distinguished: online marketing and off-line marketing. The following activities are carried out by the marketing department of A4Y in online marketing:

Search Engine Optimization (SEO): The marketing department continuously adapts the content of A4Y's website in order to achieve a better indexing by Internet search engines. The aim is to be listed in the top of the search results when potential customers search for A4Y's product categories. Furthermore, links are set between A4Y's website and the websites of relevant partners.

Search Engine Marketing (SEM): A4Y books particular keywords at various search engine providers. If a user does a search for one of the keywords, the search engine returns the link to the e-shop of A4Y as the top search result.

Newsletter: A newsletter is created with the help of the marketing department presenting the sales campaigns and the current developments in the enterprise to the customer.

Furthermore, the marketing department tries to increase the customers' interest for accessories with engravings using off-line marketing. The following activities belong to the offline marketing process:

Sales talk: The sales staff of the branch office and the general manager are trained by the marketing department. The general manager often has sales talks with major customers and the marketing department expects that more sales talks can be successful with the help of this training.

Brochures: Product brochures are distributed at promising locations, e.g., at locations where people spend time while waiting (e.g., hairdressers, dentist offices, railway stations).

Poster: Posters with the current products and special offers are placed in appropriate places on streets and in shopping malls.

All marketing activities are designed for attracting the customer's attention. A performance review takes place after carrying out the online marketing activities with the help of Google-Analytics. The online marketing measures can be evaluated and improved by this performance review. Currently, there is no performance review for the off-line marketing measures. The general management plans to be more active in social networks (e.g., Social Media Marketing (SMM)) due to the fact that social networks are becoming more and more popular. For the marketing budget, the decision was made to not define a fixed amount for every year but to link the budget size to the annual turnover. More concretely, the budget for marketing measures was limited to a maximum of 10 % of the last year's turnover.

Outbound Logistics The outbound logistics basically describes all functions of the enterprise which deal with the physical distribution of products to the customers as well as the functions associated with that. A4Y has a process that deals with invoicing and the packaging of ordered goods. The activities of this process are for example order backlog administration, consignment sale, and if necessary order grouping. The products have to be packaged in such a way that the package meets the drop test guidelines according to ISO 2206.[1] The different regulations of this standard have to be observed during the entire process. For instance, the following information is mandatory for accounting: the name and address of the addressee, an

[1] ISO standard 2206 on "Packaging—Complete, filled transport packages—Identification of parts when testing." For more information, see http://www.iso.org/

unambiguous invoice number, the invoice date, as well as an overall view of the purchased goods with their net prices/gross prices depending on the receiving party (consumer/enterprise)—the reporting of the sales tax value (tax rate) is important for the presentation of prices. Furthermore, the customer is informed about the payment terms and revocation options. Before the goods are handed in for shipping, a suitable shipping service provider has to be chosen depending on the package size and the receiving country. The insurance value of the package depends on the invoiced value of goods.

Customer Service The customer service encompasses all activities to maintain the value of the product for the customer. A4Y tries to stand out from their competitors on the market and to support the own marketing activities by offering additional services such as a telephone hotline for customer questions or a product configurator. A4Y offers different services on its e-shop platform, e.g., a telephone hotline, dispatch information for ordered goods, and an extensive product catalogue search, to encourage the customer to buy the goods of the enterprise. In the branch office additional services are offered, such as product demonstration and advice regarding engravings. A4Y strives for short delivery times so that the manufacturing process of a standard product and its delivery to the customer do not exceed two weeks. This is a relatively short time for this kind of customized product.

6.2 Supporting Business Processes

The section describes the current situation of processes with supporting function for the primary processes. This includes activities such as procurement, technology development, human resources, and general management.

Procurement Procurement in A4Y includes the acquisition of goods and services from external sources which are needed for operations. Currently the procurement process in the manufacturing unit is activated if the stock of individual parts is less than the minimum stock. The procurement process starts with an Internet enquiry to choose the most favorable supplier for the different goods or parts to be procured. As a consequence, many small orders are placed at different suppliers with different delivery times and often varying quality. A supplier will not be considered for procurement processes in the future if the goods delivered do not meet A4Y's minimum quality requirements. The requirements, which have to be taken in consideration, are availability of goods, short delivery times, correct delivery according to the order, conformity to established standards or norms, as well as a quick response time.

The general management decided to change the procurement process by introducing more extensive IT support with focus on the overall logistics process. The future IT support is supposed to register all changes in stock of the manufacturing unit and the branch office. If the actual stock is less than the defined minimum stock, the general manager has to receive a notification from the IT system.

Furthermore, the goal is to closely integrate A4Y's IT system with the frequently used suppliers by setting up of a Supplier-Relationship-Management (SRM). The SRM is supposed to manage all data regarding products in stock, possible risks, conditions, or quality. The launch of SRM should help setting up a network of regular suppliers. Thus, the many small orders can be replaced by a lower number of bigger ones and the delivery times can be reduced as well. The regular suppliers should be selected according to meeting the minimum requirements for quality. Regular suppliers, who deliver a shipment of bad quality twice, should be put on a blacklist and not considered for orders in the future.

Technology Development The e-shop requires technology-related activities in the enterprise because A4Y runs an application server for the e-shop platform and the server is protected by a firewall. The application server contains the dynamic webpages of the e-shop. The product search function of the e-shop platform is based on product data in a MySQL database. The product data are on the same server as the customer data. This server also has a firewall in order to provide protection from hacker attacks and unauthorized data access, i.e., A4Y's employees do not have access to product data without an explicit permission.

Furthermore, the branch office has a point-of-sales (POS) terminal. The POS terminal registers all sales of products in branch office and e-shop. The customer has to login to the POS terminal before he/she can place an order in the e-shop. The successful login is a precondition for the purchasing via the e-shop. Based on the customer login, a customer profile can be created which is useful for the marketing department because it can design the newsletter and e-mails with special offers targeted to the customer's profile. The customer profile contains information concerning the customer's name, address, and preferred payment methods. Sales of standard products without engraving can be done in the branch office without a login of the customer at the POS terminal. This kind of sales is registered as a purchase by an "anonymous customer." Monthly statistics about the most wanted products of the month and the mode of purchase can be generated with the help of the POS terminal. These statistics are required for the long-term pricing policy and the accounting of the general management.

A mobile data collection (MDC) device is used to collect information about the current stock. The aim is to continuously have up-to-date information about the number and kind of standards products and working funds. This device is out of date and should be replaced. During operations, the device often causes error messages and crashes. It also has a too small internal memory.

The general management decided that part of the information system of A4Y should be outsourced. The outsourcing plans concern the MySQL database and the e-shop system, both of which shall be outsourced to an external cloud provider. The management expects that this outsourcing will reduce costs for operations and the technical components of the information system.

Human Resources A4Y currently has nine employees. Two employees are working in the IT department, two in the branch office, two in the marketing department, two in the manufacturing unit (a goldsmith and a foreman), and one is the general manager (Mister Alexander Müller). The foreman receives the incoming goods, supervises the manufacturing process, reports defects to the general manager, and delivers the sold products with the company car to the shipping service provider.

Due to the increasing number of orders in the Holiday season, A4Y usually hires additional employees with a fixed-term contract for this period. There are no rules or standard procedures for hiring new personnel. In case of vacancies, the general management is responsible and will assess the specialist knowledge as well as the social skills of the applicants.

General Management The activities of the general management consist of planning, financing, controlling, quality control, and external accounting. The general manager has the only responsibility for these activities. The strategic goal defined by the general manager for A4Y is to establish the enterprise on the Chinese market by opening a branch office in China during this year.

Chapter 7
Overview of the 4EM Method

This chapter begins the description of the 4EM method by first providing an introduction to the essential features and principles that will be examined in greater depth in Chaps. 8 and 9. "4EM" is an abbreviation of "For Enterprise Modeling." The origin of the method will be explained in more detail in Sect. 7.5.

The remaining sections of this chapter present the method's basic components (Sect. 7.1), describe the view concept used in 4EM and the associated sub-models (Sect. 7.2), outline the applications and benefits of 4EM (Sect. 7.3), and account for the participatory nature of the method (Sect. 7.4).

7.1 Basic Components of 4EM

The 4EM method is comprised of three core elements, which can also be regarded as basic principles and are closely interwoven:

- A defined procedure to modeling using a fixed notation (defined procedure and notation)
- Performance of Enterprise Modeling in the form of a project with predetermined roles (project organization and roles)
- A participatory process to involve enterprise stakeholders and domain experts (stakeholder participation)

These three basic elements of 4EM are supported by appropriate tools and resources, which is illustrated in Fig. 7.1.

The procedure and notation are explained in detail in Chap. 8 using the case study presented in Chap. 6. An important principle of the 4EM approach is its modular structure, providing a self-contained, clearly defined procedure for each different aspect of Enterprise Modeling. However, how these different method

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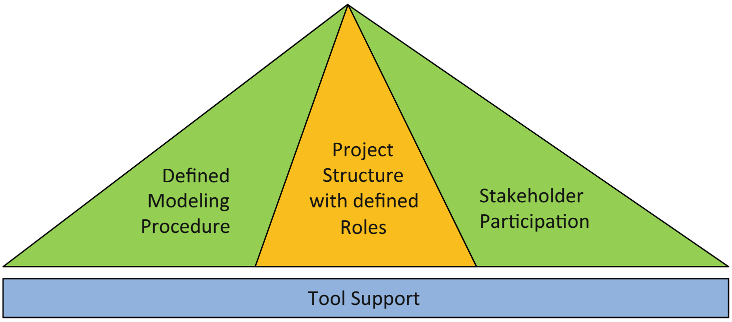

Fig. 7.1 Basic elements of the 4EM—framework

components are combined can be decided based on the problem to be solved. This flexible method structure, which can be adapted as required, thus corresponds to the basic concept of method components as described in Sect. 3.2. The individual components of the method and their respective notations define views or sub-models. Section 7.2 below explains the differences between them.

Project organization and roles are addressed in Chap. 9, where the 4EM principle of organizing Enterprise Modeling as a project becomes apparent. From a 4EM perspective, it is not enough to merely define the procedure and notation as these do not provide a clear description of the purpose and content, or an allocation of resources, or a definition of the decision-making and process structures. Understanding Enterprise Modeling as a project with a clear goal, time frame, and resources facilitates practical implementation and helps to achieve the specified purpose.

Stakeholder participation is another principle of 4EM that is reflected in both the procedure and notation and the project structure and roles. Opportunities for involving domain experts and stakeholders, such as moderated workshops or participatory modeling, have already been covered extensively among the analysis techniques presented in Chap. 4. This principle will also become apparent when discussing roles within the project structure.

In principle, all of the tools and tool categories discussed in Chap. 5 are viable as supporting tools. However, the modeling instructions and incorporated checklists for each 4EM sub-model in Chap. 8 also fall into this category. Table 7.1 shows the sections in which the individual elements of 4EM are discussed.

The instructions and working guidelines also create an organizational framework for all persons involved in modeling, problem solving, and knowledge sharing, because they not only define the meaning of the symbols, colors, formulations, etc. to be used, but also indirectly define the interaction process. This aims to increase the productivity of the activities by preventing misunderstandings and conflicts.

Table 7.1 4EM method—sections describing the core elements

4EM core elements	Discussed in section?
Procedure and notation	7.3: Overview to sub-models 8: Procedure and notation for every sub-model
Project structure and roles	9.1: project structure 9.3: roles
Stakeholder participation	4: analysis techniques including participation 9.4: roles
Tools and aids	5: modeling tools 8.1–8.6: Modeling support

7.2 Views and Sub-Models

The 4EM method uses six interrelated sub-models (Fig. 7.2), which complement each other and capture different views of the enterprise which can also be considered as perspectives, i.e., each of the sub-models represents some aspect of the enterprise. These sub-models and issues they address are:

- *Goals Model* (GM) focuses on describing the goals of the enterprise. Here we describe what the enterprise and its employees want to achieve, or to avoid, and when. Goals Models usually clarify questions, such as: where should the organization be moving, what are the goals of the organization, what are the importance, criticality, and priorities of these goals, how are goals related to each other, which problems are hindering achievement of goals.
- *Business Rule Model* (BRM) is used to define and maintain explicitly formulated business rules, consistent with the Goals Model. Business Rules may be seen as operationalization or limits of goals.

  Business Rule Model usually clarifies questions, such as: which rules affect the organization's goals, are there any policies stated, how is a business rule related to a goal, how can goals be supported by rules.
- *Concepts Model* (CM) is used to strictly define the "things" and "phenomena" one is talking about in the other models. We represent enterprise concepts, attributes, and relationships. Concepts are used to define more strictly expressions in the Goals Model as well as the content of information sets in the Business Processes Model.

  Concepts Model usually clarifies questions, such as: what concepts are recognized in the enterprise (including their relationships to goals, activities and processes, and actors), how are they defined, what business rules and constraints monitor these objects and concepts.
- *Business Processes Model* (BPM) is used to define enterprise processes, the way they interact and the way they handle information as well as material. A business process is assumed to consume input in terms of information and/or material and produce output of information and/or material. In general, the BPM is similar to what is used in traditional data-flow diagram models.

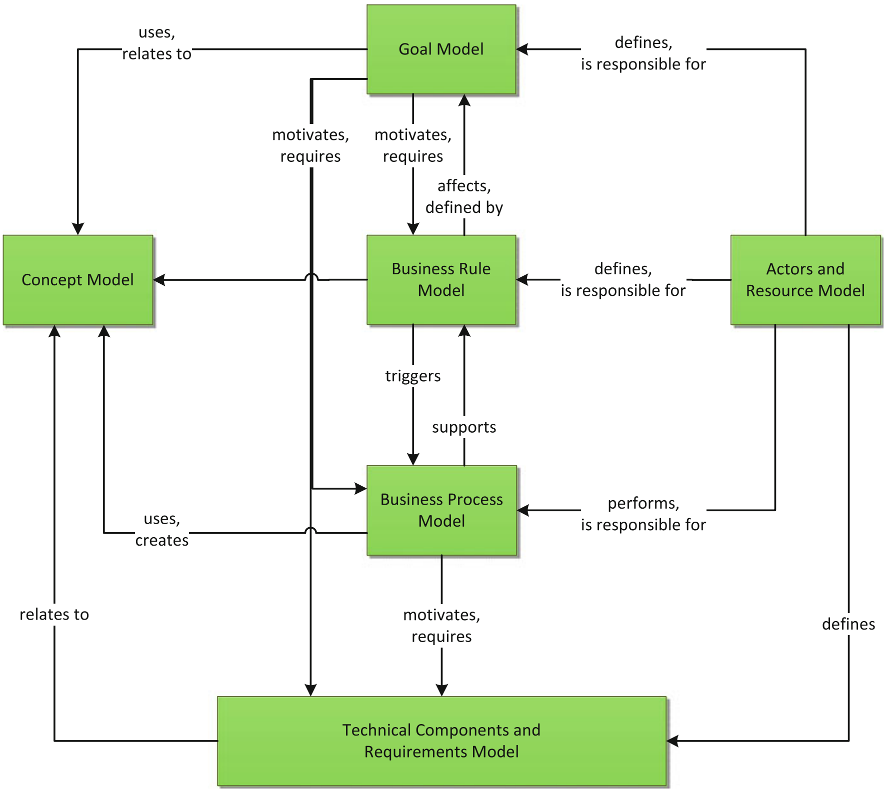

Fig. 7.2 Sub-models of the 4EM approach and their relationships

Business Process Model usually clarifies questions, such as: which business activities and processes are recognized in the organization, or should be there, to manage the organization in agreement with its goals? How should the business processes, tasks, etc. be performed (workflows, state transitions, or process models)? Which are their information needs?

- *Actors and Resources Model* (ARM) is used to describe how different actors and resources are related to each other and how they are related to components of the Goals Model, and to components of the Business Processes Model. For instance, an actor may be the responsible for a particular process in the BPM or the actor may pursue a particular goal in the GM.

  Actors and Resources Model usually clarifies questions, such as: who is/should be performing which processes and tasks, how is the reporting and responsibility structure between actors defined?
- *Technical Components and Requirements Model* (TCRM) becomes relevant when the purpose of 4EM is to aid in defining requirements for the development of an information system. Attention is focused on the technical system that is needed to support the goals, processes, and actors of the enterprise. Initially one

needs to develop a set of high-level requirements or goals, for the information system as a whole. Based on these, we attempt to structure the information system in a number of subsystems, or technical components. TCRM is an initial attempt to define the overall structure and properties of the information system to support the business activities, as defined in the BPM. Furthermore, the TCRM can be used to document the existing information system and IT landscape in an enterprise.

The Technical Components and Requirements Model usually clarifies questions, such as: what are the requirements for the information system to be developed, which requirements are generated by the business processes, which information systems and IT-components are used in the enterprise in what business process by what actor, which potential has emerging information and communication technology for process improvement.

Each of these sub-models includes a number of components describing different aspects of the enterprise. For example, the Goals Model contains business goals, business problems, divided into threats and weaknesses, causes, business opportunities, and constraints. The modeling components of the sub-models are related between themselves within a sub-model (intra-model relationships), as well as with components of other sub-models (inter-model relationships).

Figure 7.2 shows *inter-model relationships*. The ability to trace decisions, components, and other aspects throughout the enterprise is dependent on the use and understanding of these relationships. When developing a full enterprise model, these relationships between components of the different sub-models play an essential role. For instance, statements in the Goals Model allow different concepts to be defined more clearly in the Concepts Model. A link is then specified between the corresponding Goals Model component and the concepts in the Concepts Model. In the same way, goals in the Goals Model motivate particular processes in the Business Processes Model. The processes are needed to achieve the goals stated. A link therefore is defined between a goal and the process. Links between models make the model traceable. They show, for instance, why certain processes and information system requirements have been introduced.

There exist, however, limitations in the way sub-models and their relationships may be populated. These are controlled by a number of static as well as dynamic consistency rules, which control their permissible state transitions. These are necessary because they allow for analysis and comparison. How each sub-model focuses on a specific view of the enterprise will be described in detail in the following chapter.

7.3 Application Areas and Results

The 4EM method describes an approach that allows an enterprise or section of an enterprise, along with its structures and processes, to be analyzed, researched, and documented in the form of models. A number of applications for the 4EM method have already been described in Chap. 2, which discussed the practical challenges that can be addressed with EM methods. Regardless of these practical challenges, 4EM can generally be used when information and a model regarding the following aspects are required:

- How does the enterprise work at present?
- Where do problems or challenges exist that necessitate changes in the enterprise?
- What are the requirements for these changes?
- What are the options for meeting these requirements?
- What criteria and arguments can be used to evaluate these options?

When using the 4EM method, a wide variety of enterprise stakeholders (such as executives, organizational unit managers, staff from specialist departments, or domain experts) are often involved, working on the designated task with experts in the 4EM method and the analysis techniques used. The organization of this teamwork in project form is addressed in Chap. 9. In most modeling projects there are three activities to be carried out, which provide answers to the questions listed above:

1. *Analyzing*: First, the current situation in the enterprise is modeled (AS-IS model) and the discernible problems and weak points are identified. Only those who know the current situation can plan for the future.
2. *Assessing*: Possible courses of action must be discussed and assessed in light of the actual situation with its problems and weak points, as well as the enterprise's current goals and the challenges posed by the market environment. In this assessment phase, it is also very important to reveal and understand goal conflicts and priorities as well as their effects on structures and processes.
3. *Designing*: Finally, various future scenarios are investigated and the future situation to be achieved in the enterprise is devised and modeled (TO-BE model). The target situation then serves as a blueprint or specification for the changes to be made, which may be purely organizational in nature or include the implementation or revision of IT-based solutions.

The enterprise models produced in the process above (AS-IS and TO-BE) should enable the enterprise to make well-founded and purposeful tactical and strategic decisions (Fig. 7.3).

This three-stage process uses a number of the sub-models introduced in Chap. 8, each representing different views in terms of their content. One view might be business processes, for example, or the information systems that support these processes. The goal model is normally one of the sub-models with a bearing on

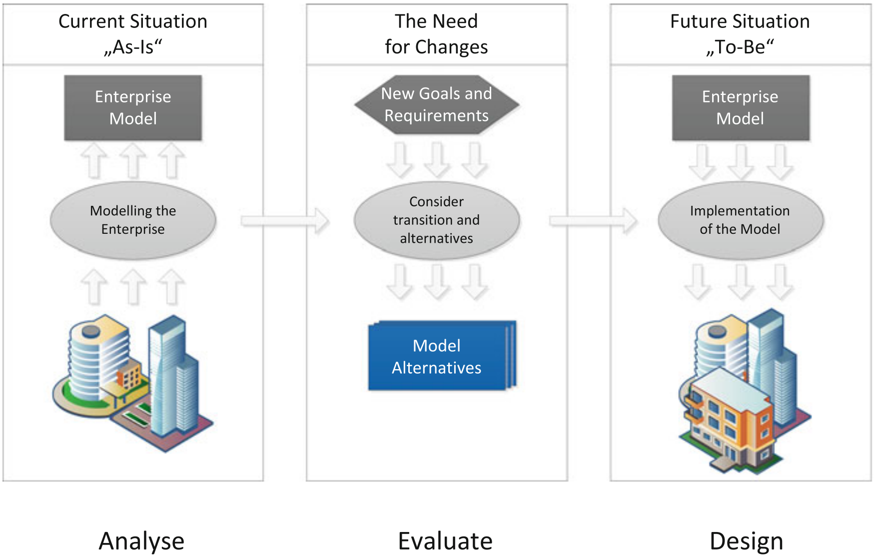

Fig. 7.3 Essential tasks of the 4EM process

all three phases of the process, and allows an enterprise's goals to be identified and described. This sub-model is certainly necessary in the assessment stage (What should be achieved? What goals have priority?), and often can also be helpful during the analysis phase (What are the analysis goals? What must be considered?). The goal model can also be used as a rationale when designing the future situation. The various enterprise goals can be linked together in the goal model, thus depicting the goal hierarchy in the enterprise. If, for example, an enterprise defines "optimize production process" as a sub-goal, this could be associated with the overarching goal "increase profits by 20 %." Goal conflicts may arise here; for example, the latter goal has a negative effect on other goals, such as "reduce operational costs by 10 %", as a software rollout that is required to optimize the production process incurs implementation costs and thus reduces profits. The relationships between individual sub-models and their views are also relevant to all three phases. In the example cited, the goal "optimize production process" could refer directly to the process to be optimized and to the stakeholders responsible, which are modeled in a business process model and an actor and resource model. Enterprise models and their related sub-models are discussed in detail in Chap. 8.

The 4EM method provides conceptual models that examine an enterprise and its requirements from a number of perspectives with varying connections. These models and their dependencies are an abstraction of the real-life situation in the enterprise and constitute the enterprise model.

In addition, the resulting models can be combined with information that allows alternative operational situations to be evaluated, for example. This information might include evaluation criteria, potential choices, measurements, and the pros and cons of the available options. This makes it possible for the model to be used as a means of evaluating changes, for instance allowing the costs of different variations to be analyzed while simultaneously documenting their effects on the organization.

In this regard, the enterprise model can aid understanding and communication between project participants or the various stakeholders in the 4EM process during every stage of development. The model effectively creates a common frame of reference across many different divisions and processes, with the result that its use is not limited to specific applications or particular groups. Amongst other things, the 4EM model's wide range of potential applications and high level of abstraction ensure that the target models remain valid for a relatively long period of time, as they are not dependent on the implementation method. Changes to the target model are only necessary when required by the enterprise's objectives or activities, rather than in the event of changes to the technological implementation.

7.4 Effects of the Participatory Approach

One of the principles of the 4EM method is for enterprise stakeholders to participate in Enterprise Modeling. Due to the participatory approach, the outcome of a modeling project not only includes the models that are developed and the decisions or changes made in the enterprise, but also results in participants having a better understanding of the problem solving process, and often even of their own enterprise.

The developers of 4EM chose participatory cooperation with stakeholders as a result of their practical experience in Enterprise Modeling. They recognized that agreements can be reached and problems solved much more effectively when stakeholders, instead of feeling "affected" by Enterprise Modeling, become active "participants." In 4EM's participatory approach, the stakeholders—under the guidance of a moderator and with the help of modeling experts—create models to solve the previously defined problem in appropriate modeling workshops. The moderator and modeling experts ensure that the domain experts and the stakeholders involved can focus completely on solving the problem, without the need to learn the syntax of a modeling language first. Once the model is created, the domain experts are consulted to discuss and validate the models created by modelers, but are directly involved in actually developing the model.

Not every modeling workshop will produce a high-quality model. However, the meetings almost always add value because the 4EM process always produces two results. Firstly, regardless of their state of development, the models that are created can always be used as a basis for other activities, whether as a starting point for discussion in further modeling workshops or to capture facts that were previously only available in the heads of individual employees. Secondly, the 4EM method changes the approach to problem solving processes as the participants are guided through a structured and consensus-based process.

There are two major advantages attributed to this approach:

1. The *participatory approach* involves stakeholders in the decision-making and problem solving process, which increases the participants' acceptance and commitment. This is particularly important if the modeling activities concern changes to organizational units, fields of work, visions and strategies, business processes, or information systems.
2. In the *conventional approach* to Enterprise Modeling, models are often created by consultants or modeling experts based on interviews, observation, or workshops, with no participation by those involved in the enterprise. By contrast, the participatory approach improves model quality as the models are created in cooperation with domain experts and the parties concerned, and are constantly reviewed and validated.

Model quality can be understood to mean correctness and consistency with respect to the notation, or may also concern the model's relevance in solving the given problem. Models that help to solve the specified problem when used as a whole are considered to be high quality. The results of the 4EM method are typically used in information system or process development projects. High-quality models may:

- Provide a clear business overview
- Support organizational learning
- Help to understand an enterprise's capabilities and processes
- Improve communication between the individual stakeholders about a problem that is to be solved through a modeling project
- Form a rationale for analysis tasks with the help of structured views and descriptions
- Easily extrapolate requirements for process-supporting information systems
- Present a consistent and more comprehensive model by systematically describing business goals, processes, requirements, etc., which is difficult with traditional text-based approaches
- Contribute to continuous improvements in the quality of enterprise processes and structures

Modeling experts also cite a changed attitude to the problem solving process and enhanced internal knowledge of the organization as the most important reasons for satisfaction with the outcome of a modeling project using the participatory 4EM approach. The stakeholders in a modeling project have different and sometimes contradictory success criteria, which must be appropriately investigated during project preparation. Ultimately, the most important gauge of a project's success is that the customer is satisfied with the result, a sign of which is commissioning follow-up projects to tackle further challenges. Moreover, the source of the participating stakeholders' satisfaction and motivation is the fact that they work together in the organization to solve a problem, which can be beneficial for every individual. This motivation is particularly important because improvement and the associated change is a continuous process that can be supported by the 4EM method. The 4EM method uses simple techniques to capture more complex facts, and is therefore highly suitable as a basis for representation and discussion. Consequently, a properly conducted modeling project can provide the following benefits for those involved:

- Better understanding of the relevant parts of the enterprise and how they interrelate
- Problem solving decisions made by the parties concerned
- A model as a rationale
- Collective discussion of critical issues to find a solution together
- Enhanced organizational learning and communication

7.5 Origin of 4EM

The 4EM Method as such is only a few years old, but result of a continuous improvement process of its predecessor EKD (see below) and other preceding methods.

In Scandinavia, Langefors (1968) made early contributions to EM. An EM method, the ABC method, was introduced in the beginning of the 1980s by Plandata, Sweden (Willars 1988), and refined by SISU (The Swedish Institute for System Development) in the late 1980s. A significant contribution of this strand of EM was the notion of considering intentional components of an Enterprise Modeling language, e.g., the goals (intentions) of a business, in addition to traditional data and process model components. SISU's version of the modeling language, denoted *Business Modeling*, was later extended into an *Enterprise Modeling method* in the ESPRIT project F^3—"From Fuzzy to Formal." The F^3 Enterprise Modeling method (F^3 1994) was then further elaborated in the ESPRIT project ELKD. The more recent modeling method is denoted EKD—"Enterprise Knowledge Development" (Bubenko et al. 2001; Loucopoulos et al. 1997).

The EKD method defines a structured approach for capturing different aspects of an enterprise in appropriate sub-models. EKD forms the main foundation for the 4EM method. The history of different Enterprise Modeling methods and of 4EM is depicted in Fig. 7.4.

Versions of EM methods from this "school" have been successfully applied in a number of European companies, e.g, British Aerospace (UK), Capital Bank (UK), National Bank of Greece, PostGirot (Sweden), Public Power Corporation (Greece), Sema Group (France), Telia (Sweden), Vattenfall (Sweden), Volvo (Sweden), etc. In addition to the "Scandinavian" school of EM, a variety of other methods have been suggested (See e.g. Bajec and Krisper 2005; Castro et al. 2001; Dobson et al. 1994; Fox et al. 1993; Yu and Mylopoulos 1994; Zorgios 1994).

The application projects have shown that one of the main advantages of the method is its acceptance by the participants in the modeling project, i.e., not only is it accepted by the modelers but also by domain experts and other participants.

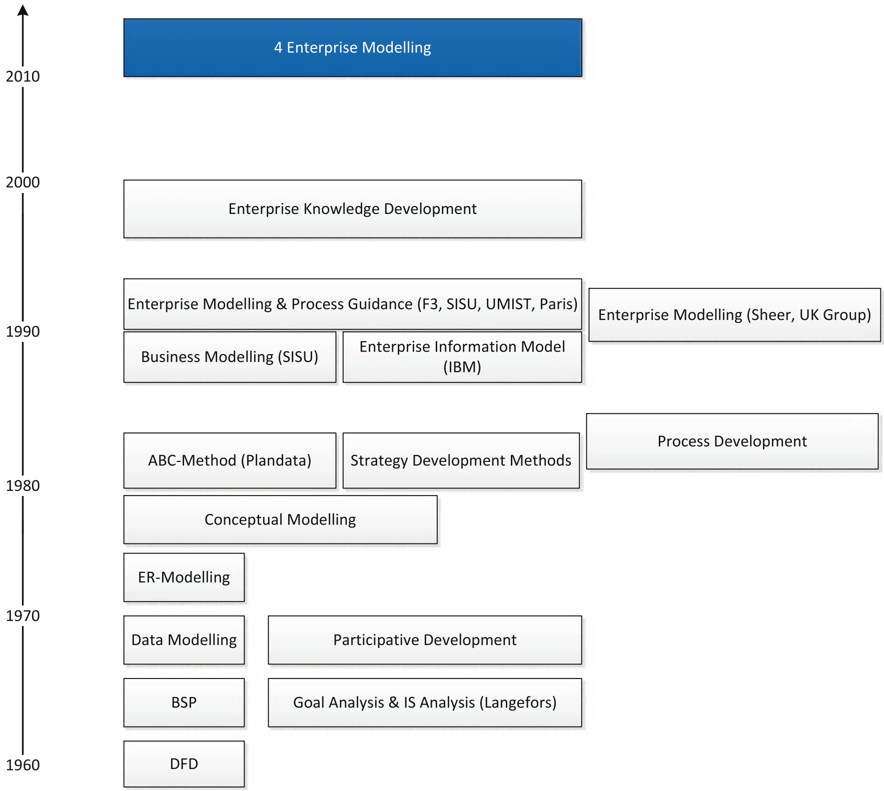

Fig. 7.4 History of the 4EM method

This better acceptance resulted in a better quality of the models developed, in an improved understanding of the enterprise, in an easier way to identify operative and strategic problems, and a faster problem solving process.

Table 7.2 shows a selection of projects, where EKD or 4EM were used for different modeling purposes.

In addition to the projects listed 4EM has frequently been used in university education. Currently, 4EM is part of university courses on Bachelor and Master level in Stockholm (Sweden), Riga (Latvia), Jönköping (Sweden), Skövde (Sweden), and Rostock (Germany).

When preparing this book, the EKD version published in 1998 was thoroughly revised and extended, which resulted in the 4 Enterprise Modeling (4EM) method. This revision included improvements in the notation (e.g., use of colors, modifications in the symbol used, adjustments in the meta-model), refinements of the modeling procedure and the project approach, and more detailed information regarding the foundations of methods and elicitation techniques.

Table 7.2 Overview to 4EM application cases

Organization	Application domain	Time frame	Project focus
British Aerospace, UK	Production and operations in aerospace	1992–1994	Requirements analysis
Telia AB, Sweden	Telecommunication	1996	Requirements elicitation, definition of project scope
Volvo Cars AB, Sweden	Automotive industry	1994–1997	Requirements analysis
Vattenfall AB, Sweden	Electricity supplier	1996–1999	Change Management Process management Competence Management
Riga Dity Council, Latvia	Public authority	2001–2003	Supportive process for knowledge management
Verbundplan GmbH, Austria	Electronics industries	2001–2003	Knowledge managemenz processes
Skaraborgs Hospital, Sweden	Healthcare	2006–2008	Strategy development; knowledge management processes
Systeam Management, Schweden	Software industries	2009	Strategy development
Future TV, Germany	Media industries	2011–2012	Alignment of IT strategy and business processes/IT
DRK, Germany	Social services	2012–2013	Development and implementation of an organizational strategy

Chapter 8
Sub-models of 4EM

This chapter presents the sub-models of the 4EM language as well as the basic principles of using them. The details of setting up a modeling project and carrying out the modeling process are discussed in Chap. 9. Furthermore, in Chap. 12 the main quality criteria for models are described. The sub-models presented in this chapter are the Goals Model, the Business Rules Model, the Concepts Model, the Business Process Model, the Actors and Resources Model, the Technical Components and Requirements Model, as well as the use of inter-model links that connect the sub-models. As a running example we will use A4Y case described in Chap. 6.

The main focus of this chapter is on the modeling language—meaning and purpose of the modeling components and the sub-models. The graphical look of the modeling components is usually influenced by the modeling tools used and can in principle be changed without affecting the outcome of modeling. There are however some general principles that should be followed—every modeling component should have a unique identifier including the type of modeling component and the graphical symbol should be well readable both on the screen and when printed. Recommended template of 4EM is shown in Fig. 8.1. Sometimes the combination of identifier and number is referred to as short name of the component.

8.1 Goals Model

The Goals Model is used for describing the goals of the enterprise along with the issues associated with achieving these goals. The Goals Model describes essentially the reason, or motivation, for components in the other sub-models. The components of this model are related to the enterprise itself and its rationale. Information system goals and requirements should not be stated here. The Goals Model forms the framework with which the relevance of processes and technical system requirements are measured and to which they are linked. Through links to and from the other sub-models, the Goals Model explains why, or why not, processes and

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_8

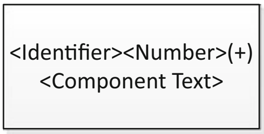

Fig. 8.1 Template of 4EM components

requirements exist or do not exist. The components of the Goals Model are related to each other through unidirectional semantic links of which the three main types are supports, hinders, and conflicts.

8.1.1 Components of the Goals Model

Component types of the Goals Model are the following: *goal, problem, cause, constraint, opportunity*. However, observations from a number of practical modeling sessions show that sometimes it is necessary to add additional components to the model, such as comments, assumptions, scenarios, tasks, etc. The purpose of such extensions is usually to improve the expressiveness and clarity of the model.

8.1.1.1 Goal

A business *Goal* is a desired state of the enterprise that is to be attained. It is used for expressing goals regarding the business or state of business affairs, i.e., what the enterprise and its employees want to achieve, or to avoid, and when.

Goals may be expressed as a measurable set of states, or as general aims, visions, or directions. Goals can be several meanings, such as business goals, objectives, intentions, needs, business requirements, desired states, etc. Intentional sentences should begin with the phrase "*The goal is...*". This phrase can be omitted but the expression should be such that if added it would still remain grammatically and logically correct. Figure 8.2 shows an ambiguously formulated goal on the left while the goal on the right is more precisely formulated.

It is recommended to follow the principle of SMART goals, meaning that every goal should be specific (S), measurable (M), accepted (A), realistic (R), and time

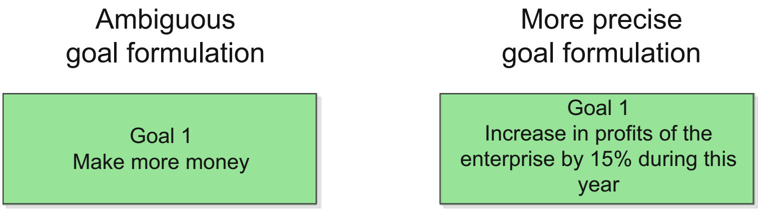

Fig. 8.2 Formulation of the goal statements

framed (T). This guideline contributes to increasing the understandability and usability of the model. In Fig. 8.2 the goal on the right follows this principle.

Goals may also have the optional variables *priority* and *criticality* (with possible values: *low, medium, high*), which allow modelers to assign different priority levels and perceived degree of criticality.

Goals modeling requires the participants to reflect over, and state their short as well as long-range goals about the enterprise. It also requires the modeling participants to discuss and agree upon issues such as the individual importance of goals, the criticality of goals, and the priority of goals, as well as evaluating alternative ways of achieving goals. These issues should not necessarily be discussed at once. It is more useful that the modeling group returns to them during the course of the modeling workshop.

8.1.1.2 Problem

A *Problem* is used for expressing that the environment is in, or may reach, some non-desirable state of affairs that needs to be addressed, which hinders the achievement of goals. By documenting perceived problems, a basis is created for detecting hidden goals that may otherwise only be implied, because problems typically hinder the achievement of some goal. If a stated problem cannot be seen as hindering some goal, then either the set of goals is incomplete or the problem really is not a problem of the enterprise.

Problems may be specified into two subtypes:

- *Weaknesses*—a type of problem describing factors that may reduce the possibility of achieving a goal. Weaknesses typically are factors that can be considered as internal with respect to the problem domain.
- *Threats*—a type of problem describing influencing forces that may reduce the possibility of achieving a goal. Threats typically are external factors coming from outside of the problem domain.

Figure 8.3 shows examples of problems.

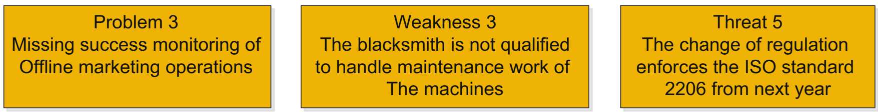

Fig. 8.3 Problem, weakness, and threat

8.1.1.3 Cause

A *Cause* is used for expressing the explanations or reasons for Problems. Causes are usually situations or states, outside the control of the project, process, and organization. It may be something that is well understood and does not need to be analyzed further. Typically, a cause cannot be affected by the enterprise. An example is given in Fig. 8.4.

8.1.1.4 Constraint

A *constraint* is used for expressing business restrictions, rules, laws, or policies from the outside world affecting components and links within the enterprise model. Internal business rules and policies of the organization are defined in the Business Rules Model. Figure 8.5 provides an example.

8.1.1.5 Opportunity

An *opportunity* is used for expressing resources that can make certain goals easier to achieve, achievable states not regarded as Goals, or even to state new goals of the enterprise. For instance, new communication technology may facilitate an enterprise's possibilities to achieve a goal to enlarge the international market of its products. Opportunities are situations that we may want to take advantage of and consider for development (see Fig. 8.6 for an example). If so, the Opportunity should be transformed into a Goal at a later modeling stage.

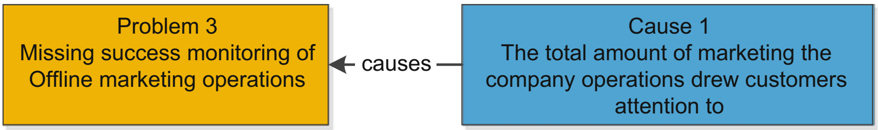

Fig. 8.4 A cause linked to a problem

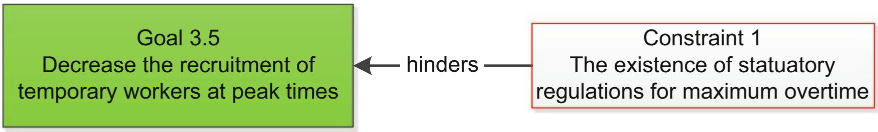

Fig. 8.5 A constraint hindering a goal

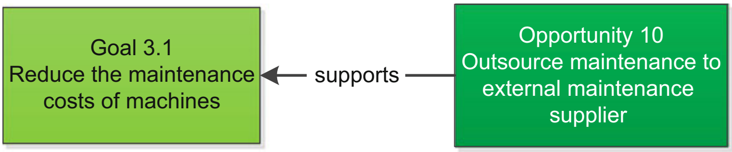

Fig. 8.6 Opportunity supporting a goal

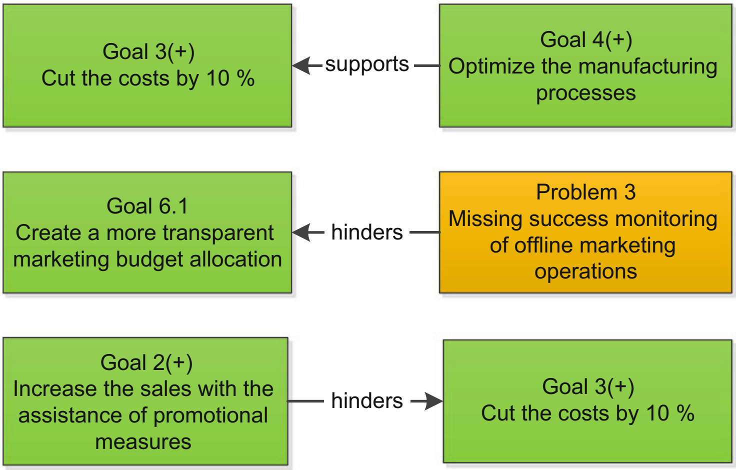

Fig. 8.7 Examples of binary relationship types in Goals Model

8.1.1.6 Links Within the Goals Model

The link types between the components of the Goals Model are (Fig. 8.7):

- *Supports* relationship, that is used to show that fulfilling one goal supports fulfilling another. Supports is essentially seen as "vertical" relationship, i.e., it is used to refine or decompose goals into other often more operational goals.
- *Hinders* relationship, that is used to show negative influences between components of the Goals Model, and can be considered as opposite to "supports."
- *Conflicts* relationship, that is used in a situation when an achievement of a goal is in conflict with another.

Initially the Goals Model may have a high level of abstraction. To obtain more clarity and to specify goals in more detail it is often necessary to decompose or to refine them to sub-goals. Such possibilities are provided by *AND*, *OR*, as well as AND/OR relationships.

The AND refinement relationship is used to specify a set of unique sub-goals that are necessary to satisfy a goal (Fig. 8.8).

The OR refinement relationship is used to specify a set of alternative sub-goals that support a goal. It is sufficient to satisfy only one goal from the set (Fig. 8.9).

The AND/OR relationship is used to specify a set of alternative sub-goals—to support a goal. A combination of sub-goals from the set will satisfy a goal (Fig. 8.10).

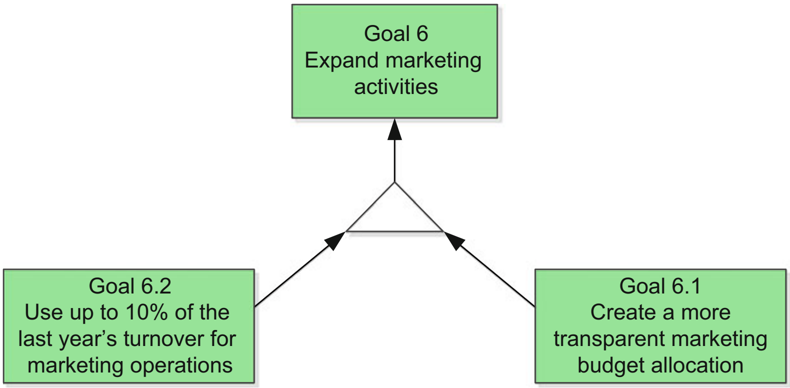

Fig. 8.8 Example of goal refinement with AND relationship

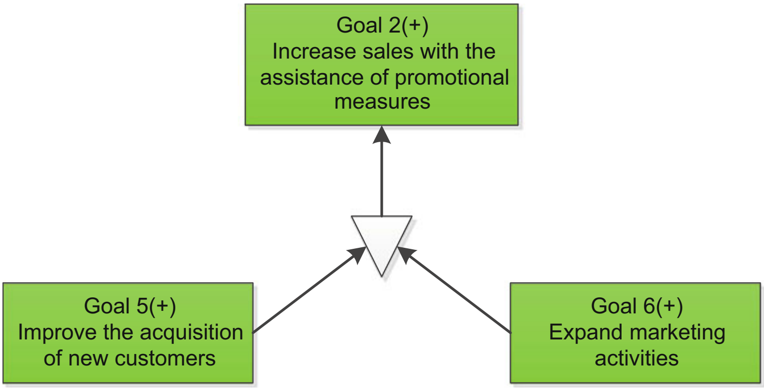

Fig. 8.9 Example of goal refinement with OR relationship

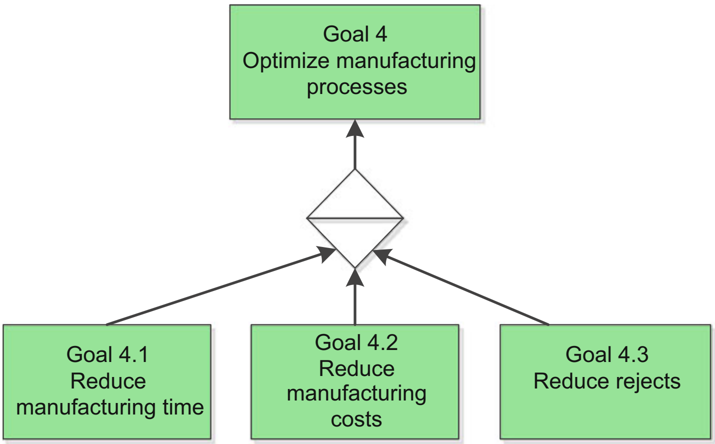

Fig. 8.10 Example of goal refinement with AND/OR relationship

8.1.2 Notation

The notation of the Goals model is depicted in Fig. 8.11.

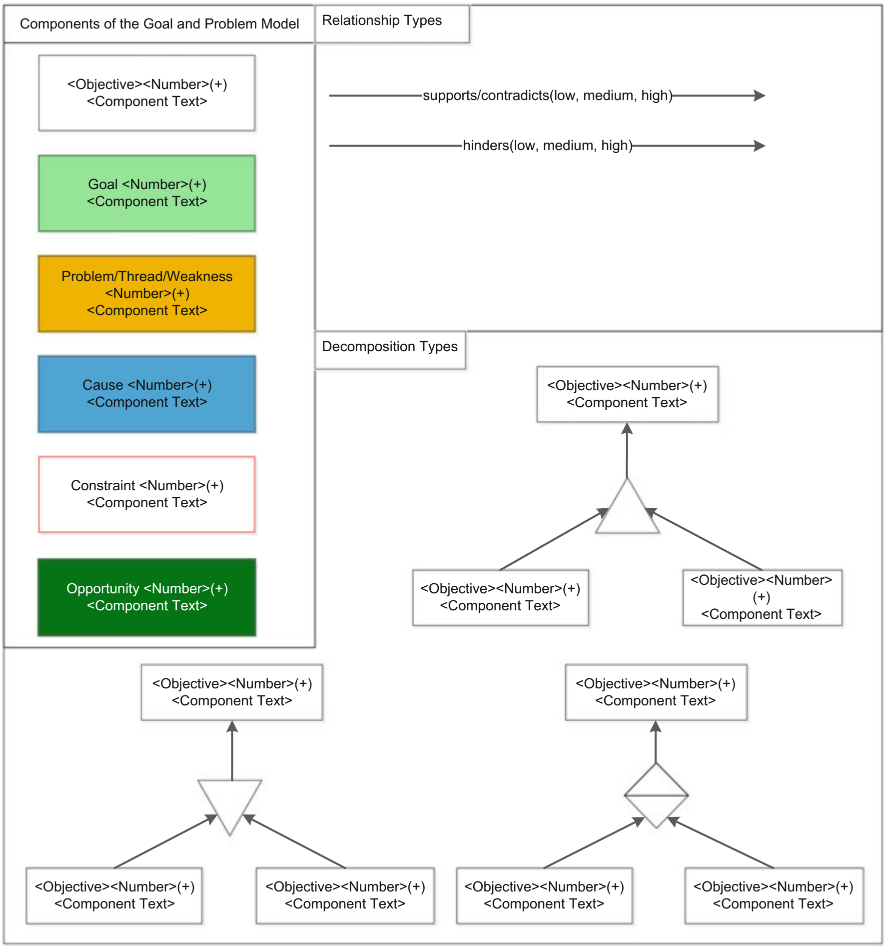

Fig. 8.11 Notation of Goals Models

8.1.3 Example Goals Model

8.1.3.1 Modeling the Current Situation (the AS-IS Model)

A4Y's primary objective for the current year is to reach a profit increase of 15 % (Goal 1). There are two sub-goals that support the achievement of this primary objective. The company can increase its profits by increasing its sales through promotional measures (Goal 2), by lowering its operating costs by 10 % (Goal 3), or by implementing a combination of Goal 2 and 3 (Fig. 8.12).

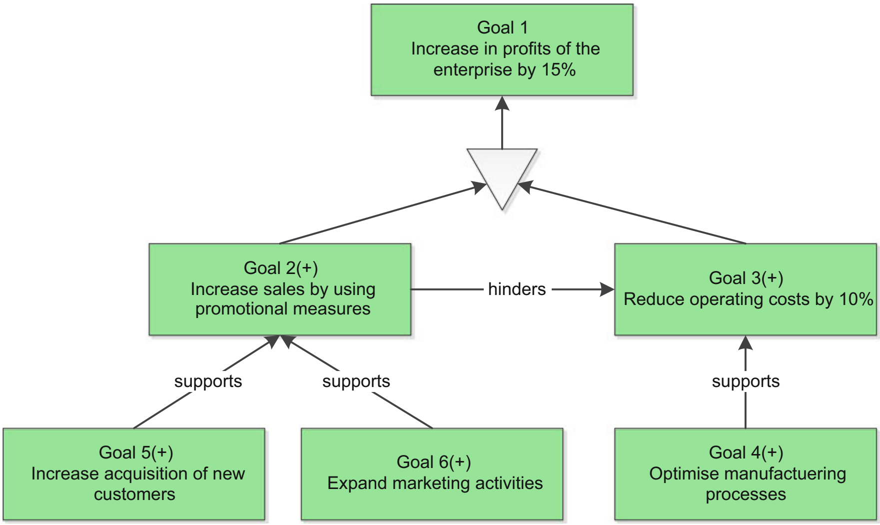

Fig. 8.12 Top goals of A4Y

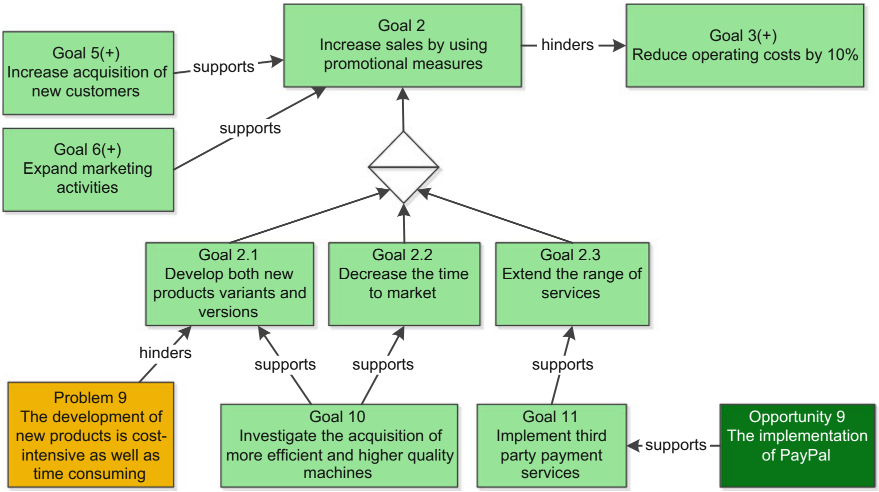

Fig. 8.13 Further refinement of goal 2 by defining sub-goals and exploring opportunities

In order to increase sales, the company A4Y can acquire new customers (Goal 5) or expand its marketing activities (Goal 6). Both goals support Goal 2. Further refinement of Goal 2 can be done by introducing more sub-goals: development of new product versions/variants (Goal 2.1), reducing the time to market (Goal 2.2) or extension of services (Goal 2.3). As these goals belong to Goal 2 they can be seen as refinement of this goal. Therefore, Goal 2 is marked in the top-level model with a (+) to indicate the existence of a decomposition (see Fig. 8.12). This decomposition with the sub-goals included is illustrated in Fig. 8.13. In order to reach these goals, the company already investigated potential measures, such as the introduction of a new payment system (Opportunity 9).

However, the achievement of Goal 2.1 is also associated with the problem that development of new products is time-consuming and is associated with substantial costs (Problem 9). This problem has an indirect effect on Goal 3, as it is in conflict with the reduction of operational costs (see Fig. 8.13). To resolve this conflict, the company has to decide how to deal with this issue in the future. The decision should be documented in the final version of the model. After further analysis of the sub-goals of Goal 2, Goal 10 is introduced, which defines the need to investigate the possibility to acquire more efficient machinery, as well as Goal 11 that identifies the need to implement third-party payment services. Opportunity 9 documents one such option—to use PayPal services. At this stage this is modeled as an opportunity because the company has not yet decided which supplier to use for these services.

In order to increase the profit of the company according to defined goals, operational costs should be reduced in addition to increasing sales. This objective is modeled with Goal 3, which in turn consists of several sub-goals. On the one hand, Goal 3 consists of the sub-goal of optimizing production processes (Goal 4 in Fig. 8.12) and on the other hand it consists of several supporting sub-goals (see Fig. 8.14). Thus, Goal 3 is also marked with a (+). There are also weaknesses, threats, and restrictions influencing the goals (see Fig. 8.14). For Goal 3.2, the company has documented a weakness that the shipping guidelines so far have not been applied in a satisfactory way. Therefore, this weakness hinders Goal 3.2. Another problem that hinders Goal 3.1 is the risk that the blacksmith does not have the necessary knowledge for maintenance of the machinery. Both problems

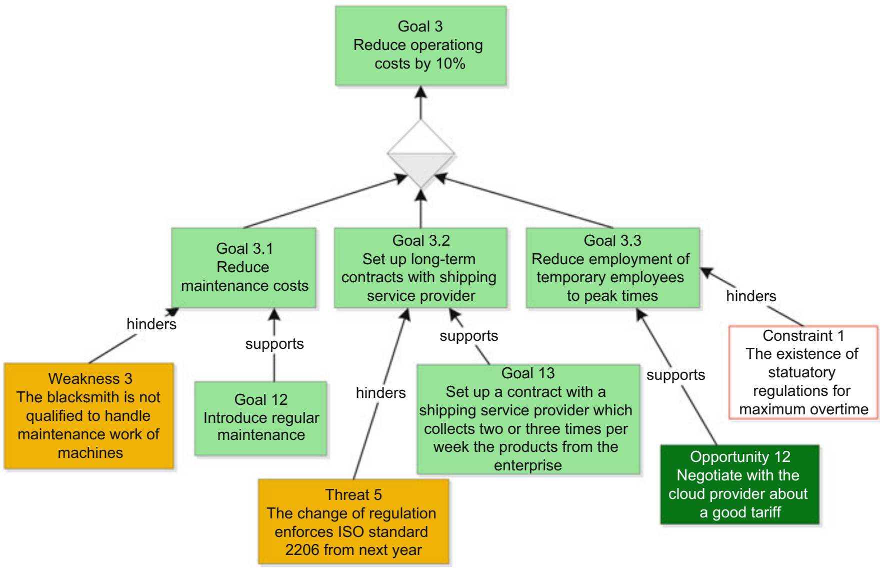

Fig. 8.14 Refinement of goal 3

(Weakness 5 and Threat 6) can be solved by simple measures. Nevertheless, there is a restriction, which cannot be influenced by the company and which hinders the achievement of Goal 3.3—in periods with high workload, the company either hires additional workers for a limited period of time or the regular employees work overtime. In both cases the length of temporary employment and the maximum overtime of regular employees is strictly regulated by law (Constraint 1).

8.1.3.2 Modeling the Company's Vision (the TO-BE Model)

A4Y decided not to invest in new machinery for developing new products and product variants in the near future. Based on this decision, an agreement is reached on how to solve the conflict between Goals 2 and 3. The agreement is to increase sales through promotional activities to a certain degree, and to put the main focus on reduction of operating costs.

Accordingly, Goal 2.1 and the associated Problem 9 were removed, because it was assumed that the high costs associated to this goal could hinder Goal 3 (see Fig. 8.15) which is not acceptable.

So far the model of the future state (TO-BE model) has been developed by simplifying and removing modeling components. This, of course, is not the only

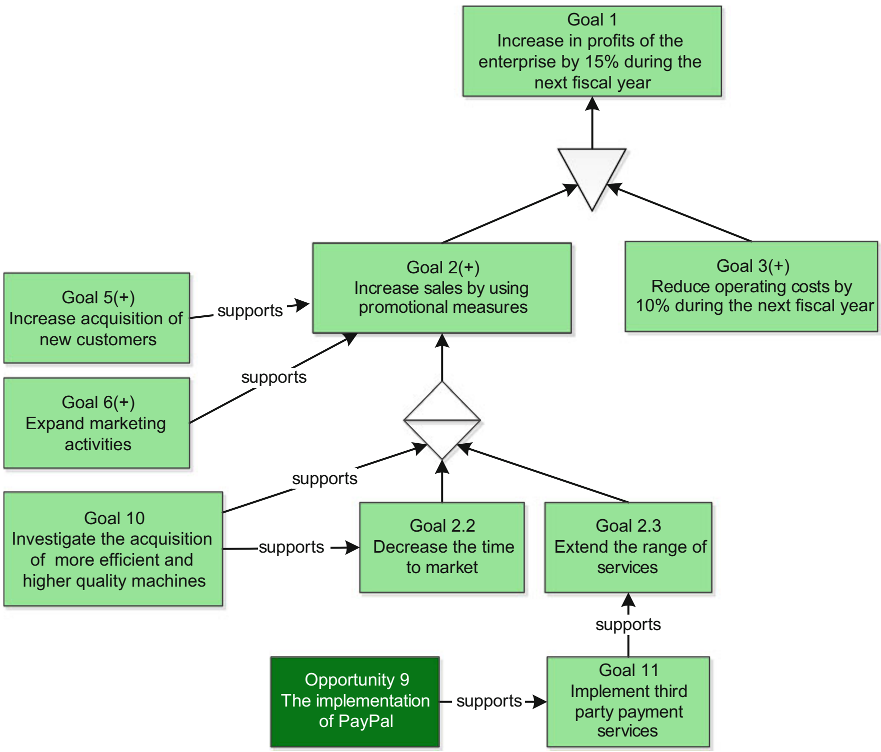

Fig. 8.15 Future state goals for Accessories4you (TO-BE Goal Model)

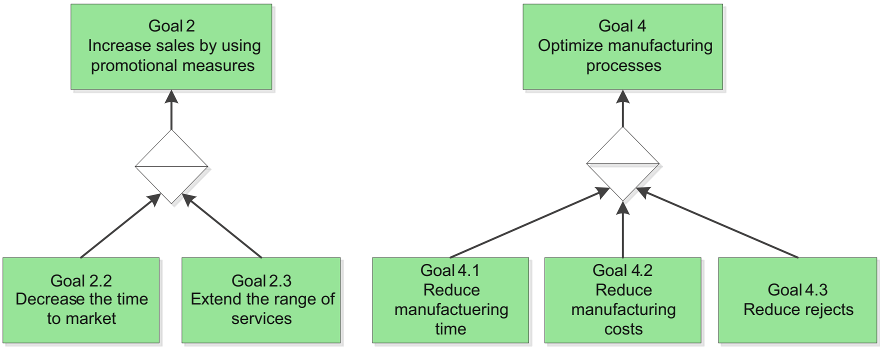

Fig. 8.16 Goal refinement in the TO-BE Goal model

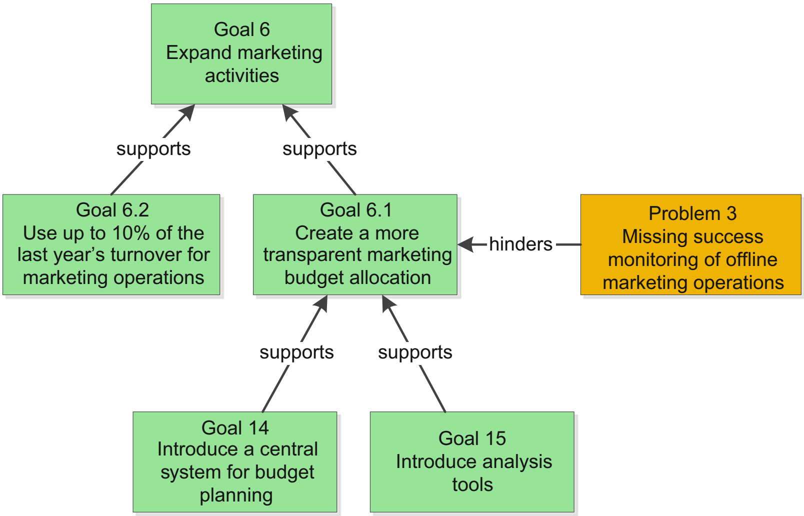

Fig. 8.17 Further goal refinement in the TO-BE model

way—there also is a need to develop the model by introducing new components that support the main objective of the company. For example, Goal 6 and Goal 4 are extended with new sub-goals (Goal 6.2, Goal 4.1, Goal 4.2, Goal 4.3) as shown in Figs. 8.16 and 8.17.

8.1.4 Developing and Refining the Goals Model

In the previous section we showed a small example of goal modeling for the AS-IS and TO-BE states of an organization. There are some common principles of developing a goals model in a modeling workshop, which are discussed here.

Developing a Goals Model is initially a brainstorming activity. Views and contributions from all participants must be considered, which normally makes the initial product of modeling unstructured and difficult to understand. Initial versions of Goals Models often look like islands of goals and problems where the grouping of modeling components implies certain categorization with respect to the modeling problem. Once this is done the following steps include structuring, classification, and operationalization of Goals Model components. This is normally done collaboratively in an iterative fashion, where participating stakeholders are continuously consulted to validate the progress. Naturally, this also leads to discovering new goals and/or problems, which are in turn analyzed and added to the Goals Model that emerges as a result of the modeling effort.

It is important, when developing a Goals Model, to concentrate on the business itself, and not on supporting information system and more technical goals related to the systems. Information systems goals will be modeled in the Technical Components and Requirements Model (Sect. 8.6).

The static rules of the enterprise, as well the dynamic rules that govern the permissible state changes of the enterprise, are also informally defined in this sub-model. Normally "business rules" can be seen as refinements of higher level business goals or constraints. The business rules are then further elaborated in the Business Rules Model (Sect. 8.2).

At any stage of goal modeling, it is useful to use, or at least to keep in mind, some driving questions. These will keep the modeling effort focused and moving forward. Table 8.1 suggests a number of driving questions for goal operationalization and refinement of goals. These two actions deserve a closer look.

The purpose of the *goal operationalization* is to elaborate detailed measures for fulfilling high-level goals. Operationalization of the Goals Model encourages the development of a goal network, usually a hierarchy, where top-level strategic goals are decomposed into a number of more operational sub-goals. However, it needs to be pointed out that in practice categorizing goals into strategic or operational goals is not easy or even needed, because in the goal hierarchy there are also goals "in the middle" which are not as specific as operational goals and not high enough in the hierarchy to be called strategic. The key aspects of the goal operationalization process are:

- *Emphasis on creativity:* goal operationalization reflects a creative jump from present facts to future possibilities that bring into being something new that has not previously existed.
- *Emphasis on the dynamic nature of the modeling process:* the result of the process is not static but depends on the design decisions and the visions of the future situation during the operationalization process. This means that the outcome of the process is not always the same.

The operationalization is characterized by two principal types of activities—goal refinement and conflict management.

During *goal refinement*, new goals are generated from the initial high-level goals into detailed and clarified goals. In this sense a high-level goal is refined into one or

Table 8.1 Driving Questions for goal modeling

Question	Motivation
What are the strategies of this part of the enterprise?	Goal modeling aims to capture the organization's vision and strategy. In most cases parts of the strategy are defined and hence need to be captured in the model
Are there stated policies in the enterprise that may influence this model?	New designs introduced in the model should be aligned with the overall legal framework of the business. This might concern internal as well as external laws, policies, and rules
Which conventions, rules, regulations, and laws are relevant?	These need to be discussed and in some cases modeled as constraints or even problems if they restrict the business. Compliance to rules and regulations can also be modeled as business goals
What would you like to achieve?	This aims to capture stakeholder intentions concerning the problem domain. Typically each stakeholder comes up with a few proposals that are then discussed and introduced in the model
Taking a particular goal, how can we make this goal more specific, more relevant to our project/company?	This question aims to make formulation of a goal more specific and measurable in order to arrive at a SMART goal
Are there any particular problems hindering this?	This question is linked to the above, triggering thinking about various obstacles to the vision that emerge in the model
Is this problem related to a particular goal?	Each stakeholder may propose a few problems that are then discussed and introduced in the model
What is the cause of this problem?	In some cases problem causes may need to be discussed and modeled
How can this problem be eliminated?	This question triggers thinking about potential solutions to problems. It might actually happen that in the initial stages of modeling a Goals Model contains a large number of problems, but at later stages they are solved by formulating appropriate goals
Are there any particular opportunities that one could use?	This question is useful when finding new alternatives to business solutions
What actions could be taken to improve the situation?	This question usually triggers seeking for solutions to problems and leads to goal operationalization. It can also lead to switching to modeling business rules and/or business processes
How can this goal be achieved? Can this goal be defined in operational terms, by identifying a number of supporting sub-goals?	These are more concrete questions leading to defining operational sub-goals

(continued)

Table 8.1 (continued)

Question	Motivation
Why and How?	Asking "why" to every goal typically extends the model "upwards" and allows goals supported by the goal being analyzed. Asking "how" to every goal typically extends the model "downwards" and helps formulating sub-goals that need to be fulfilled to achieve the goal currently being analyzed. In some cases the "how" question also leads to formulating business rules and/or business processes because these components also deal with implementing enterprise strategies. These two questions essentially are used for goal refinement and operationalization

more sub-goals that can, in turn, be refined in sub-sub-goals. The result of these successive refinements is a multilevel hierarchical structure, starting from high-level vague enterprise objectives down to specific operational goals. In goal refinement, it is possible to use AND/OR relationships in the structures, to refine goals into several alternative combinations of sub-goals, or a sub-goal can be realized by several alternative models.

Goal *conflicts management* consists of a number of activities such as the following:

- Conflict *detection:* This focuses on identifying conflicts between goals. It may be difficult to relate new goals to existing goals and to determine the effect of the former on the latter. To do this, one should exhaustively search the goal model and compare the new goal to each existing goal for conflicts. A reasonable way to search for potential goal conflicts is to use the high-level goal conflicts that have already been identified during the goal acquisition stage. The heuristic rule is that it is more likely to find conflicts between sub-goals of previously identified conflicting high-level goals.
- Conflict *classification*: This focuses on identifying the kind of conflict that has been detected. *Ends conflict*—Goal conflicts may occur when two contradictory goals are desired. *Means conflict*—When actors hold identical goals. However, these goals are in conflict because each actor wants to use the same resource. Conflict classifications may be used by conflict management methods to react accordingly.
- Conflict *handling* focuses on acting in case of conflict. Alternatives are the following:
  - *Ignore*: for example, when conflict does not prevent further development. However, it is necessary to keep track of the conflict in case its impact increases.

  – *Ameliorate:* the balancing of conflicting goals may not be clear until the various design possibilities are explored in terms of alternatives. This way the decision is shifted to the model generation stage, when more concrete data about a situation is available.
  – *Resolve* the conflict. Often, a goal conflict implies the unavailability of any specific alternative to achieve both goals. In this case, the ranking of goals may be useful for deciding a potential dropping of a goal. However, some goal conflicts may be overcome by: redefining the goals, specifying the context in which each goal is achieved or finding alternative goal refinements that have fewer conflicts.

The two key issues in managing conflicts are: *tracking* known conflicts and *recording* information about these conflicts, such as the circumstances that led to these conflicts.

Very often, the high-level goals, problems, business rules, etc., acquired at the elicitation contain a number of informal and imprecise requirements. Initial versions of a model might also contain certain redundancy, which is allowed in order to support the discussion and to accommodate stakeholder wishes. It is recommended that the output of the initial Goals Model be structured at an early stage. This task involves:

- *Goal classification:* To improve comprehension and understanding of a multitude of goals, it maybe advisable to classify them in a matrix table, where they may be categorized according to origin, stakeholder, function, domain, etc. This will allow for comparison and analysis and will potentially uncover the need for further discussion based on the analysis of the patterns of the goals.
- *Goal prioritization:* A prioritization of goals allows for conflict resolution between goals. A higher level goal acts as a constraint on a lower level goal.
- *Goal correlation:* Goal correlation is perceived as the positive or negative interaction between goals. In general, positive correlation among goals by supports relationships is desirable, which implies that satisfaction of one goal will support the satisfaction of the other goal. On the contrary, the existence of antagonistic goals could prevent the satisfaction of goals. Furthermore, failure to recognize antagonistic goals could cause confusion throughout the modeling process. In addition to analyzing the goals model, goal correlations can also be analyzed by creating a connectivity matrix—where all goals are listed as rows and columns and each cell represents a relationship. In larger models this sometimes allows discovering new relationships.

8.2 Business Rules Model

The Business Rules Model is used to define and maintain explicitly formulated business rules, consistent with the Goals Model. Business rules may be seen as operationalizations or limitations of goals. Business rules are the rules that control the enterprise in such a way that they define and constrain which actions may be taken in the various situations that may arise. These may be in the form of:

- Precise statements that describe the way that the business has chosen to achieve its goals and to implement its policies or
- The various externally imposed rules on the business, such as regulations and laws.

Business Rules often form a hierarchy where lower level rules define the way the higher level rules or goals are implemented. Business Rule modeling is closely related to Goals modeling. Rules are defined by goals while also affecting the fulfillment of other goals. They trigger business processes and refer to concepts defined in the Concepts Model. Actors in the Actors and Resources Model are responsible for achieving and defining business rules. Business rules may also require certain functionality from information systems. Components of the Technical Components and Requirements Model may, therefore, be motivated by business rules.

8.2.1 Components of the Business Rules Model

Business rules may be categorized into Derivation Rules, Event-action Rules, and Constraint Rules that are further classified into Static and Transition Constraints.

Derivation rules are expressions that define the derived components of the information structure in terms of entities that are already present in the information base of the modeled enterprise. Derivation rules are introduced as a means of capturing structural domain knowledge that needs not to be stored. Its value can be derived dynamically using existing or other derived information. A derivation rule is, for instance, "A bad library client is a client that does not return a loan on time for two consecutive times."

Event-action rules are concerned with the invocation of activities. In particular, action rules express the conditions under which the activities must be taken, i.e., a set of triggering conditions and/or a set of preconditions that must be satisfied before their execution. For instance, "If the return of a loan is more than 4 days overdue, send a reminder."

Constraint rules are concerned with the integrity of the enterprise information , or with the enterprise activities and their permitted behavior. A constraint is, for instance, "the salary of an employee must not decrease." Constraints can be further specialized into:

- *Static constraints* apply to every state of the information base and are time-independent. They represent conditions that must hold at every state. A static constraint is, for example, "location of each copy of book is unique and only one."

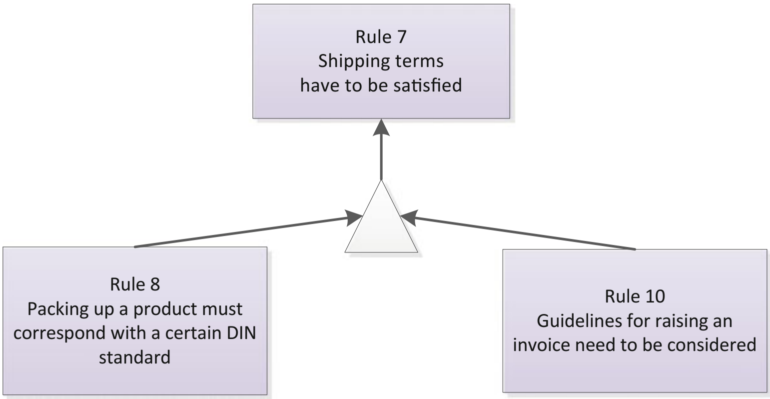

Fig. 8.18 Example of rule decomposition using AND relationship

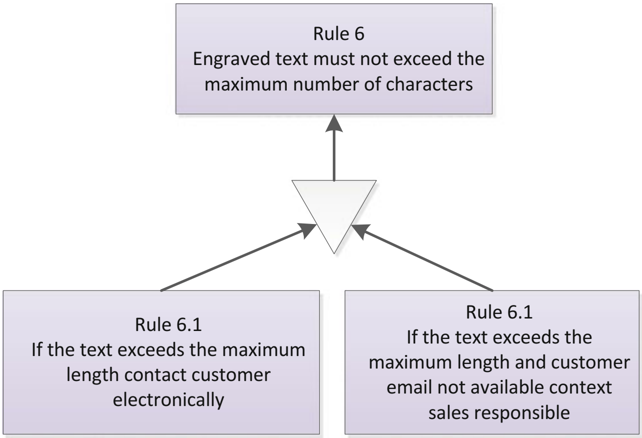

Fig. 8.19 Example of rule decomposition using OR relationship

- *Transition constraints* define valid state transitions in the information base, thus specifying restrictions on the behavior of the system. A transition constraint is, for instance, "A copy of book is missing, if the loan that includes it is overdue for more than 4 weeks."

The relationship types between rules in the Business Rules Model are:

- *Supports* relationship is essentially seen as vertical, i.e., it is used to refine or decompose rules.
- *Hinders* relationship is used to show negative influences between components of the Business Rules Model, and can be considered as opposite to supports.

As in the Goals Model, there are also possible AND/OR decomposition structures in Business Rules Model (Figs. 8.18 and 8.19).

- *AND* refinement relationships represent a set of unique sub-rules that are necessary to satisfy to support the original refined rule.
- *OR* refinement relationships represent a set of alternative sub-rules. To support the original rule it is necessary to satisfy only one rule from the set.

8.2.2 Notation

The notation of the Business Rules Model is depicted in Fig. 8.20.

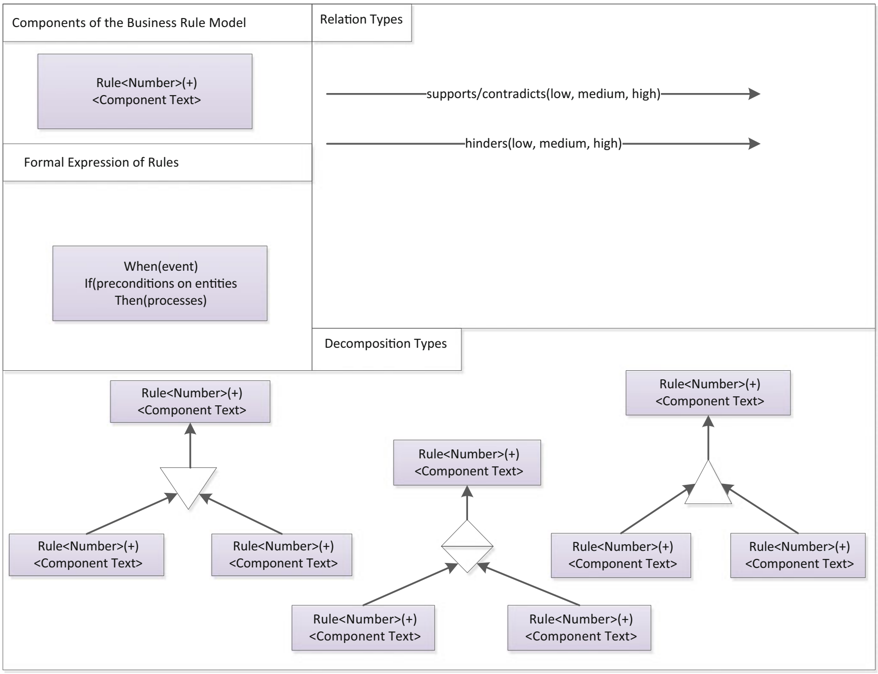

Fig. 8.20 The notation used in the Business Rules Model is similar to that for the Goals Model

8.2.3 Example Business Rules Model

8.2.3.1 Modeling the Current Situation (AS-IS Model)

As shown in the Goals Model, the primary goal defined by the company is the profit increase by 15 %. Other goals were defined to support Goal 1. Many of the goals are connected to business rules, which further specify conditions for achieving the goals and create possibilities for the company to monitor goal achievement. In this context, A4Y developed several rules to be followed by the staff in the different business processes. For example, the two Rules 9 and 5 are intended to support the objective “Reduce time to market” (Goal 2.2); see Fig. 8.21. Rule 9 supports Goal 2.2 with the directive that the manufactured products have to be shipped daily. The second important rule (Rule 5) states that the manufacturing process must not take longer than 2 weeks. Thus, both rules support the objective of selling the products as soon as possible.

A4Y has identified a number of rules that are derived from other rules, i.e., they are rules that build on each other. First, the rules on the refinement level must be met before the “higher level” rule can be applied. For example, Rule 27 aims at selecting the logistics service provider according to the packet size and the recipient country. In order to follow this rule, Rule 7 must be considered which requires that the shipping guidelines should be observed at all times.

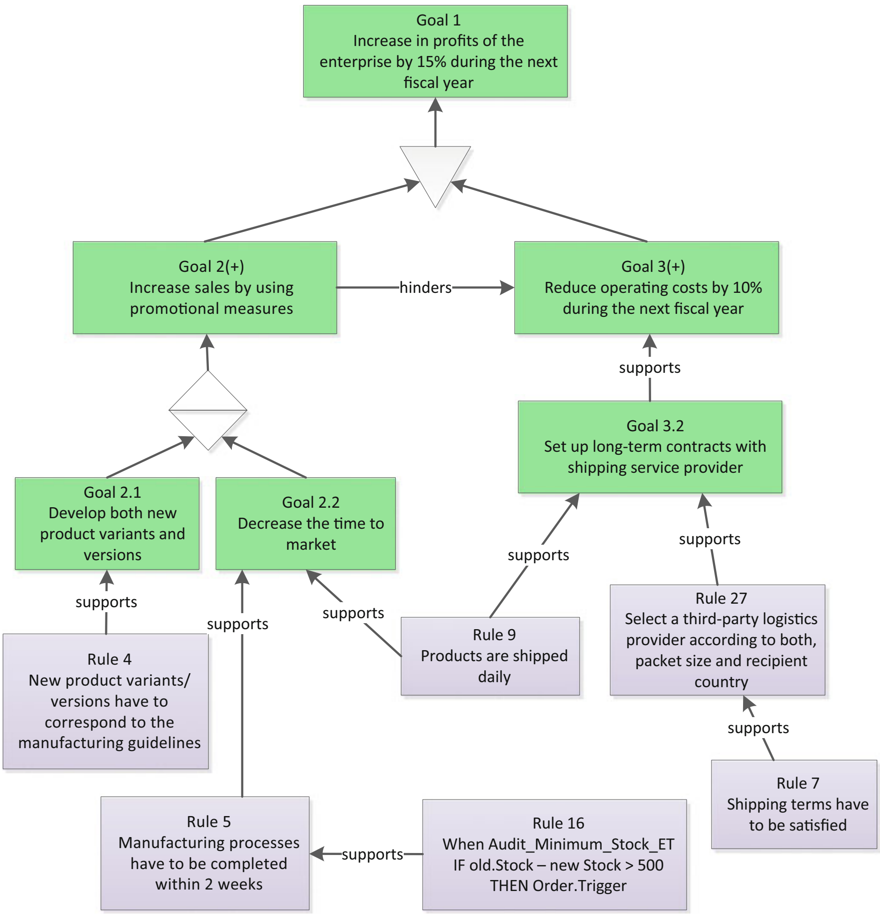

Fig. 8.21 Example of a goal and rule connections in the Business Rule Model

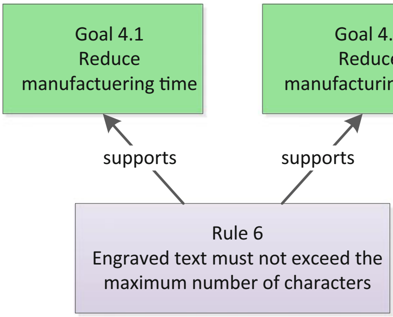

Fig. 8.22 Example of a rule contributing to several business goals

For the manufacturing part of the business, the company has a rule (Rule 16, Fig. 8.21) that states that an order should be triggered when the number of items in stock falls below a minimum inventory of 500 items. In this context, also Rule 5 is affected, as an empty warehouse can significantly prolong the production process or even halt it. By formalizing this relationship, dependencies can be detected quickly and support is given, regarding how this rule has to be applied in order to guarantee an appropriate amount of parts in stock. The rules are illustrated in Fig. 8.21.

Furthermore, it may happen that the same rule can apply to multiple objectives. For example, the Goals 4.1 and 4.2 both are supported by Rule 6, since that directive specifies the maximum number of characters in the engraving and helps to avoid unnecessary costs and delays in production (see Fig. 8.22).

To comply with the shipping policies and avoid legal consequences for the company, two additional rules are defined by management—Rule 7 is refined by defining Rule 8 and 10. Firstly, the product must be packed in accordance with international standards and, secondly, other guidelines were created to ensure proper billing. These two rules are visualized in Fig. 8.23 and define preconditions for a smooth and accurate shipping process.

Furthermore, the management defined rules to be applied in the business processes as complement to the goal-related rules. Rule 26 "Report poor quality to the CEO" at the same time supports Rule 11 in control of the delivered goods and is part of Process 12.5. In this process, the quality control for incoming goods is carried out. If any defect should occur, this must be reported to the CEO (see Fig. 8.24).

When examining dependencies between all rules defined for AA4Y, one rule is discovered which prevents reaching certain goals: Rule 3 defines that the CEO and all involved parties have to explicitly agree, if a manufacturing order or procurement order has to be changed. This means for Goal 4.1—to just mention one example—that any customer order requires the explicit agreement of the CEO. If the CEO is not available, the production process for this order cannot be started. This in turn contradicts Goal 4.1 that aims to reduce the production time, since the required flow of information and tasks resulting from Rule 3 rather extend the production time than shorten it (see Fig. 8.25).

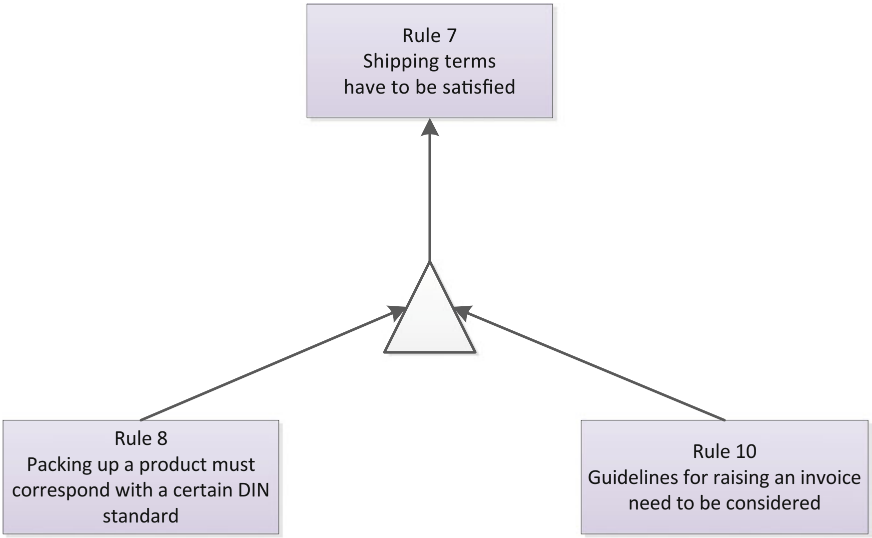

Fig. 8.23 Example of AND decomposition in the business rule model

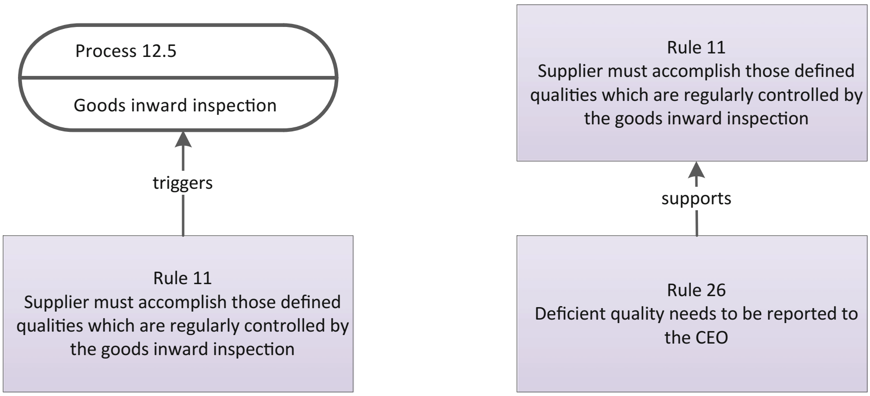

Fig. 8.24 Example of a rule related to both a process and another rule in the business rule model

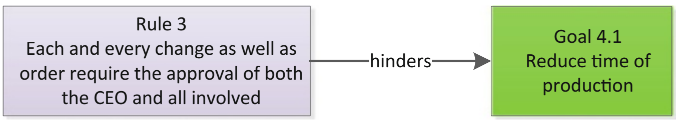

Fig. 8.25 Example of a rule that hinders a goal in the business rule model

8.2.3.2 Modeling the Future State (TO-BE Model)

A4Y decided not to invest in new machines for developing new products and product variants in the near future. The reason for this is the intention to increase sales by promotional activities, and to focus on the reduction of operational costs.

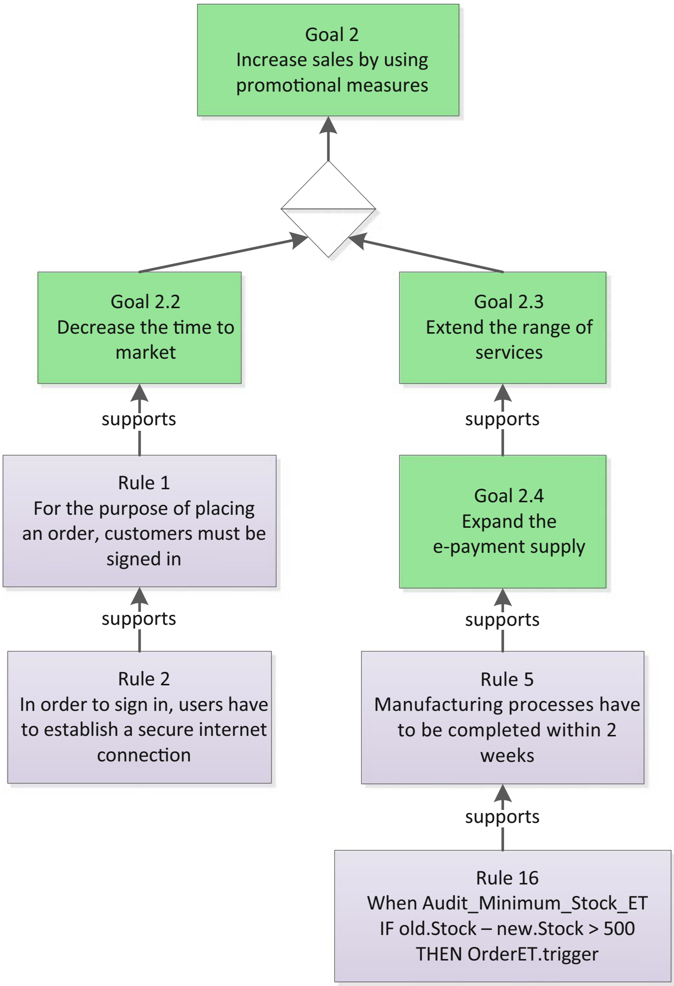

Fig. 8.26 Example of an updated rule model in the target model

Accordingly, Goal 2.1 was removed in order to avoid an increase in operational costs. When removing Goal 2.1, the corresponding rules also had to be eliminated, as they have no further use (see Fig. 8.26).

A4Y also decides to establish contracts with shipping service providers, which include pickup service for the goods to be shipped. Due to this proposed measure, Rule 9 has to be removed and replaced by Rule 28 (see Fig. 8.27). Rule 9 defines that products should be shipped on the day of their completion, i.e., the foreman has to deliver the products to the shipping service providers as soon as they are completed. This is considered inefficient and shall now be replaced by Rule 28 "Products should be ready for shipping." According to the new rule, the foreman has to prepare the products for shipping, but no longer has to deliver them to the shipping service provider. All products ready for shipping are picked up by the shipping service two to three times a week.

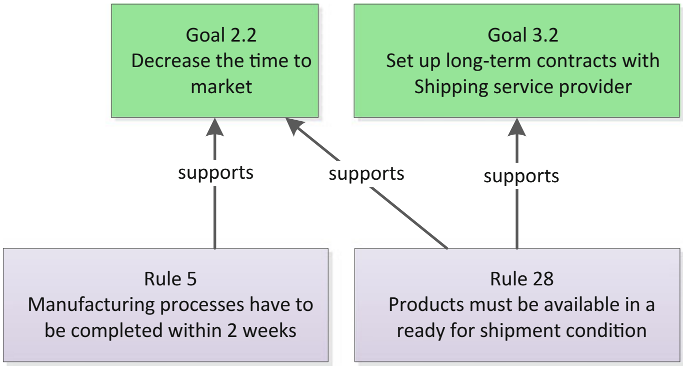

Fig. 8.27 Example of replacing a rule in the business rule model

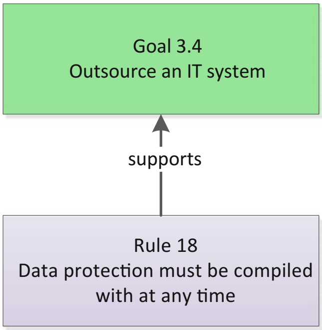

Fig. 8.28 Example of adding a rule in the business rule model

As the company also decides to outsource part of the IT system, a new rule needs to be added to Goal 3.4 (see Fig. 8.28), defining that privacy has to be observed at all times (Rule 18). It should be noted that not every goal requires a rule.

As a result of a thorough analysis of the rules defined in the AS-IS model, the management of A4Y decides to remove or replace certain rules. As already discussed when describing the AS-IS model, Rule 3 stating that any changes require the consent of each stakeholder involved and the manager him/herself hinders Goal 4.1, reduction of production time. As a consequence, it is decided to remove this rule, i.e., Goal 4.1 "Reduce production time" can be performed more efficiently.

8.2.4 *Introducing More Formality in the Business Rules Model*

Business rules are seen as a formal part of organizational design. In many cases they are expressed in natural language. But in view of the inherent informality of natural language, formal expression of rules is needed in some cases. In 4EM this can be achieved by expressing business rules in the following way:

```
When {event}
If {preconditions on entities}
  then {processes}
```

It may, however, not always be possible to formulate a business rule using this proposed pattern. Generally, there are several ways by which business rules can be stated:

- Informally such as in normal language,
- Formally such as structured English, or
- Formally by using specially developed rule languages, e.g., Object Constraint Language (OMG 2000), SBVR (OMG 2008)

The latter two express rules in an unambiguous way that contributes to easier implementation of them in an information system design. Such rules should contain only one atomic rule, that is, a specific formal statement of a single constraint, fact, derivation, or term and cannot be decomposed further. For example, we can rewrite Rule 16: "When the stock below 500 order new" as shown in Fig. 8.29.

From a rule written in this way, modeling participants and designers are able to get more precise information about the event, condition, and the process to be triggered; see Fig. 8.30.

However, in a formal way it is possible to express only atomic rules. Rules that are more complex need to be expressed in natural or seminatural language and then decomposed or refined by using AND/OR relationships. Also, there may be also atomic rules that are almost impossible to define in a formal way, e.g., rules that are related to nonfunctional requirements.

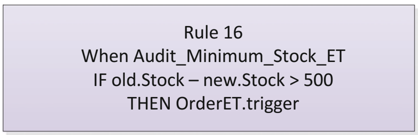

Fig. 8.29 Example of a single constraint

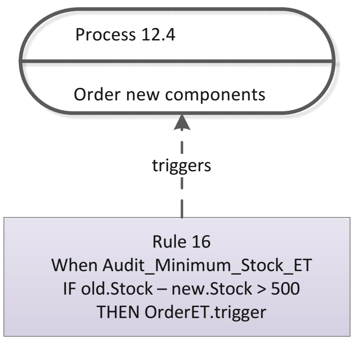

Fig. 8.30 Example of a rule triggering a process in Business Processes Model

Table 8.2 Driving questions for business rule modeling

Question	Motivation
Are there stated rules and policies within the company that may influence this model?	Every company has stated internal rules that need to be included in the model if they influence the problem at hand or the envisioned solution
By which rules can the goals of enterprise can be achieved?	This question aims to further operationalize a specific goal by defining rules that help its fulfillment
Does a rule relate to a particular goal?	Rules can relate to goals by supports, hinders, or conflicts relationships. In the case of the latter two relationships the conflict needs to be resolved by either reformulating the goals or reconsidering the rules
How can this rule be decomposed into simpler rules? *How can this rule be defined in an operational way?*	These questions aim at deeper rule operationalization
How can the enterprise conform to the specification of the rule? How do you validate that a rule is enforced?	These questions aim to establish if certain business processes or concepts need to be established in order to comply with the rule
Which process triggers this rule?	In the case of event-action rules there is a need to consider which business processes are triggered by the rule and if the process has the appropriate inputs and outputs in terms of information and/or material
Who is responsible for this rule?	This question aims to establish a responsibility for the rules in terms of Actors and Resources Model components (e.g., role or organizational unit)

8.2.5 *Developing and Refining the Business Rules Model*

Business rule modeling is often linked together with modeling other types of sub-models. For example when developing goals there may be a need to define certain rules, when modeling business processes specifying exceptions may be needed, and when modeling concepts a need to define integrity constraints may arise. There are several kinds of driving questions that could be useful when eliciting and analyzing business rules; see Table 8.2.

8.3 Concepts Model

The *Concepts Model* is used to define the “things” and “phenomena” which are used in the other models. Concepts may be tangible, such as e.g. “car,” or intangible, such as e.g. “quality.” The Concepts Model must, at least, include components by which we can describe the contents of the different information sets and flows of the Business Processes Model. For example, the goal expression “To maintain and improve the library’s services” requires a definition in the Concepts Model of the concept “library service.” It is vital that important concepts used in other models are defined here to avoid the possibility of misunderstandings amongst participants and stakeholders. Inconsistencies are hence avoided.

A Concepts Model includes components such as *concepts, binary relationships, and information attributes*. Also, the *ISA* and *PartOF relationships* are included in the Concepts Model to permit generalization as well as complex component modeling. The Concepts Model also allows the possibility of defining different “Concepts Model Component Groups.” A group of this type is simply a view of a part of a Concepts Model, and includes a subset of the Concepts Model’s concepts, relationships, and attributes. A group can be a member of another group, etc. Groups may overlap each other in terms of their components.

The main purpose of the Concepts Model is to serve as a dictionary for reasoning about “things” and “phenomena” included in the other models. Hence the 4EM language for Concepts Modeling is relatively simple. A Concepts Model, or most often parts of it, can also be used for database design. In this case, the notation for the Concepts Model proposed here would most likely have to be replaced with a more formal data modeling notation e.g., Object-Role Modeling (ORM) (Halpin and Morgan 2008). The choice of modeling language does not affect the modeling process itself. It is generally possible to begin with the notation we describe in this book and then, later on, switch to more advanced concepts modeling language, e.g., ORM or UML Class Diagrams (OMG 2005). This may be particularly important when the Concepts Model is used as a requirements source for a database design.

8.3.1 Components of Concepts Model

The Concepts Model follows the same principles as most other modeling languages for data models—it consists of concepts, attributes, and a set of associations.

Concept is something in the domain of interest and application that we want to reason about and to characterize and define using relationships to other concepts.

Attribute is a component type that is only used to characterize concepts, i.e., it is a property of the concept (see Fig. 8.31).

Concepts can be related to each other by means of semantic relationships, such as binary relationships, generalization/specialization (ISA) relationships, and aggregation (PartOF) relationships.

A *Binary relationship* is a semantic relationship between two concepts or within a concept. The semantics of the relationship is defined by the modeler by naming it. Binary relationships are inherently bi-directional. Each direction can be given a name, preferably in the form of a verb phrase. The direction indicated by the arrow may be called the forward, or primary, direction and the opposite direction the inverse direction. An example of permitted multiplicities for binary relationships is given in Fig. 8.32. The concepts participating in a relationship can be said to play

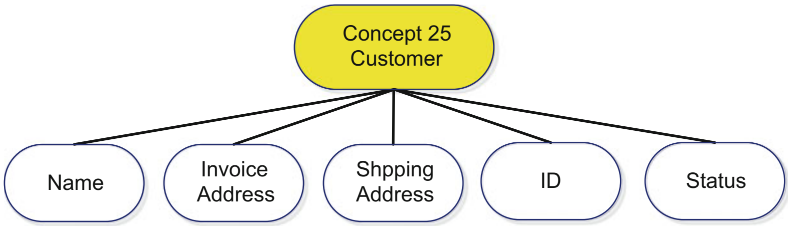

Fig. 8.31 Example of a Concept and its attributes

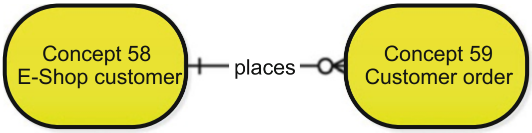

Fig. 8.32 Example of a binary relationship

certain roles in the relationship. In the relationship “An E-shop customer places several Customer Orders; Each Customer Order is placed by exactly one E-Shop customer” (see Fig. 8.32), the customer is the one who places the order, while the order is what “is placed” by the Customer.

8.3.1.1 ISA Relationships

An *ISA relationship* is a specific kind of semantic relationship between concepts. If “A” ISA “B,” then “B” is the more generic concept and A is the specific concept. Establishing this kind of relationships is also referred to as generalization. The opposite or inverse of generalization is called specialization.

The most significant property of an ISA relationship is that of inheritance. All that is specified to be true about the generic concept is also true for the specific concept. That means that all attributes, their values, and constraint (rules) are inherited from the more generic level concept down to the more specific level concept as are all relationships in which the more generic level concept participates.

The subtypes that result from a particular specialization of a concept can be non-overlapping. Consider, for instance, the specialization of Product into Engraved Product and Standard Product (see Fig. 8.33). This states that no single product can be both engraved product and standard product, at least not at the same time. Such a specification is called total.

A specialization is total when all the instances of the generic type are members of one specific type, i.e., when the specialization is a partition of the generic type. When the specialization is partial there are instances of the generic concept (type) that is not a member of any of the subtypes. For example customer has two subtypes e-shop customer and anonymous customer, but more subtypes are possible as well.

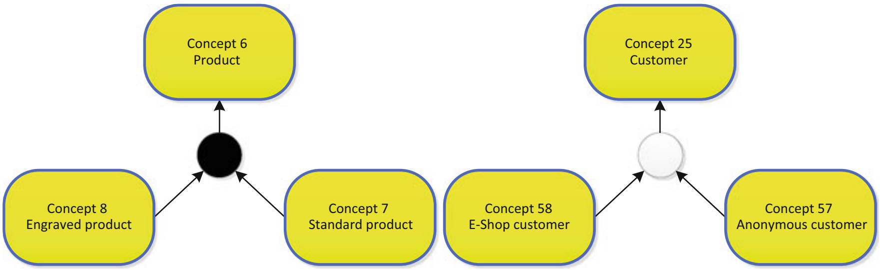

Fig. 8.33 Example of total and partial generalization

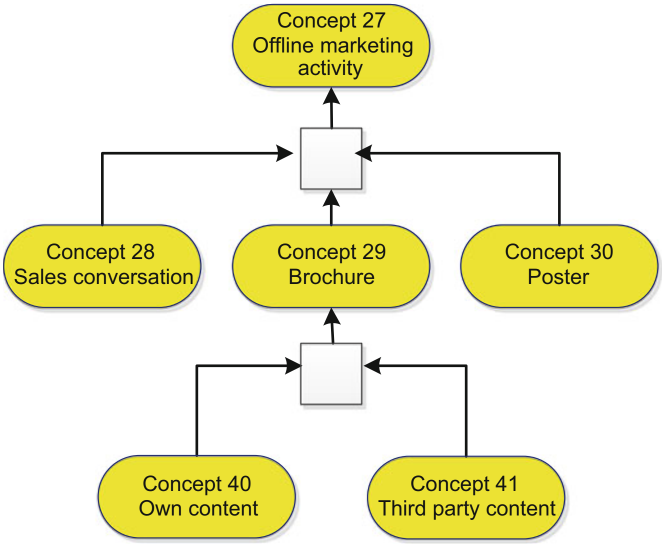

Fig. 8.34 An example of a PartOF relationship structure

8.3.1.2 PartOF Relationship

A *PartOF relationship* or an aggregation is a special form of semantic relationship, where the interrelated concepts are "strongly and tightly coupled" to each other. The aggregate concept is an assembly of parts, and the parts are components of the aggregate. The component concepts are often subordinate to the aggregate concept.

The most typical example of an aggregation is a part dependency, where the part at the top level consists of a number of components, and where each or some of these components at the next level are seen as aggregates, which in turn have parts.

The PartOF relationship construct is included in the Concepts Model for reasons of convenience, making it possible to use it whenever it is considered natural and rewarding to see and operate on something as part of a hierarchy or a structure of components.

The example in Fig. 8.34 shows that an off-line marketing campaign consists of a component structure. It is defined to have three components: a printed advert, a brochure, and a poster. A brochure in turn consists of own content and third-party content.

8.3.2 Notation

Notation of the Concepts Model is shown in Fig. 8.35.

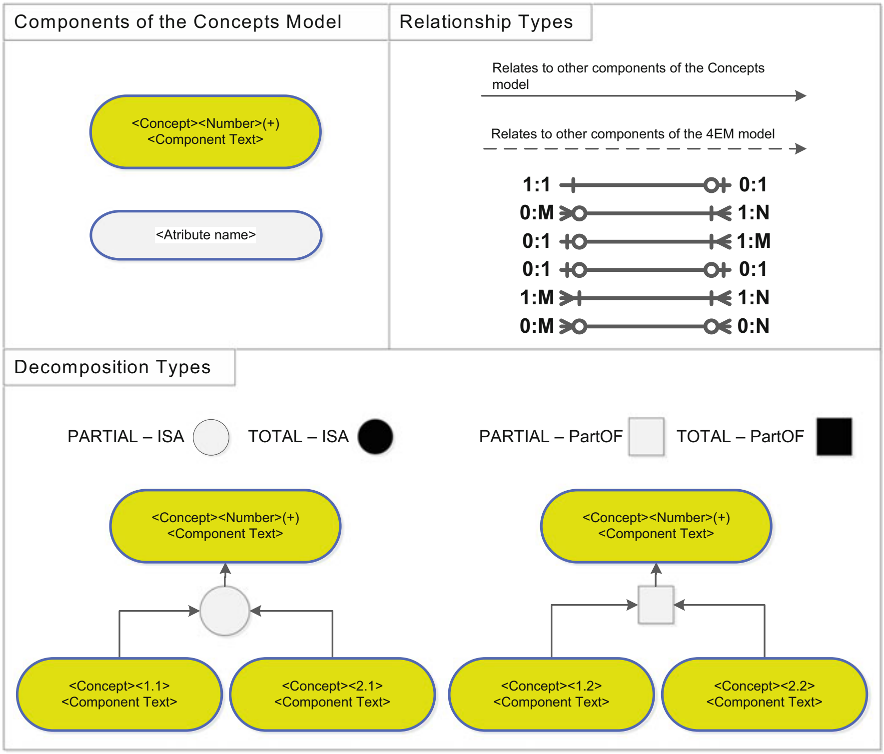

Fig. 8.35 Notation used for Concepts Modeling

8.3.3 Example of a Concepts Model

8.3.3.1 Modeling the Current Situation (AS-IS Model)

A4Y sells accessories in the form of physical products. A product (Concept 6) is based on sample blanks (Concept 14) and can be engraved (Concept 8) or be resold as a standard product (Concept 7). Sample blank, also called pattern blank, is a basic component that can be manufactured into a product if it is faultless. If a production order for the production of standard products exists, in the first step a sample is minted or produced using a laser. Subsequently, the sample is passed on to production, if it shows no flaws (Concept 15). The example is shown in Fig. 8.36.

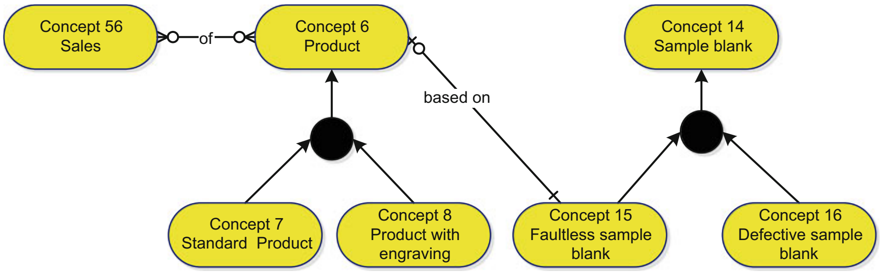

Fig. 8.36 Example of modeling the concept "product" in the Concepts Model

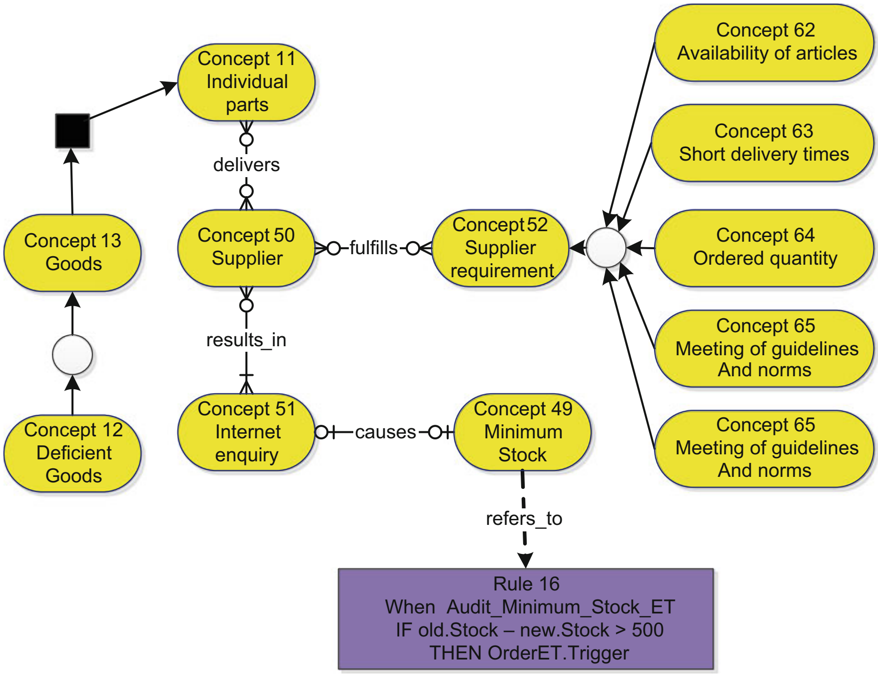

Fig. 8.37 Example of modeling the concept "supplier" in the Concepts Model

All information and properties that have been defined for the concept "Product" also apply to the refinement of this concept, i.e., "Product with engraving" and "Standard product." Since there are no further refinements, a total ISA relation has to be used here. Once the requested product is produced, it can be sold.

A pattern blank consists of different components (Concept 11), which are delivered by suppliers (Concept 50). The selection of suppliers is conducted by an Internet search (Concept 51). Among other reasons, this search will be initiated if the number of parts in stock (Concept 49) drops below the threshold of 500 items—this is expressed with Rule 16 (see Fig. 8.37). In the future, the

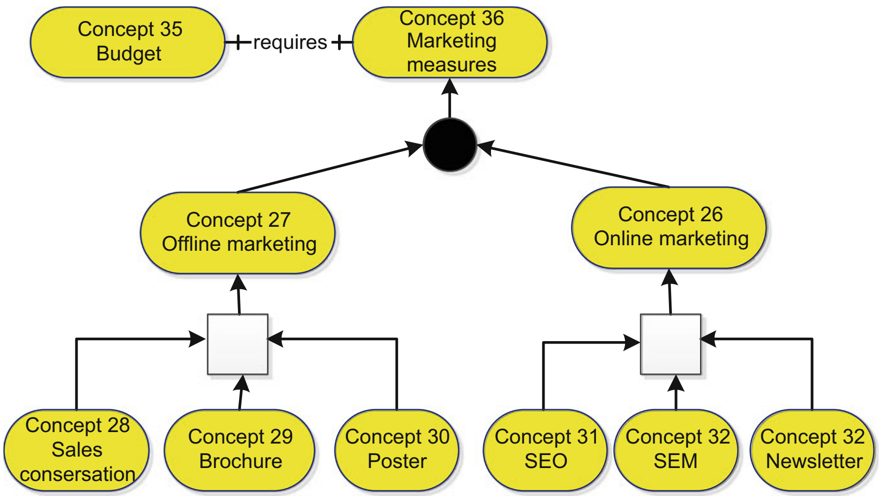

Fig. 8.38 Example of the division of marketing activities in the Concepts Model

company wants to introduce a supplier relationship management (SRM) in order to establish long-term relationships to suppliers and ease the task of supplier selection. For assessing and selecting suppliers a number of criteria were defined; see Concept 52 and its specializations.

The company has a certain budget available to conduct marketing measures. These measures are divided into online (Concept 26) and off-line marketing (Concept 27). In connection with both concepts, a number of measures are carried out, which are linked using partial PART_OF relations to the concepts. For example, the off-line marketing consists of sales pitches (Concept 28), the creation and distribution of brochures (Concept 29), and posters (Concept 30). The online marketing is divided in a similar manner into the concepts search engine optimization (SEO) (Concept 31), search engine marketing (SEM) (Concept 32), and newsletter (Concept 33). The division of marketing activities in the concept model is shown in Fig. 8.38.

8.3.3.2 Modeling the Future State (the TO-BE Model)

With respect to the future development of A4Y it showed that the concept model does not require substantial modification, as the planned changes in processes and objectives do not have serious impact on the concepts.

However, the company wants to establish a defined number of regular suppliers when introducing a supplier relationship management system (SRM). The intended effect is to avoid the time-consuming Internet search by establishing a network of regular suppliers. Due to this measure, Concept 51 is replaced by the new concept “Selection of regular suppliers” (Concept 67); see Fig. 8.39.

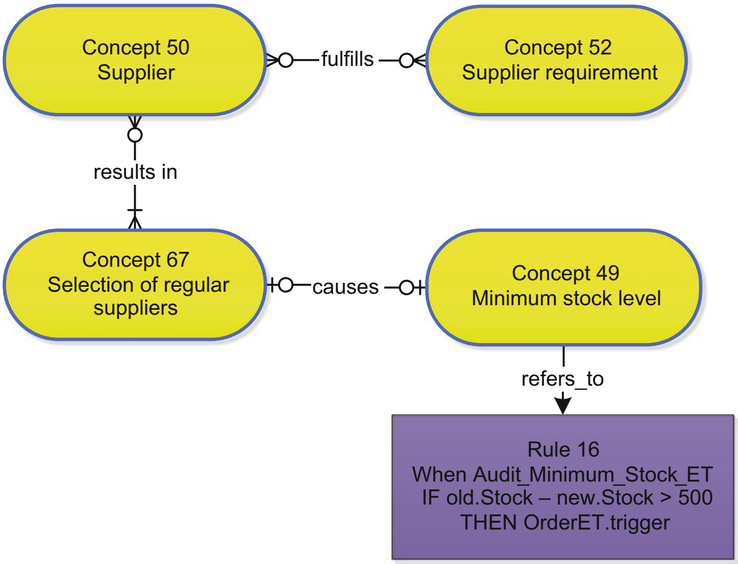

Fig. 8.39 Example from the target model for the exchange of concepts in the concept model

8.3.4 Developing and Refining the Concepts Model

It is important to understand that in the real world there may be many more relationships between concepts, but not all of them are relevant and necessary to present in the Concepts Model. Deciding on the relevant concepts and relationships depends on the modeling scope. The Concepts Model includes components, among others, that represent information, needed by or produced by processes in the Business Processes Model. Therefore, if there is a need for some process of the Business Processes Model, for instance, "Search for availability of a book in Library's Catalogue," then the Book and its Copy must be included in the Concepts Model, and their relevant attributes stated.

Note that the inclusion of the information in the Concepts Model does not imply realization in a computerized information system. It may be manually produced, disseminated, and maintained as well.

Whether concepts such as supplier and stock should be included as a component of the Actors and Resources Model depends on whether the concept is involved in any relationship as an actor or a resource which has to be documented with respect to components of the Actors and Resources Model or other models and their components. One such relationship could be that we later wish, in the Technical Component and Requirements Model, to state some information system requirements concerning the Actors and Resources Model resource "stock."

Above we have exemplified a concept that, with different interpretations and different uses, can appear in different sub-models. It is important to distinguish sharply between these different uses and to put components in the appropriate models at the start, before the models grow too large and confusing.

In the Concepts Model we may use "real entities." Experience has shown, however, that when performing modeling operations, it may be very illustrative, and supportive for human understanding, if the Concepts Model can play the role of a "dictionary of concepts." General concepts like "Profit," "Marketing," "Sales Effort," "Customer Value," and "Productivity" can sometimes be needed to be documented, and their relationships discussed. It can happen that these concepts are introduced in texts of goal statements in the Goals Model, and need further definition and discussion.

Perhaps it is important to discuss different types of "Productivity" by using specialization relations, and to discuss how the components are related to "Profit" or some specialization of it. Note, however, that these concepts, if not further refined as "data," will not appear as information consumed or supplied by processes in the Business Processes Model.

While modeling concepts there several driving questions that can be used to facilitate the modeling process; see Table 8.3.

Table 8.3 Driving questions for concept modeling

Question	Motivation
Which are the main concepts of this application?	The Concepts Model needs to define the central concepts of the problem being modeled
How are these concepts related?	Relationships among concepts represent important facts of the problem domain
Why is this concept needed?	Every concept should in some way contribute to the clarity and completeness of the overall organizational design
What do we need to know about the concept in the application? When and where do we need this (with ref. to the Business Processes Model)?	These questions help identifying relevant attributes of the concept
How many instances of this concept are there?	This allows the modeling team to consider what might be needed to manage this concept and what information needs to be known about it
How does an instance of this concept come into existence? *What makes an instance of this concept come into existence?* *What makes an instance cease to exist?* *How does an instance cease to exist? Are the above situations reflected in the Business Processes Model?*	These questions trigger the modeling team to consider the business processes that need to be modeled to deal with the concept at hand
Is a concept type generically related to some other type?	Allows identifying more general concepts and relationships among them

8.4 Business Process Model

The Business Process Model is designed for analyzing the processes and flows of information and material in the enterprise. Process can be decomposed into sub-processes. Components of the Business Process Model are primarily motivated by components of the Goals Model as well as enable goals of the Goals Model to be achieved.

The Business Process Model describes the organizational activities, i.e., the functions and processes of the enterprise. The core of the enterprise is the set of processes, contributing to the value of the enterprise. For achieving a good abstraction and overview, the Business Process Model permits full freedom of decomposing processes into subprocesses, etc., to any level. Depending on the purpose of the modeling, the processes described can be existing, or future, planned processes.

8.4.1 Components of the Business Process Model

The components of the Business Process Model are similar to most process modeling approaches. Its main components are process, external process, information set, and material set.

Process is a collection of activities that:

- Consumes input and produces output in terms of information and/or material,
- Is controlled by a set of rules, indicating how to process the inputs and produce the outputs,
- Has a relationship to the Actors and Resources Model, in terms of the performer of, or responsible for a process, and
- As an instance of a Business Process Model is expected to consume, when initiated, a finite amount of resources and time.

External process is a collection of activities that are:

- Located outside the scope of the organizational activity area in focus,
- Communicating with processes or activities of the problem domain area, and are
- Essential to document.

External processes sometimes can be considered as sources or terminators for some information or material flows. A typical example of external process may be a customer process that requests for certain library service or receives the service.

Information or *material set* is a set of information or material sent from one Process or External Process to another process.

The contents of Material and Information flows between processes are described by referencing them to their definitions in the Concepts Model where they can be decomposed if necessary. Information or material flows must have at least one sending Process or External Process and at least one receiving Process or External Process.

8.4.2 Notation

The Notation of the Business Process model is depicted in Fig. 8.40.

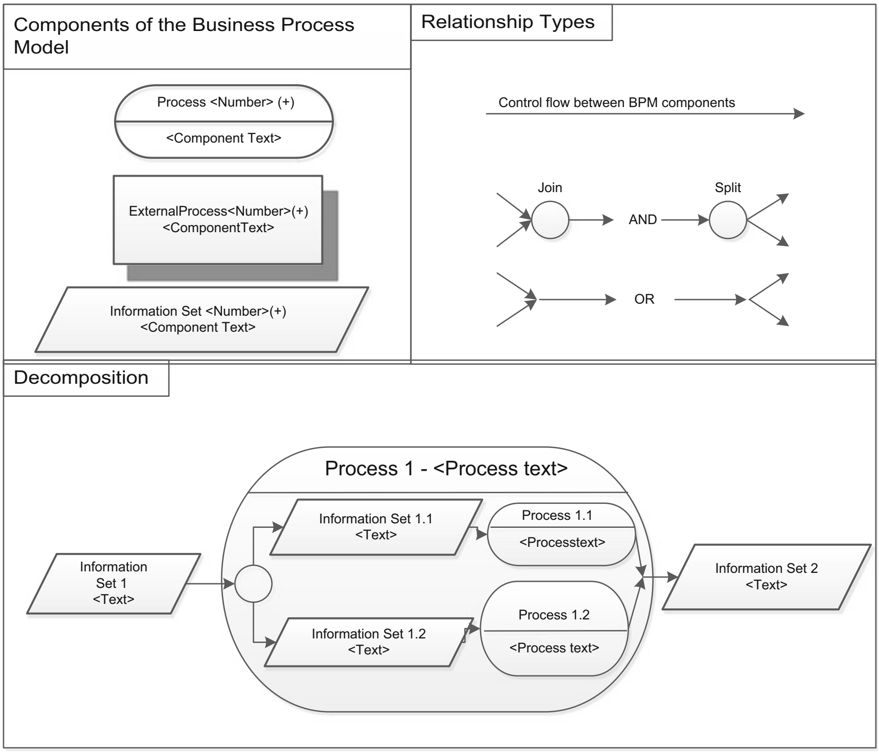

Fig. 8.40 Notation for Business Process Model

8.4.3 Process Decomposition

The higher level processes should be separated from the lower level processes with a decomposition mechanism. This means that a process is broken down into several subprocesses, each of them performing a part of the process. Each subprocess can in turn be decomposed into subprocesses. In theory this can be done until a level of atomic actions is reached. In most cases such level of detail is impractical and even if there is no maximum level of decomposition depth it is suggested to avoid unnecessarily complex structures. In most cases three or four levels of decomposition are sufficient. The basic principle of decomposition is shown in Figs. 8.41 and 8.42.

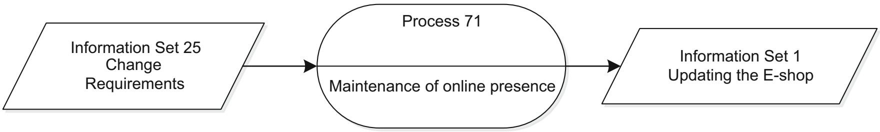

Fig. 8.41 The process "Maintenance of the online presence" is not decomposed

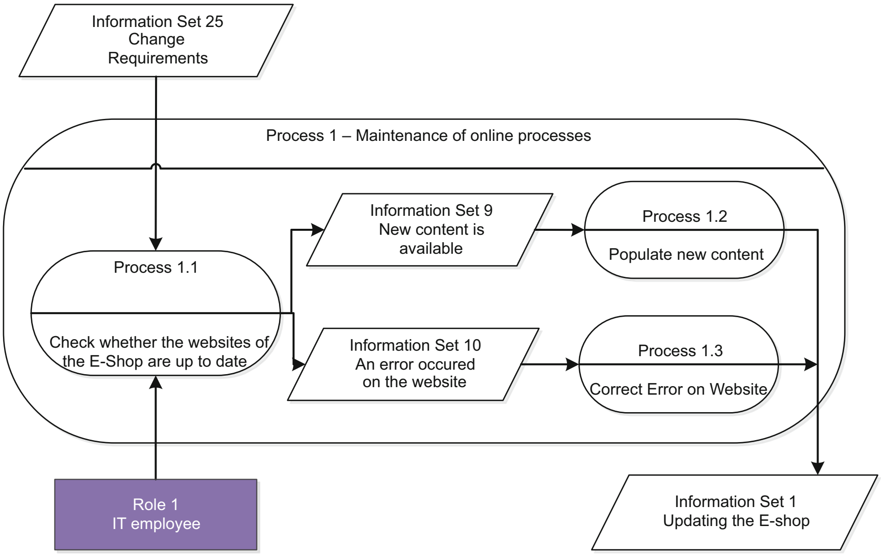

Fig. 8.42 A process "Maintenance of the online process" decomposed

In Fig. 8.42 Process 1 is decomposed into three subprocesses, each of them performing a different part of the main process. Note that the incoming and outgoing information sets are the same on both decomposition levels.

8.4.4 Example of Business Process Model

8.4.4.1 Modeling the Current Situation (AS-IS Model)

Using off-line and online marketing (terms in the Concepts Model), the customer (Role 2) is made aware of the company's products. The customer has two options to choose a product. The first is during a sales pitch with an employee in A4Y's shop, and the other one is using the product catalogue search in the e-shop (Process 2). The catalogue is maintained (Process 1) by the IT staff (Role 1), which includes updating the information (Information Set 1). If the customer has chosen a product (Information Set 8) and a customer profile exists (Process 24 and Information Set 11), the customer can place an online order (Process 3). However, if the customer profile is missing, it must be created before ordering (Process 23). This relationship is shown in Fig. 8.43.

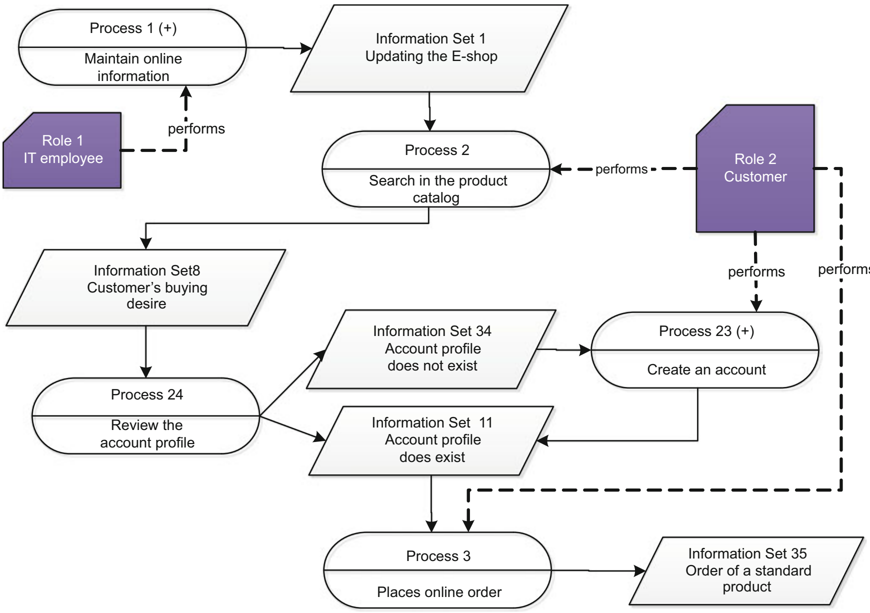

Fig. 8.43 Example of a business process model: Process of a customer order

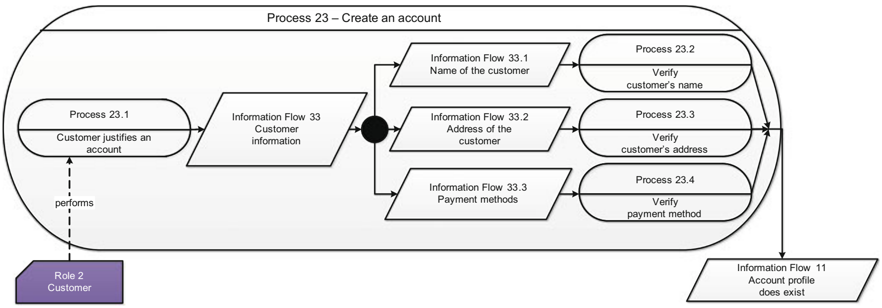

Fig. 8.44 Example of a process in the business process model that is composed of several subprocesses

Process 23 consists of several subprocesses. In order to create a customer profile, the customer must provide certain personal information (Information Set 33), including the name (Information Set 33.1), the address (Information Set 33.2), and the desired payment methods (Information Set 33.3). This information is verified subsequently (Process 23.2, 23.3, 23.4) and stored (Information Set 11) (Fig. 8.44).

As soon as manufacturing of the product ordered by the customer is finished, a shipping order (Information Set 3) is commissioned. The foreman delivers the ordered goods to the shipping service providers. In order to make this process more efficient, the company plans to establish long-term contracts with shipping service providers, which lead to a different way of shipping the goods: instead of separate shipping orders for each product and varying schedules for collecting the

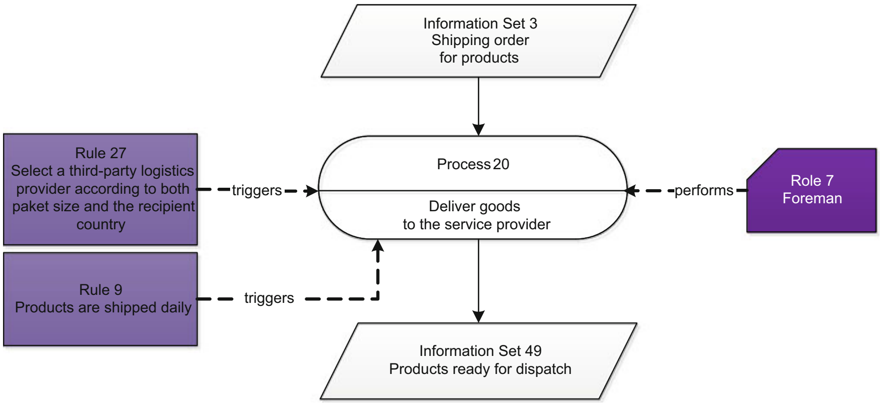

Fig. 8.45 Example of a process interaction with rules and roles

goods, the shipping service provider will collect the goods according to a predefined schedule (see Fig. 8.45).

8.4.4.2 Modeling the Changes (TO-BE Model)

The development of the "TO-BE" business process model shows that no significant changes of the AS-IS situation are required for the future development of the company. Only two modifications of the AS-IS model have to be made: The management of A4Y decides to extend and elaborate its online presence with a particular emphasis on online marketing; hence an additional process, the social media marketing (Process 15.4; see Fig. 8.46), is added to the online marketing. This step is motivated by the intention to establish an online presence in social networks, as they are enjoying a growing popularity.

The second change concerns the shipping of products. As described in the AS-IS model, the foreman currently has to deliver the products to the different shipping service providers. Instead, the management intends to establish contracts with the shipping service providers, which includes a pickup service of the products by the service providers from the branches of A4Y two to three times a week. Thus, Process 20 is removed from the target model and an External Process 1 "Shipping of products" is introduced. This external process is to be carried out by the shipping service providers (External Process 1 in Fig. 8.47).

8.4.5 Developing and Refining the Business Process Model

Components of the Business Process Model must be motivated by the enterprise goals defined in the Goals Model. Processes of the Business Process Model are performed on, or with, information described by components of the Concepts Model, such as concepts, attributes, and relationships, or Concepts Model component groups. Components of the Business Process Model also are closely related to all components of the Actors and Resources Model. The relationships between

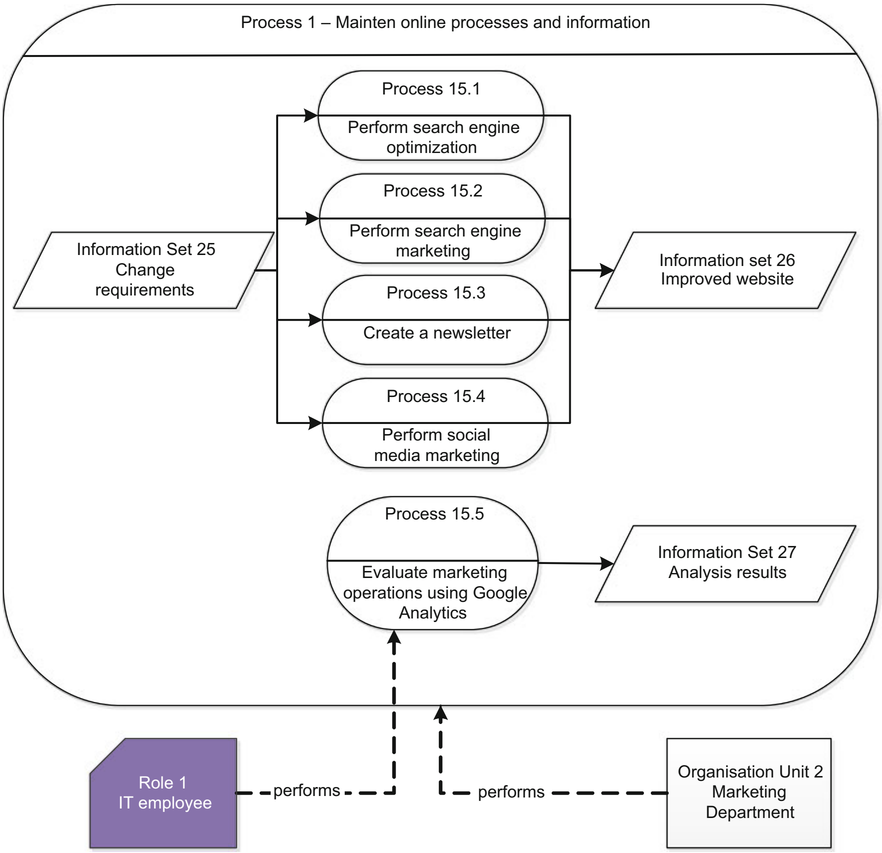

Fig. 8.46 Example for a process change in the Business Process Model

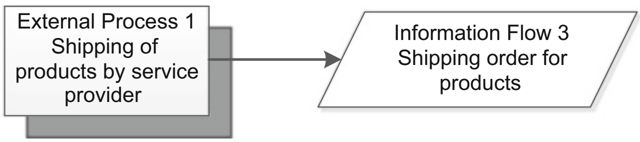

Fig. 8.47 Example for replacing and internal process with an external process in the business process model

Business Process Model and Actors and Resources Model can be of many different types, such as:

- actor A performs process P,
- actor A is_responsible_for process P,
- actor A supports process P or
- and actor A is_a_consultant_to process P.

In general, each Business Process Model component must, at some decomposition level, have a relationship defined to the Actors and Resources Model.

Table 8.4 Driving questions for business process modeling

Question	Motivation
Which are the main processes of the enterprises?	The Goals Model typically governs which the main processes are that need to be modeled with respect to the problem at hand
How are these processes related?	Processes are related on some decomposition level and by using the same information flows
Why is this process needed?	This allows identifying the rationale for the process to exist. Most often this will lead to identifying inter-model links with the Goals Model
Which information and material flows does it need? From which processes do they come? What information and material flows does it produce? Which processes use them?	Processes must have input and output in terms of information or material sets. Without identifying this the process model is not useful for implementing in the organization
Are the information and material sets represented in the Concepts Model?	Information and material sets should be defined in the concepts model
Are situations that "create" or "destroy" these information or material sets reflected somewhere in the Business Processes Model?	This question helps establishing more links between the Process Model and the Concepts Model
Which rules trigger this process?	Some business processes are triggered by rules and hence inter-model relationships need to be established with the Business Rules Model
Which actors are responsible for performing and supporting this process?	Responsibilities for processes need to be specified in order for the process design to be considered complete. Hence, inter-model relationships with the Actors and Resources model need to be established

It is important that modelers observe that the Business Process Model describes processes of the business area, and not systems or organizational units. In order for a component to qualify for inclusion in the Business Process Model, it must describe a set of possible processes, that all can be perceived to have a start and a stop time. At higher abstraction levels, this set of processes can be reasonably well defined. The main distinctions between a process (type) and an Actors and Resources Model component (actor) are:

Temporal:

- When an Actors and Resources Model component is created, it exists until it is disposed of or excluded from the environment.
- The Business Processes Model describes types of processes, for which instances exist for a limited time.

Instantiation:

- The Actors and Resources Model contains components at the instance level, e.g., organizational units, individual resources or human actors, and roles.
- The Business Processes Model describes processes at the class level.

Some driving questions in Business Process modeling are given in Table 8.4.

8.5 Actors and Resources Modeling

The Actors and Resources Model defines the types of actors and resources, or individual actors, involved in enterprise activities. The Actors and Resources Model describes how different actors and resources are related to each other and how they are related to components of the Goals Model, e.g., goals, and to components of the Business Process Model, i.e., processes. It describes the existing or future business system in terms of human as well as nonhuman resources. It allows the inclusion of a description of a socio-technical system to be developed that cannot be depicted in the Business Processes Model and Concepts Model alone.

By studying the Actors and Resources Model and its relationships to other models, we can see how different actors exhibit dependencies between themselves, e.g., an actor may be dependent on a number of other actors with respect to performing a certain task or process.

8.5.1 Components of Actors and Resources Model

The Actors and Resources Model defines the actors and resources involved in the enterprise activities, articulated in the Business Process Model, or actors related to other models or to the development of an information system. Actors and resources can be individuals, organizational units, nonhuman resources, and roles.

Individual denotes a person in the enterprise. For example: John Smith, Anne Dewey, etc. Individuals are identified by their name. However as names may not be unique they should be used sparingly. Essential persons with specific skills or roles are included in the Actors and Resources Model insofar as they clarify in some way and add meaning to the model and its relationships. Individuals may play roles and belong to organizational units. Individuals can, however, be related to other individuals, to roles, organizational units, and nonhuman resources, by binary semantic relationships. The ISA and PartOF relationships are not relevant for individuals.

Organizational unit can represent every organizational structure in the enterprise such as group, department, division, section, project, team, subsidiary, etc. For example: Planning Department, Technical Team, Telecommunications Group, Inventory Department, Computing Subsidiary, etc. Being actors, Organizational units can have subunits. They may also play roles and have other actors belonging to them. There are no predefined inter-model relationships from or to organizational units to any other non-actor model component of the enterprise model. Organizational units can, however, be related to other organizational units, to individuals, roles, and nonhuman resources by binary semantic relationships.

Nonhuman resources can be types of machines, systems of different kinds, equipment, etc. For example, "Volvo S80," "FAX machine," "MS Word 2011" are Nonhuman resources. Being actors, Nonhuman resources may have components and may be generalized or specialized. Nonhuman resources may also play roles, e.g., Nonhuman resource "Volvo S80" plays a Role "people carrier." Of course, the same Role in a different situation may be played by the different Nonhuman resource "Train X2000." Nonhuman resources may be resources for processes. They can also be related to other nonhuman resources, to individuals, organizational units, and roles by binary semantic relationships.

Roles may be played by the Individuals and Organizational units in different contexts. An organizational unit may for instance play the roles of administrator and authorizer in the same context. It may be important to identify requirements depending on the role they have. For example: Author, Approver, Controller, Supervisor, Manager, Project Leader, Process Owner, etc., are roles played by individuals, organizational units, or nonhuman resources. They may belong to one or more organizational units, and be related to other roles, to individuals, organizational units, and nonhuman resources by user-named binary relationships. Roles can be generalized or specialized, and be component roles. Roles may perform processes and be responsible for performing of processes and achieving of goals. They may also define goals.

Binary relationships are used for describing different kinds of relationships between its components. The two main purposes of binary relationships between Actors and Resources Model components and components of other sub-models are the definition of:

- *Responsibility*: a relationship between actors, between actors and business processes, business rules, and goals. Responsibilities can be delegated or transferred among actors. Responsibilities can be:

  Organizational: related to the freedom of an actor to make decisions for other enterprise entities, such as goals, rules, resources, business processes, and other actors. Responsibility here also means accountability for any malfunction, damage, or low performance of enterprise entities. Organizational responsibilities can be represented with the following relationships:
  - actor_defines_goal
  - actor is_responsible_for goal
  - actor defines_rule
  - actor is_responsible_for rule
  - actor is_responsible_for resource
  - actor is_responsible_for business_process
  - actor owns_resource
  - actor monitors_another actor

  Operational: are related mainly to the execution of tasks and they indicate that an actor is committed to perform a business process or that a business process is assigned to an actor. We can represent operational responsibilities with the relationship, "actor performs process," that means that performer of a task has the responsibility of properly carrying it out.
- *Dependency*: is a relation among enterprise actors. An actor depends on another actor for something that can be either a resource or a business process. Two types of dependency can be identified:

– *Operational*: concerns dependencies created by the flow of work. For example, actors depend on others to get and use a resource that is needed by the business process they perform, or an actor may wait for an output from another actor's process, etc.
– *Authority*: concerns dependencies created because of organizational rules, regulations, or relationships of authority and power. For example, a user needs a password to work in a computer system, a clerk needs permission to use international telephone lines, etc.

Dependency can be simultaneously of the operational and authority type.

Two specific relationships are also part of the Actors and Resources Model:

ISA is used to describe *generalization relationships* between roles of the Actors and Resources Model. The expression "A ISA B" states that components playing the role B also play the role A. Properties and relationships owned by A are inherited by B. This means, for instance, that if A is operating process P, then B is also operating process P.

PartOF, used as "B PartOF A," states that B is a component of A. We can imagine that these types of relationships can be useful in modeling organizational hierarchies, for instance that OrgUnit X PartOF OrgUnit Y, or expressing component relationships of technical systems.

8.5.2 Notation

The notation of the Actors and Resources Model is depicted in Fig. 8.48.

8.5.3 Example of the Actors and Resources Model

8.5.3.1 Modeling the Current Situation (AS-IS Model)

In the actors and resource model, the case company A4Y is represented as the top organizational unit (OU 1), which is headed by a CEO (Role 4). All other organizational units (OU 2, OU 3, OU 4, OU 5) are part of OU 1. The role of the CEO in the company is taken by the individual "Alexander Mueller" (Individual 1). Furthermore, the role of the CEO may also act as sales agent in relation to customers (Role 2) or communicate with external suppliers (Role 8) regarding orders for his company. Figure 8.49 shows an example of the actors and resources model.

Dependencies between the IT department and the "e-shop" (Resource 1) interact with the information system (Resource 2), which is controlled by the IT department (OU 3). The IT staff (Role 1) in the IT department maintains the e-shop, i.e., the provided information is always kept up to date and potential problems are promptly solved (see Fig. 8.50).

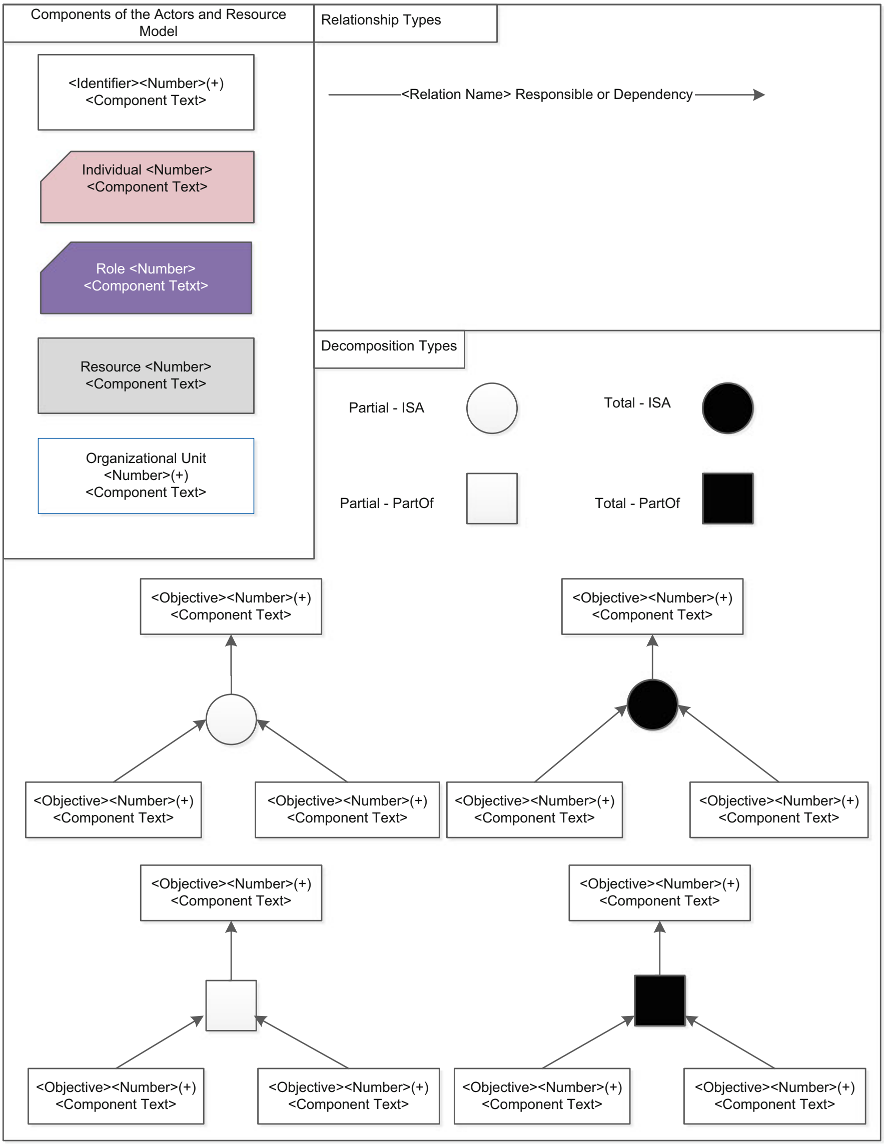

Fig. 8.48 The notation for the Actors and Resources Model components

If the customer orders a product with an engraving, this order is sent to the production organization (OU 5) and received by the employees of the production organization. Subsequently, the blacksmith (Role 5) is involved in the production process. If goods ordered from an external supplier (Role 8) arrive, the delivery is received and checked by the foreman (Role 7). Both roles, the foreman and the blacksmith, belong to the production organization (OU 5). Once the production process is finished by the blacksmith, the foreman can handle the shipping. He

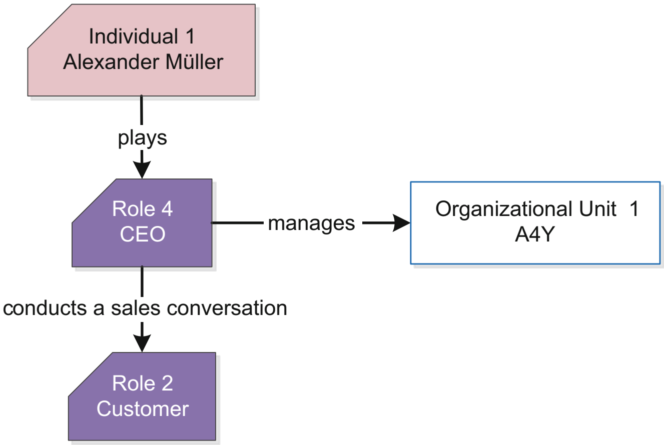

Fig. 8.49 Example of the actors and resources model

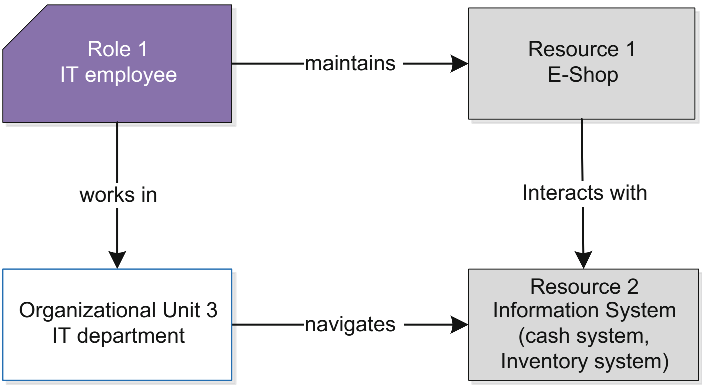

Fig. 8.50 Example of the interaction of roles, organizational units and resources in the actors and resources model

delivers the goods to selected shipping service providers (Role 9). These dependencies are illustrated in Fig. 8.51.

8.5.3.2 Modeling the Changes (TO-BE Model)

Based on the model of the current situation it is decided that no major change is needed for the future development of A4Y. The management, however, opts for two minor changes. The delivery of products to the shipping service providers shall no longer be performed by the foreman. Instead, a contract with the shipping service providers (Role 9) shall be established including a pickup service two to three times

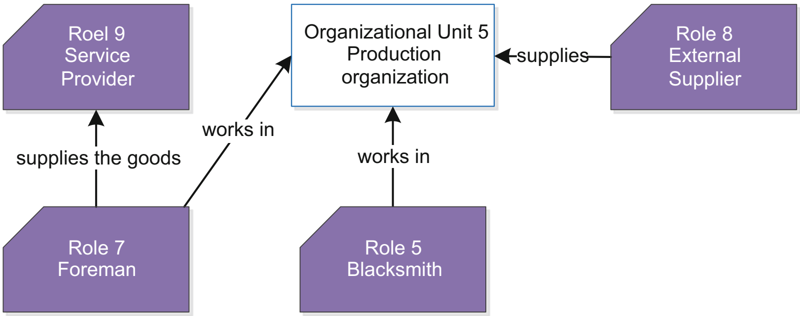

Fig. 8.51 Example of the interaction of roles with organizational units in the actors and resources model

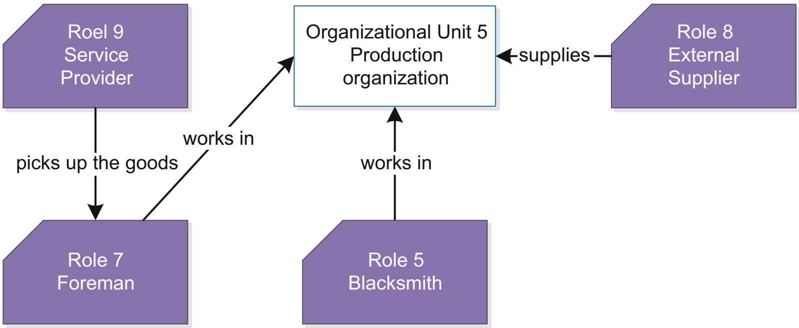

Fig. 8.52 Example of the target model: transformation of the interaction of roles.

each week, i.e., the foreman is contact point for the pickup of the products to be delivered (role 7) (see Fig. 8.52).

Furthermore, it is decided by the management to outsource the e-shop and other information systems of the company to cloud providers (OU 6). Consequently, an external information system (Resource 3) has to be established in the future, located at the cloud provider. This information system includes the aforementioned e-shop as well as other systems to be used in the company, such as a logistics system, SRM or CRM. These systems are intended to interact with the company's internal information system (Resource 2), which is controlled by the IT department (OU 3) (see Fig. 8.53). However, critical IT systems, such as the cash register and inventory system, remain included in the company's internal information system (Resource 2).

Although the e-shop will be outsourced, the maintenance of the shop information will still be performed by the company's internal IT staff (Role 1). This also includes the possibility to perform extensions and further development of e-shop functionality.

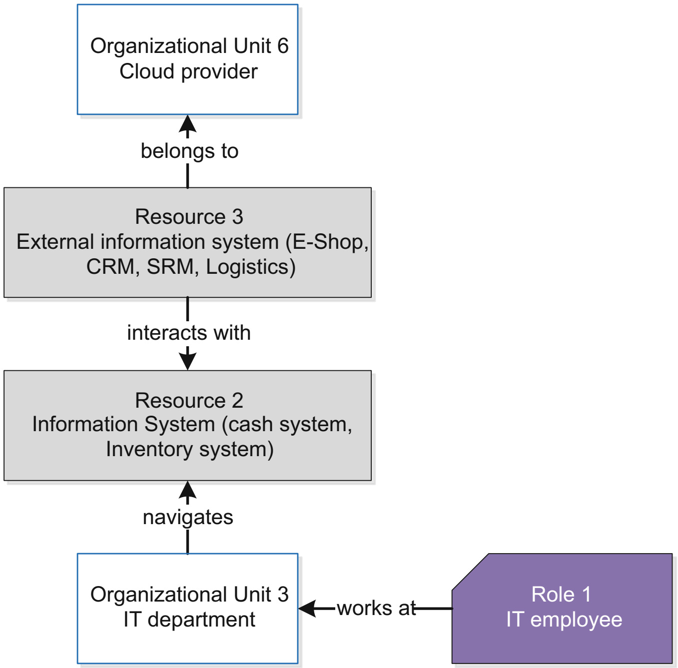

Fig. 8.53 Example of the transformation of resources in the actors and resources model

8.5.4 Developing and Refining the Actors and Resources Model

Roles played by units or individuals can also be actors as can nonhuman resources of different kinds, for instance, hardware or software systems or components. Links between the Business Process Model components and the Actors and Resources Model components describe the kind of relationship that exists between a particular process and an actor or a resource.

Driving questions for facilitating the modeling process and improving the quality of the model are given in Table 8.5.

8.6 Technical Components and Requirements Modeling

What has been elaborated by the Goals Model, Business Rules Model, Concepts Model, Business Processes Model, and Actors and Resources Model is an initial description of the enterprise's design in terms of its goals, its business rules, its processes, its "system of actors," and its information entities. If we wish to develop

Table 8.5 Driving questions for actors and resources modeling

Question	Motivation
Which are the main actors of this application?	Each problem domain has a number of actors and their relationships among each other and to other components of the model need to be documented
How are these actors related?	Relationships among actors are important part of the organization's structure
Why is this actor needed? *Which resources does this actor own and why?* *For which resource is this actor responsible?*	These questions aim to investigate the rationale behind the organizational structure by establishing links with the goal model
What is its purpose? *For which process is this actor responsible?* *Which processes does this actor perform?* *Which goals are defined by this actor?* *Which business rules are defined by this actor?* *For which business rules is this actor responsible?*	The purpose of the actor is represented by its relationships with other sub-models (goals, rules, business process)

an information system to support the processes, then there is a need to deal with technical information system requirements, initially in a less formal way.

Therefore, the 4EM approach includes a simple sub-model to describe, and to relate to each other, initial, unclear information system requirements. This sub-model resembles, in structure, the goals model, and, indirectly, information system models. Initially one needs to develop a set of high-level requirements or goals, for the information system as a whole. Based on these, the information system is structured in a number of subsystems, or technical components. For each subsystem, a set of goals is then defined that are more specific as well as requirements. These goals and requirements have to be derived from, and be consistent with, the earlier sub-models discussed above. The Technical Components and Requirements Model can also be used to capture the existing information systems and IT-components in an enterprise. To capture the as_is situation is of particular importance, if future developments of the IT-landscape in an organization will be based on the existing components. The Technical Components and Requirements Model is an initial attempt to define the overall structure and properties of the information system to support the business activities, as defined in the Business Process Model. In Fig. 8.60 the relationships between the Technical Components and Requirements Model and other sub-models of the enterprise model are shown.

8.6.1 Component of the Technical Components and Requirements Model

The Technical Components and Requirements Model includes the following types of components—IS goal, IS problem, IS Requirement (that is further specialized into IS Functional and IS Nonfunctional Requirement) and IS Technical Components.

Information System Goal is used for expressing high-level goals regarding the information system and/or subsystems or components. They may be expressed with measurable or nonmeasurable properties, aims, visions, or directions. Information system goals are typically motivated by activities of the Business Processes Model, and may be motivated by goals in the Goals Model.

Information System Problem is used for expressing undesirable states of the business or of the environment, or problematic facts about current situation with respect to the information system to be developed. Information system problems typically hinder information system goals.

Information System Requirement expresses a requirement for a particular property of the information system to be designed. The property can be functional or nonfunctional. A requirement expression always refers to components of the Business Processes Model and may refer to components of the Actors and Resources Model and the Concepts Model. Information system requirements may support or hinder information system functional or nonfunctional requirements.

Information System Functional Requirements are used to express definite requirements regarding a functional property of the information system or some of its subsystems. Functional requirements must be clearly defined with reference to the Concepts Model. Preferably, a formal or at least a semiformal way of expressing a requirement may be needed. Every data concept, referred to in the functional requirement, must be defined as a component of the Concepts Model. Functional requirements can be directly supported by information system goals, but they are more often seen as refinements of the stated information system requirements. Functional requirements are supported by components of the other sub-models, in particular the Business Processes Model, but also the Goals Model. A functional requirement must be related to a process or a subprocess, defined in the Business Processes Model.

Information System Nonfunctional Requirements are used for expressing any kind of requirements, constraints, or restrictions, other than functional, regarding the information system to be built or the process of building it. Nonfunctional requirements are not always definite and can sometimes be negotiated and relaxed. It may, for instance, happen that two nonfunctional requirements cannot both be satisfied in the same full degree, due to some financial restrictions. In this case, the level of achievement of these requirements must be negotiated. Some nonfunctional requirements may hinder other nonfunctional requirements, goals, and information system problems. They may support, or be supported by, information system goals and information system requirements. They can be related to, and be supported by, components of the Goals Model, and processes in the Business Processes Model. A Nonfunctional requirement can be related to a component on the Actors and Resources Model with relationships "involved_actor."

Information System Technical Components are used for expressing any kind of part of the existing or envisioned architecture of the information system needed for supporting the enterprise design specified in other sub-models. There can be components, packages, services, or even entire systems. The purpose of this component is to specify the required IS components on a crude level from a point of view of a business actor.

Relationships between these types of components of the types are *supports*, *hinders*, and operationalization relationships *AND, OR, AND/OR*. They are defined and permitted in the same way as for the Goals Model. Between IS technical components a PART_OF aggregation relationship similar to the one in Concepts Model is also permitted. Between IS technical components and IS goals binary relationships of type *has_goal* and *has_requirement* are also possible.

8.6.2 Notation

The notation of the Technical Components and Requirements Model is depicted in Fig. 8.54.

8.6.3 Example of Technical Components and Requirements Model

8.6.3.1 Modeling the Current Situation (AS-IS Model)

In order to guarantee a smooth manufacturing process of the products, certain technical components (TC) are required. The main component is an information system (TC 1), which consists of the components "Database system" (TC 2), "e-shop system" (TC 3), "Cash system" (TC 4), "Ordering system" (TC 5), and the "Inventory system" (TC 6). There is also the requirement of the company that the "Production system" (TC 5) and the "Cash system" (TC 4) must support the "Inventory system" (TC 6). This is to ensure that the inventory information always is up to date, i.e., whenever the production process is completed or sales of products are registered the inventory information has to be updated in order to avoid availability problems of goods. The overall structure of the information system is illustrated in Fig. 8.55.

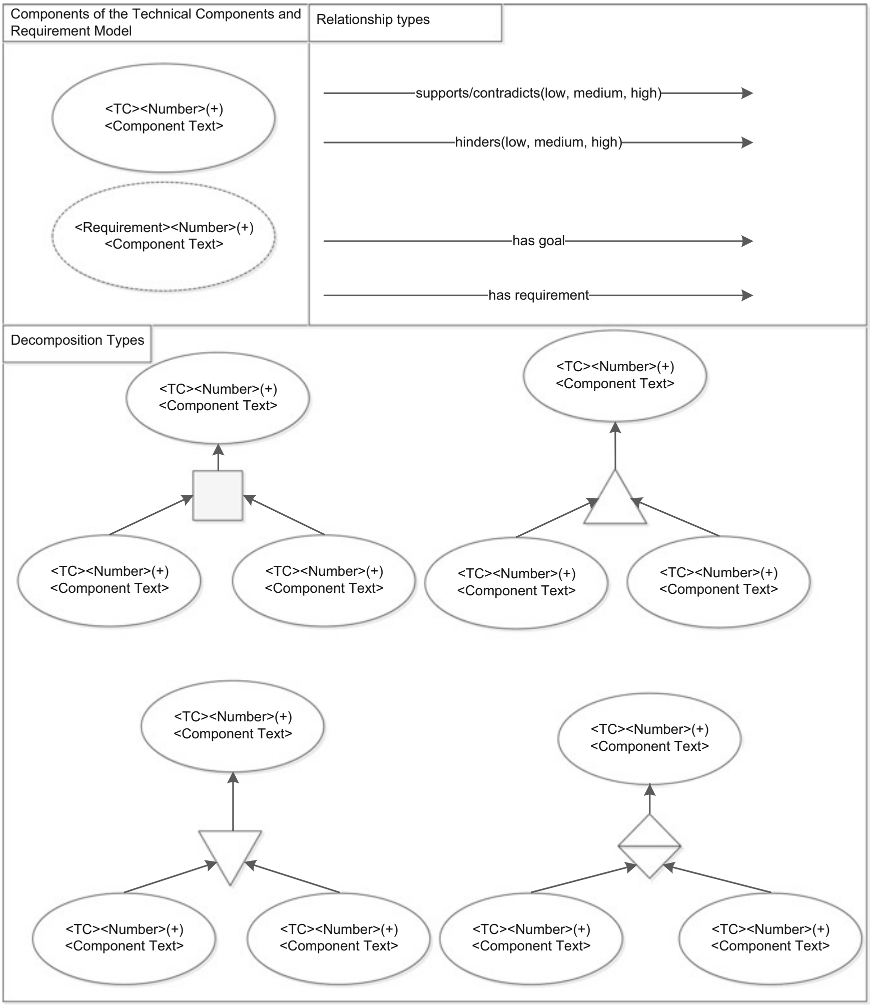

Fig. 8.54 The notation for the Technical Components and Requirements Model components

Management also defined functionality of the "e-shop system" (TC 3) as required for the future. It is expected that this functionality will be provided by separate components, which can be used by the customers (see Fig. 8.56). A "Product catalogue search system" (TC 3.1) shall enable the customer to find the desired products faster in the variety of offered products. In addition, the "Ordering system" (TC 3.2) has the task to provide the customer the opportunity of online ordering. The third functionality shall offer supportive services (TC 3.3) to customers, which e.g. include supplementary product information or maintenance recommendations. Thus, these three components are a necessary support for the e-shop system (TC 3).

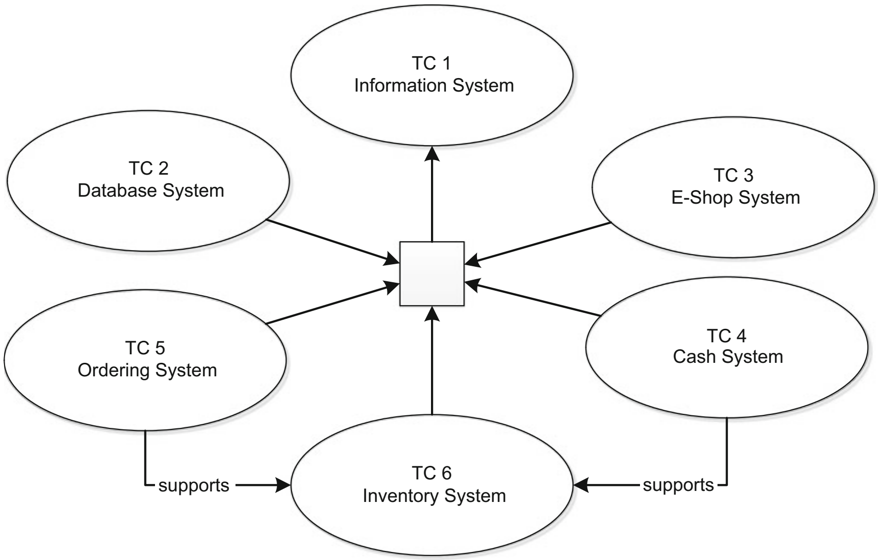

Fig. 8.55 Structure of the information system in the case study

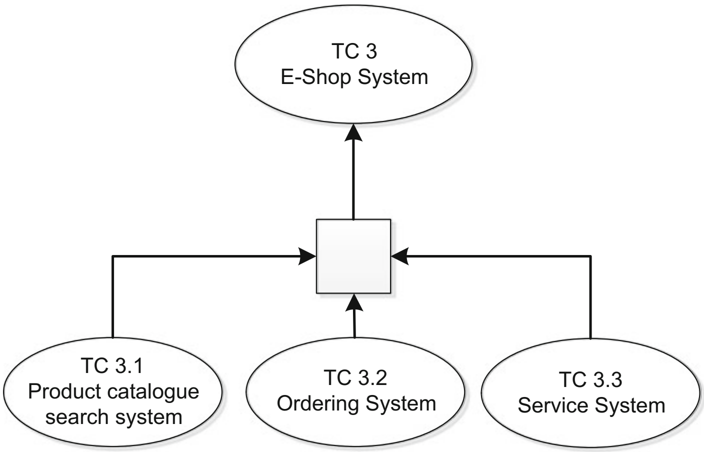

Fig. 8.56 Supporting technical components of the e-shop system

Furthermore, the analysis of the current situation reveals that one of the existing technical components has shortcomings and causes delays in the business processes. The mobile data collection (MDE) device (TC 7), which the employees have to use to capture register changes in the inventory, is outdated and no longer supports the daily work in a satisfactory manner. This technical component (TC 7) has a negative impact on the inventory system (TC 6), which is captured by using a "hinders" relationship. In addition to requirements regarding the technical components, management also

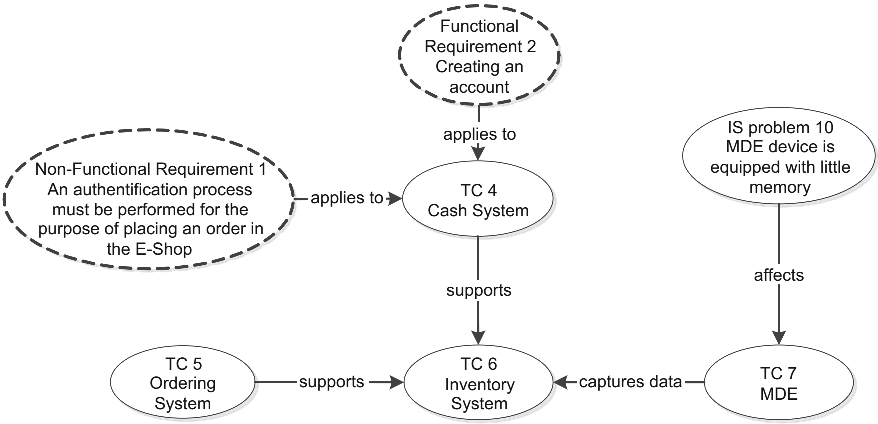

Fig. 8.57 Example of functional and nonfunctional requirements in the technical components and requirements model

defined functional requirements for future IT support. For example, the cash system (TC 4) should be able to create a customer profile (Functional Requirement 3), if a customer wants to place an order online. One of the nonfunctional requirements (Nonfunctional Requirement 1) specifies that authentication of a client must have been performed before this client can buy something online. These requirements and the technical components are illustrated in Fig. 8.57.

8.6.3.2 Modeling the Future State (TO-BE Model)

For the future, management decided to outsource the e-shop (TC 3) in order to save costs. Nevertheless, the e-shop (TC 3) should still remain integrated into the company's internal information system (T 1) in order to allow for the IT staff of A4Y to maintain the entire system. When outsourcing the e-shop, a new technical component "external information system" has been added (see Fig. 8.58). The external information system (TC 8), which includes the e-shop, also has to support the cash system (TC 4), for example, for processing online orders.

Moreover, management plans the introduction of a logistics system (TC 7 in Fig. 8.59), such as an ERP system. This logistics system (TC 7) should capture all inventory changes in A4Y warehouse. If the number of items in stock drops below a defined minimum value, the system shall automatically send a message to the manager. This is also a functional requirement for the logistics system. Furthermore, the obsolete MDE devices (TC 7) shall be removed from the company and replaced by new equipment (TC 9).

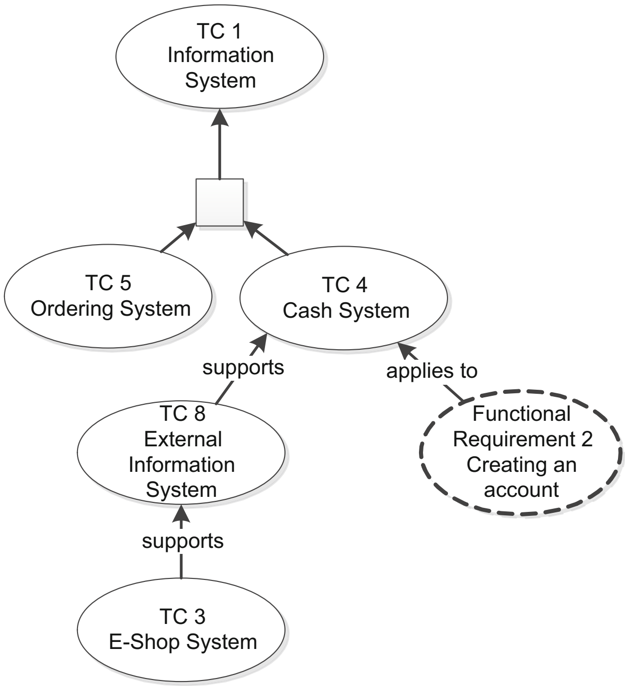

Fig. 8.58 Example from the target model: Change of a technical component and related requirements in the technical components and requirements model

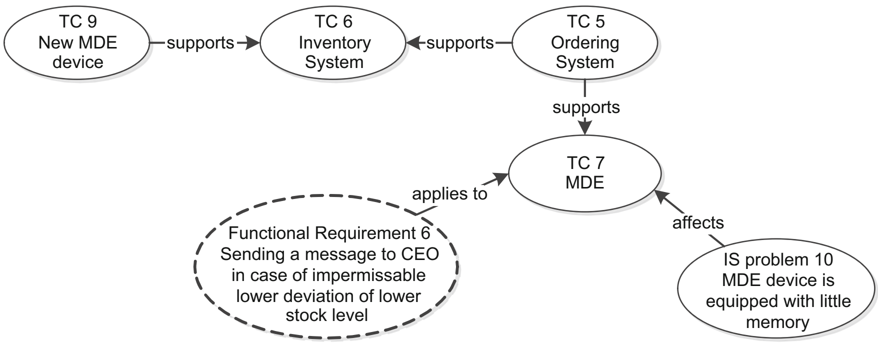

Fig. 8.59 Example from the target model: new technical component and associated requirements in the Technical Components and Requirements Model

8.6.4 Developing and Refining the Technical Components and Requirements Model

The Information System Goals and Problems modeling components are of the same type as Goals Model components. They have similar rules of naming and defining as Goals Model components. IS Goals, for example, should also start with “The goal is… ”. However, modeling IS requirements, one should remember that the focus in this sub-model must be on IS requirements and components, and not on general organizational or business issues. The components of this sub-model must also be measurable and verifiable, since they form the basis of the design of the Information System. Expressions like “better than,” “bigger than,” “the best,” etc., do not normally contribute to the understanding of a particular requirement. The components of this sub-model must be closely related to the components of the Business Process Model, Goals Model, or Business Rules Model.

The main driving questions in Technical Components and Requirements Model modeling are (Table 8.6):

Table 8.6 Driving questions for technical components and IS requirements modeling

Question	Motivation
Which constraints and standards exist regarding communication with existing systems or existing hardware?	This question aims to identify what other information systems are potentially influencing the business design currently being developed
Which are the important requirements regarding nonfunctional requirements type X where X can be e.g. security, or availability, or performance, etc.?	This question addresses nonfunctional requirements for the system, which is an area often overshadowed by the focus on functional solutions
Which constraints are there regarding existing software or programming systems that are to be used?	The new solutions will have to fit in the existing IT architecture and technologies used, and hence it this needs to be considered
Which economic, personnel, political, or other constraints are there? *Are there legal restrictions to developing the system?*	These questions probe for possible constraints with respect to the implementation and usage context of the envisioned IT solution
Can this requirement (or information system Goal, or …), be refined more clearly (perhaps decomposed) and in a way that it can be measured or verified? *Considering this goal/process/rule, what IS requirements would support it?*	These questions aim at eliciting more detailed IS goals and requirements needed for supporting the overall business design
What IS or IT-components are currently used to support business processes?	This aims at capturing the current state in the enterprise? This aims at capturing the current state.

8.7 Relationships Between the 4EM Sub-models

The previous sections explained the purpose of each 4EM sub-model including components and relationships. The references, or links, between the 4EM sub-models were also mentioned but will be recapitulated in this section. The essential links between the sub-models are shown in Fig. 8.60.

In developing a full enterprise model, links between components of the different sub-models play an essential role. For instance, statements in the Goals Model might require that different concepts used in the statements have to be defined more clearly. This is done in the Concepts Model, and a link is specified between the corresponding Goals Model component and the concepts in the Concepts Model. In the same way, goals in the Goals Model motivate particular processes in the Business Processes Model. The processes are needed to achieve the goals stated. A link is therefore defined between a goal and the process to be carried out to achieve it. Links between models make knowledge traceable. It is, for example, possible to see why certain processes and information system requirements have

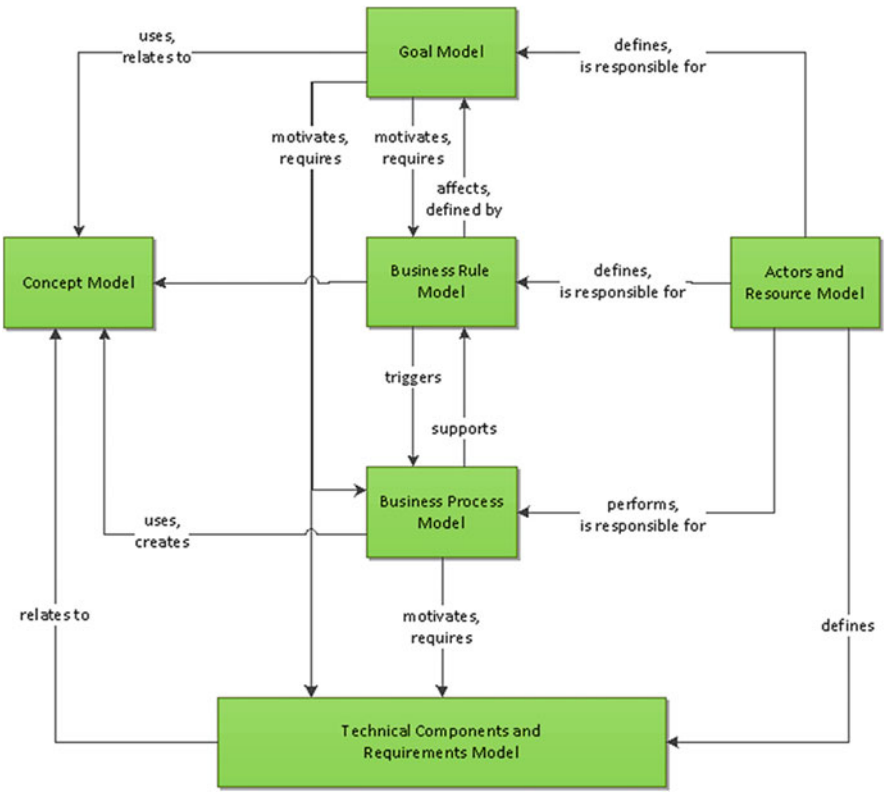

Fig. 8.60 Relationships between sub-models

been introduced. Figure 8.60 provides an overview of links between the sub-models.

Inter-model links are shown with dashed arrows. The example displayed in Fig. 8.61 illustrates different links between sub-models of the enterprise model.

Links between the Goals Model and the Concepts Model are normally used to explain a component of the Goals Model by pointing, from a Goals Model component, to one or more components of the Concepts Model referred to in the description of the Goals Model component. For example the Goal 2.1 “to develop both new products variants and versions” refers to concept 6 “Product.” In CM concept 6 is further explained.

Links between the Goals Model and the Business Processes Model typically relate to goals of the Goals Model to processes of the Business Process Model with a “motivates” relationship. For example: goal 2.2 “decreasing the time to market” could initially motivate a particular, high-level process in the enterprise, e.g., process 13 “Create a standardized product.”

Link types between the Goals Model and the Actors and Resources Model can mean several things: they may motivate or require the introduction of particular new actors, e.g., Customer Relations Agents (motivated by the goal to improve relationships with customers), or they may describe which Actors and Resources Model component are responsible to achieve a particular goal or defines it, etc. e.g. in Fig. 8.61 role 5 Blacksmith is responsible for Goal 2.2.

Links between the Goals Model and the Business Rules Model typically describe how different components of the Goals Model are implemented in terms of business rules of the Business Rules Model. For example, the goal 2.2 “to decrease time to

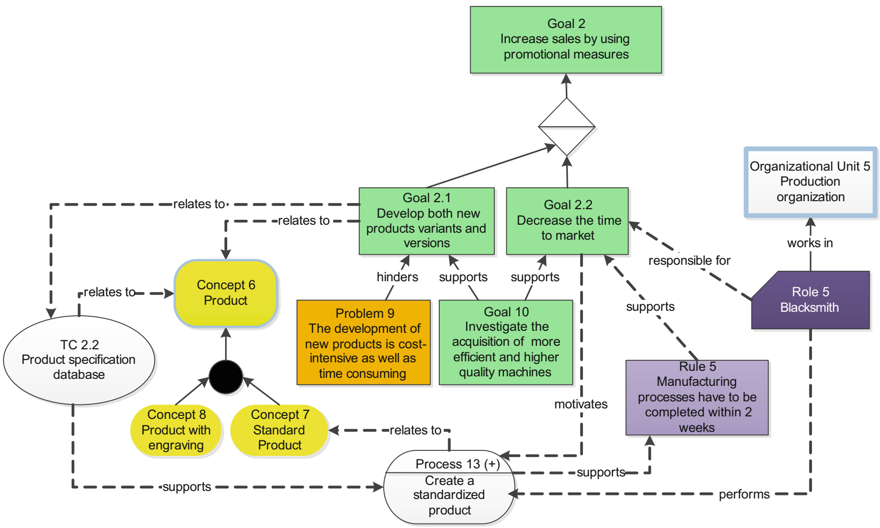

Fig. 8.61 Inter sub-model links (*dashed arrows*) between a Goals Model fragment and components of other sub-models

market" is supported by a business rule 5 in Business Rules Model which states that the manufacturing process has to be completed within 2 weeks. There are more examples about Goals Model and Business Rules Model interconnection in Sect. 8.2 about business rule modeling.

Links between the Business Rules Model and the Business Process Model typically describe how processes of the Business Process Model are triggered by business rules of Business Rules Model. Business processes can also support business rules. For example process 13 "Create a standardized product" supports Rule 5. In Fig. 8.62 Rule 1 requires that customers should be signed in to place an order.

Links between the Business Processes Model and the Concepts Model are typically between Information Sets of the Business Process Model and components of the Concepts Model. See for example Fig. 8.62.

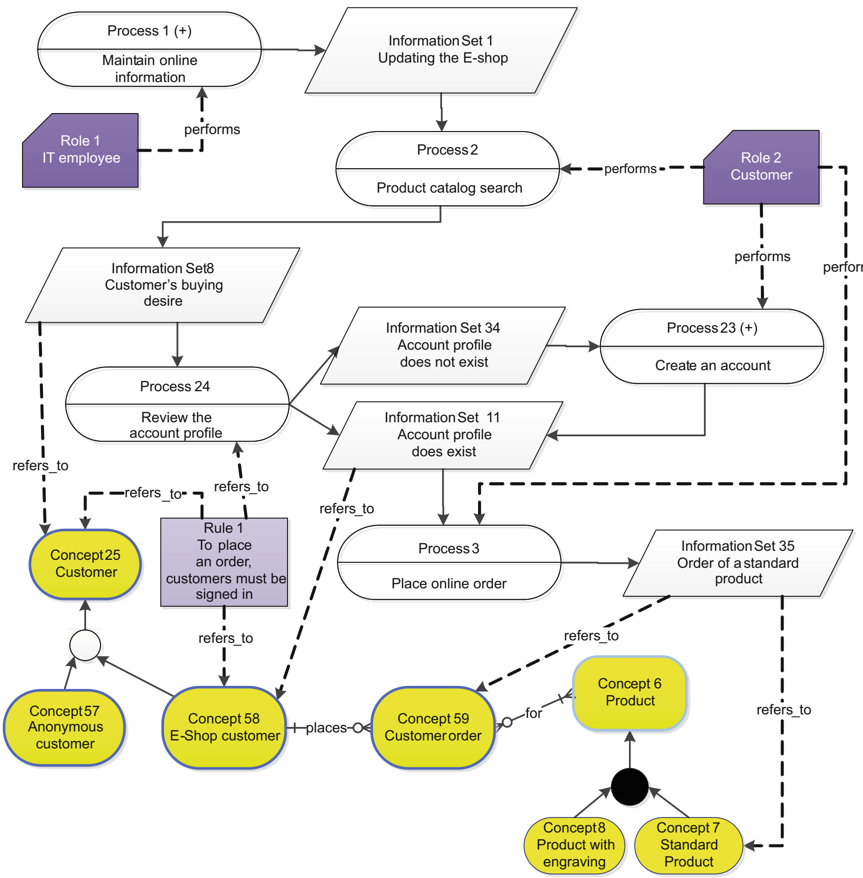

Fig. 8.62 Links between information sets in the Business Process Model and Concepts Model components

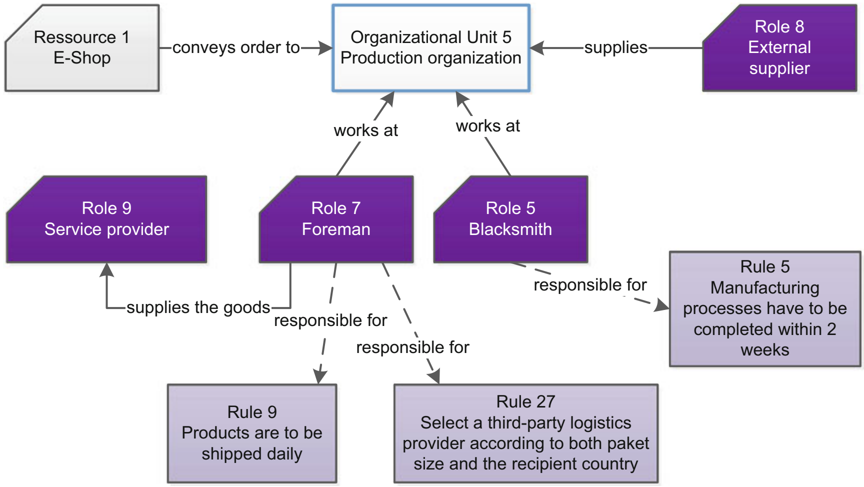

Fig. 8.63 Fragment of an Actors Resources Model showing that some roles are responsible for rules

Links between the Business Process Model and the Actors and Resources Model typically describe how different components of the Actors and Resources Model are related to or involved in processes of the Business Process Model. Examples of link names are performs, is_responsible_for, and supports. For example, the role IT employee performs the process “Maintain online presence”.

Links between the Actors and Resources Model and the Business Rules Model typically describe how different components of the Actors and Resources Model are related to business rules in the Business Process Model. Common link names are: defines, is_responsible_for. For examples, see Fig. 8.63.

Links between the Technical Components and Requirements Model components and the other model components show why certain components exist and how they contribute to the business, i.e., they help the business and IT alignment. Most typically, business process and goals motivate information system goals, information system requirements, and components; see Fig. 8.64.

Model components may thus be linked in a number of ways. Which links should be established depends on the purpose of the particular 4EM project. Each produced Enterprise Model has a purpose and focus and the links within each Enterprise Model should therefore reflect these. Every link represents a statement, about the enterprise and possibly its information systems requirements. The semantics of every such link should be analyzed carefully. There is, however, a set of minimal links that should be defined for the representation to be considered complete. Figures in this section show some of the links between sub-models in the A4Y case. More about inter-models links from the perspective of model quality is given in Sect. 12.3.5.

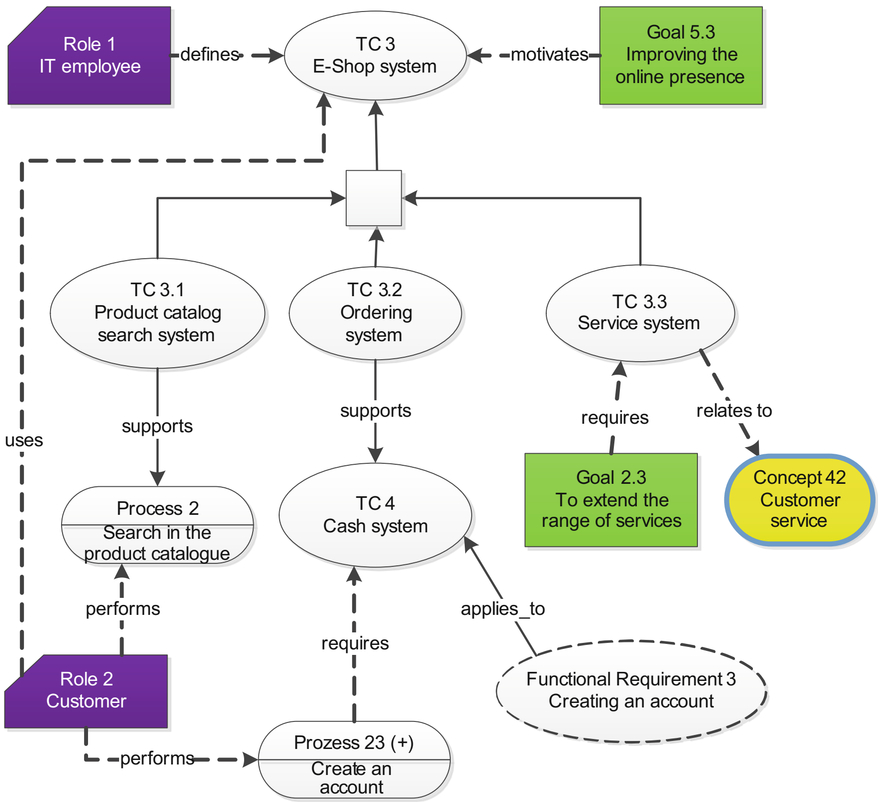

Fig. 8.64 Inter model links related to IS technical components

8.8 Auxiliary Modeling Components

In previous sections we have described the 4EM sub-models and their components. In addition to these "ordinary" modeling components, it is sometimes useful to extend the enterprise model with some additional modeling components. The reasons for doing so may vary. One reason, for instance, is to improve the expressiveness of the model, or to allow more "freedom" for the modeling team. This is most often the case in the first modeling sessions, where the most important task is to generate initial ideas and to familiarize participants with the modeling process.

The types of modeling components one may add to any sub-model of EM are not strictly prescribed or defined. The only requirements are that everybody in the modeling group accepts and understands the meaning of these and that the modeling facilitator accepts that particular extension of the method as beneficial. Some of the added auxiliary modeling components can later be reformulated using the regular component types.

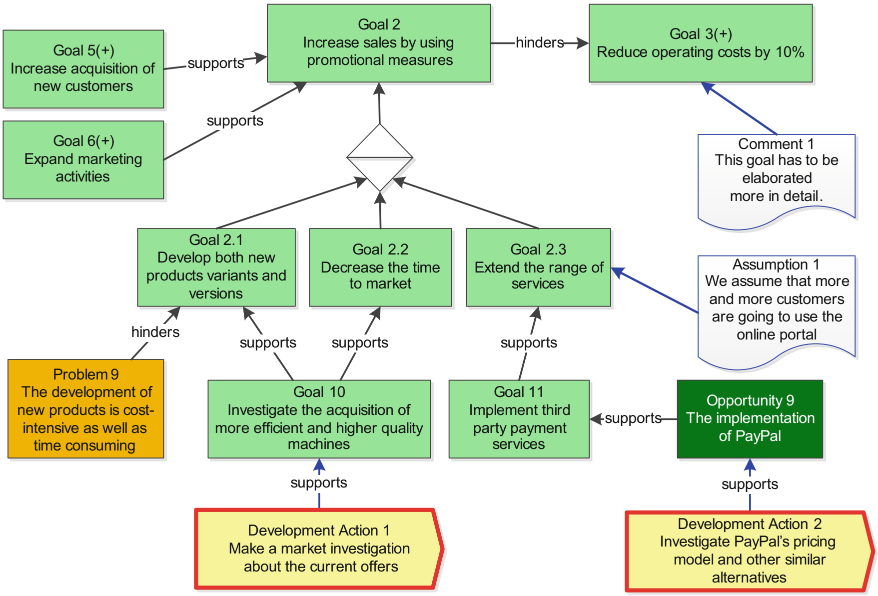

Fig. 8.65 A fraction of a Goals Model containing several auxiliary modeling components

The most common additional modeling components modelers use are the following:

- *Comments*—usually clarify some of the modeling components, or the whole model, or they contain some information that the modeling group found important, though difficult to express in terms of the ordinary modeling components. Comments may also contain directions for further elaboration of the model. If comments address some particular modeling component these are interlinked by arrows.
- *Development actions*—used to express concrete actions for development of a model, refinement of a particular modeling component, or a group of components, or an action needed in the project, for example, in order to gain more knowledge about a certain design alternative.
- *Assumptions*—used in a similar way to the ordinary modeling components. We use assumptions to express hypothetical types of facts. They can be lined to any other modeling component by types of links such as motivates, supports, hinders, conflicts, etc. Later, during the elaboration and refinement phases of the model, assumptions can be transformed to opportunities, problems, weaknesses, threats, goals, processes, information system requirements, etc.

Examples of some auxiliary modeling components are given in Fig. 8.65. However, these are not the only modeling components that may be included in the Enterprise Model. Sometimes it is even easier to replace a whole sub-model with another. For instance, if the notation of the Business Process Model is not suitable for a particular task, it can be replaced. However, the integrity of the inter-model links must remain consistent as previously described.

Chapter 9
Project Organization and Roles

The ability to carry out Enterprise Modeling in practice requires not only the basic methodological knowledge covered in Chaps. 7 and 8, but also suitable project organization in the enterprise in question. This chapter describes how a 4EM project should be set up in practice, including both the roles involved in the project team and the organizational prerequisites in the enterprise in question. It also illustrates typical project phases and discusses options for implementing the participatory approach. The principles and recommendations presented here also apply to other EM approaches that share the same overlying philosophy of multi-perspective and participatory modeling.

The chapter begins with an overview of the project phases in Sect. 9.1 and then deals with the most important phases in Sects. 9.2–9.8. Change management in EM projects is briefly discussed in Sect. 9.9.

9.1 Overview of Project Phases

The 4EM approach is not merely intended to produce an enterprise model, but to serve as the basis for problem solving, organizational development, and change decisions. The success of the method and its result also depend on how the approach is introduced in an enterprise and how the modeling process is carried out. This chapter will set out guidelines for introducing and using the approach in an organization. Even though this approach and its predecessors have been used and documented for several years, the practical implementation of a method by its users (e.g., work distribution, procedure, component selection, etc.) changes over time. These guidelines should therefore be considered as knowledge that is subject to constant development and expansion.

Among those who have used the 4EM method in past projects, the method has a reputation for offering the following benefits:

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_9

- The method gives structure and comprehensibility to the modeling process
- The method adds clarity and rigor to the model representation
- The method supports organizational learning and helps to preserve organizational knowledge
- The method helps to make changes and restructuring in an organization easier to achieve

In practice, it has also been observed that 4EM is difficult to explain due to its high level of flexibility in individual cases, because false expectations can be raised particularly at the start of a problem solving process. The risk of "overestimating and simplifying" often leads to the belief that the 4EM approach can "magically" solve hard problems. Despite its versatility, it is important to ensure that the various phases and modeling activities are consistently integrated when using 4EM.

This chapter will primarily describe the structure and progression of an EM project in an organization using the 4EM method. In doing so, it will set out prerequisite, goal definition, and communication guidelines for conducting a modeling project, as well as basic principles for organizing modeling projects.

A modeling project usually involves a number of phases. The next sections of this chapter explain the typical main phases of such a project as well as the issues and problems that arise in the process, and propose suitable solutions:

1. Define scope and objectives of the project (Sect. 9.2)
2. Plan for project activities and resources (Sect. 9.3)
3. Plan for modeling session (Sect. 9.4)
4. Prepare modeling session (Sect. 9.5)
5. Conduct modeling session (Sect. 9.6)
6. Analyze and refine models (Sect. 9.7)
7. Present results to stakeholders (Sect. 9.8)

Figure 9.1 describes the project phases in the form of a process model. It should be considered as a stereotype process, which needs to be adapted to fit each individual project because in real-life projects the actual steps and information sets might differ slightly. It is also possible that additional steps are needed, e.g., to ensure integration with other development projects or to involve a broad group of stakeholders.

The EM process follows generic principles of carrying out projects for various purposes. This is because we strongly believe that aligning EM activities with the general project activities improves stakeholder acceptance of the modeling way of working.

Table 9.1 shows how different actors are involved in the steps of the EM process. More about the actors involved can be found in Chap. 10.

Throughout this chapter, references will be made to processes and information sets in this model. In the beginning of each second level section, an overview of the subprocess in question is provided, before it is discussed in more detail.

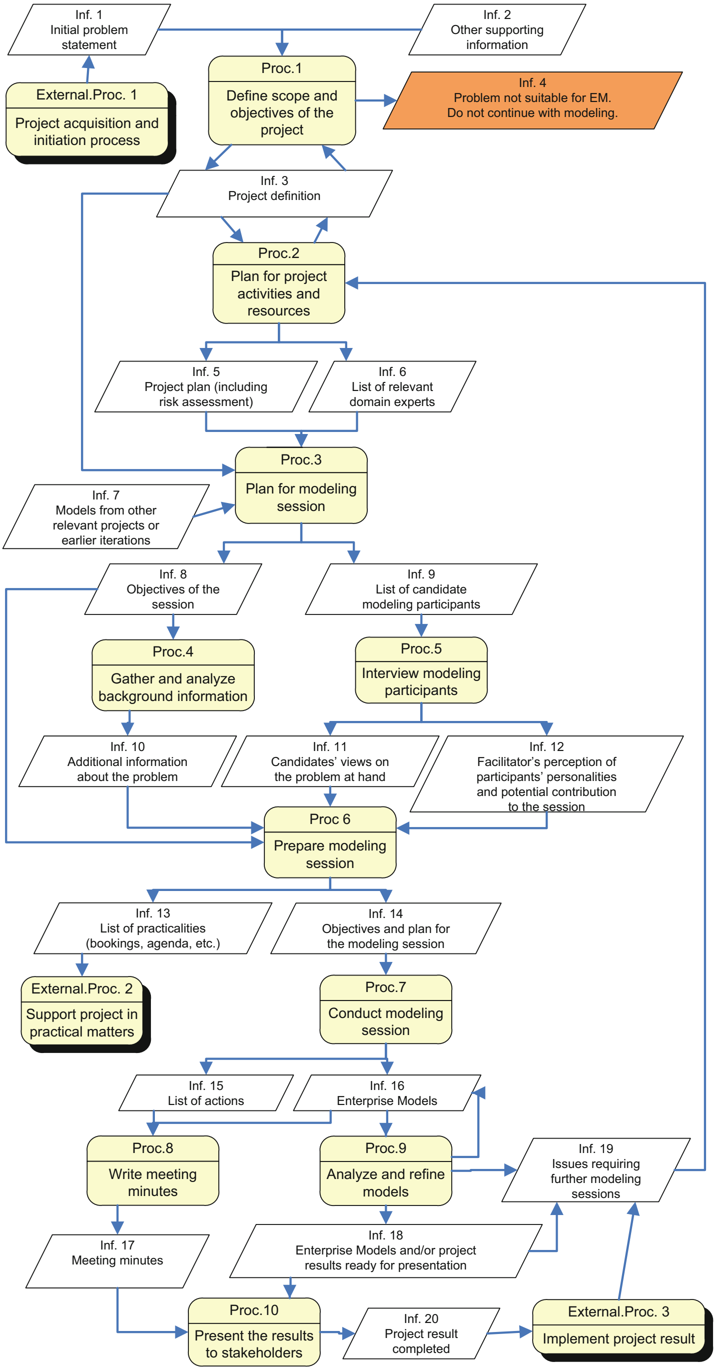

Fig. 9.1 The EM process model showing processes and information sets (Persson and Stirna 2010)

Table 9.1 Actor involvement in the EM process steps

EM Process Step	Problem owner	Domain expert	EM project leader	EM facilitator	Tool expert
P1 Define scope and objectives of the project	R		P		
P2 Plan for project activities and resources	R		P	P	
P3 Plan for modeling session	P		R	P	
P4 Gather and analyze back-ground information			P	R	
P5 Interview modeling participants		P		R	
P6 Prepare modeling session	P		P	R	
P7 Conduct modeling session		P		R	P
P8 Write meeting minutes			P	R	P
P9 Analyze and refine models	P		P	R	P
P10 Present the results to stakeholders	R	P	P	P	

R responsible, *P* participates

9.2 Define Scope and Objectives of the EM Project

We assume that the EM project is commissioned either as a result of selling consulting services or that another in-house development project has decided to address a specific problem area by a modeling approach. In either case, there usually exists an initial problem statement (information set 1 in Fig. 9.1) and an organizational actor that will benefit from solving the problem—the problem owner.

At this stage the problem owner and the EM project leader should discuss the problem to find its boundaries, what the likely ways of solving it might be, and what the expected outcomes are. This would form a project definition (information set 3 in Fig. 9.1). In this process model we assume that the organization has already assessed its suitability for using the participative approach to EM, but if it has not been done, or some doubts arise (e.g., a strong sense of hidden agendas) then the EM project leader should assess the situation in the organization.

The problem should also be assessed for being suitable for EM. More about assessing the organization and the problem at hand is available in, e.g., Nilsson et al. (1999), Persson (2001), as well as Stirna et al. (2007). If the organization or the problem is found to be unsuitable for EM, then the problem owner and the project leader should choose other ways of solving the problem, e.g., by the consultative approach or by brainstorming. When dealing with complex and/or wicked problems (Rittel and Webber 1984) it might be difficult to formulate a clear problem definition. In such cases the project might organize a modeling session with an objective to find out what the real problem is and how to tackle it.

9.2.1 Establishing the Project in the Enterprise

Conducting an Enterprise Modeling project only makes sense if it meets with approval and support in the enterprise. This requires executives or budget managers and those responsible for the divisions in question to be convinced that the project is beneficial to their areas of responsibility as well as to the organization as whole. In order to justify the human and monetary resources required for a modeling project, it is often necessary to discuss the expected benefits during project initiation.

The following aspects can generally be used when highlighting benefits:

- The project creates value that contributes to the overall success of the enterprise
- Cost savings through process efficiency and structural improvements
- Enhanced competitive advantages
- More efficient IT support for critical business processes
- Improvements in the documentation and transparency of organizational processes
- Expansion into new markets

Preparation for a 4EM project should involve not only executives, but also employees, specialists, and user groups. When changes are initiated that affect our status quo, it is human nature to be rather cautious and often distrustful if we cannot assess the potential changes. It is therefore important to establish trust by briefing those concerned according to their initial situation and interests—in other words, motivation points should be produced for the parties involved. These motivation points may take very different forms depending on the individual's role and position. For instance, executives are motivated more by the project's value contribution to the overall success of the enterprise, but staff members may instead be motivated by work process improvements which they have initiated. The enterprise stakeholders who are relevant to the project should (be made to) feel confident that the modeling project is not a threat to their employment or positions, but in fact is intended to support and improve day-to-day work. Concrete examples from previous successful projects within the enterprise or elsewhere should be used as a rationale.

Stakeholder analysis is intended to assist in identifying project participants, their interests, and potential motivation points. To this end, the following questions should be answered:

- Who has an influence on the project?
- Who is affected by it?
- What expectations does the individual/group have of the project?
- What is the attitude towards the project (positive, negative, or neutral)?
- What degree of influence does the individual/group have (low, medium, high, or crucial)?
- Are there are any competing projects (in terms of the results, budget, or political power)?

The potential effects on those involved should be classified according to level (none, low, medium, high, or very high) and type (positive, negative, or neutral).

From the project goal, the time frame for implementing changes, and the stakeholder analysis, it is possible to identify the project type or the significance of the project for the enterprise. Firstly, enterprise policy projects and strategic projects can be distinguished. Both are highly interdisciplinary and interdepartmental, and hence offer potential for conflicts. Enterprise policy projects are often marked by a specific task (e.g., software rollout), while strategic projects may feature alternative scenarios (reorganization) and a longer duration. It is also possible to identify operational and innovation projects, which, as a rule, are less socially complex (e.g., due to being limited to certain departments or teams) and have shorter implementation timescales. Operational projects have a very limited solution scope and usually are rather short.

At the end of the preparatory phase, the project team should be able to answer the following questions:

- Who instigated the project and why?
- Who is and who must be informed of the project goals/the problem at hand?
- Who is needed to initiate the project and who is impacted by the effects of the project?
- Have the answers to these questions been documented in a project description and approved in a project order by the appropriate managers?
- Are there any aspects of the project that cannot be mentioned or documented openly (pointing to hidden agendas)?

9.2.2 Project Goal

There can be a wide variety of reasons for using an EM approach to solve a certain problem in the organization. Regardless of the reason for the project or its trigger, however, the project goal should be defined at the start of the modeling project. This also involves establishing the expected outcome, or what the result should be at the end of the modeling project—"What problem is the method intended to solve, and what benefit will it provide?" In the course of the modeling project, the project goal is generally further refined by a Goals Model and made more concrete by other sub-models, such as modeling goal-related business processes.

Definition of the project goal requires some initial knowledge about the nature of the problem at hand. 4EM provides methodological support for this through goal/problem modeling. By analyzing the problems that have been observed and identifying subproblems and the affected or associated processes and organizational units, it is necessary here to determine which parts of the enterprise should be included in a model of the actual situation because they are affected by the problems or the solution, and what areas need not be investigated. Although the goal/problem model is the focus here, it should be supplemented by initial versions of the business process model or stakeholder/resource model.

The process of defining the project goal could take the following form:

- Preparing for goal and problem modeling by selecting participants from the enterprise (enterprise employees who know both the problems that have emerged and the processes and organizational units affected), filling the modeling team roles (particularly the role of moderator), agreeing deadlines, and booking rooms. At this stage, the employees selected should be the project commissioner or other relevant stakeholders on the management/problem owner level because the focus of modeling at this stage is to negotiate the project goal with the commissioner.
- Conducting a modeling session to create a goal/problem model, often using conventional tools and plastic sheets. This stage includes identifying relevant business processes (without refining them) and relevant stakeholders or resources
- Editing the results after the session
- Holding a workshop with the modeling session participants to present the results and discuss their factual accuracy
- Deriving and documenting the project goals together with the modeling workshop participants and those responsible for the pre-project planning in the enterprise

The following example is intended to illustrate how a project goal can be gradually edited and thus refined by using various sub-models.

Example 9.1. Gradual Development and Refinement of a Goal Model
The case study company A4Y wishes to develop a strategy for its long-term development of their human resource capital. This application will initially concentrate on the Goals Model.

- What are the company's long-term goals in general?
- Which goals regarding human resources are recognized and how are these goals related to the company's long-term goals?
- Which problems are experienced and which external threats and constraints do exist, etc.?

This type of analysis and goal modeling may very well also introduce the need for improved conceptual analysis and modeling of concepts essential for the problem at hand, e.g.,

- What do we mean by "human resource"?
- How can we measure the current status regarding human resources?
- What do we mean by "competence" and how do we measure competence?
- What kind of competencies may we need in the future regarding the stated goals?

(continued)

Example 9.1 (continued)

The above questions will help identifying concepts and creating a Concept Model. The analysis of goals and concepts may also lead to the development of a Business Processes Model.

- What qualification measures will be offered to the employees, how can these measures be booked and how are they implemented, and what support for competence development is realized by these processes?
- Which capabilities are required for implementing and performing these processes?
- What kinds of future competences are required to reach the goals defined?
- Should we be interested in developing a future "system" for developing and maintaining human resources in the company in the future? New types of positions, roles, and skills may require developing further the Actors and Resources Model.

Regarding the information system support, the overall question to be addressed may be formulated as: "Does our current set of information systems satisfy the need for information support for the long-term strategy of the company, and—if not—what has been changed to arrive at a satisfactory solution?". This question involves, more or less, all the models described in Chap. 8. First, the goals of the future situation must be analyzed, as described above. Next, based on this set of goals, the set of business rules and processes must be examined and redesigned. A new Actors and Resources Model will most probably be developed. The established information systems must be described with their properties in a Technical Components and Requirements Model (TCRM version 1). Afterwards, a model of the future set of required technical components and their requirements (TCRM version 2) must be developed based on documented goals, rules, processes, concepts, and actors for the future business system. A comparison between the properties of the current technical system (TCRM version 1) and requirements of the future set of information systems (TCRM version 2) provides here the basis for analyzing needs for changes and further developments. Clearly, in many cases different alternatives of future information systems may be analyzed.

The above example shows that a relatively unpretentious application case, like the strategy for long-term development of human resource management, requires different perspectives of the enterprise and nearly all 4EM sub-models. A 4EM project has to start from clearly defined scope, task, and expectations with respect to the results of the project. The tasks and expected results have to be clear to the stakeholders involved in the project. In this context, the following questions can support defining a project's targets completely and concisely:

- What is the goal of the modeling project, i.e., which problem has to be solved and which goals shall be reached?
- What is outside the scope of the project, i.e., what is not to be considered within the project?
- Which benefits have to be reached at what point in time for what stakeholder group?
- Who is/are the target group/s of the project results? Who is the recipient of the final deliverables of the project?
- How does the project support the enterprise strategy and which goals are supported?
- Which priority does the project have for the enterprise?
- What is the intended time frame for the project?
- Which frame conditions, budget frames, and expectations exist with respect to the project?
- Which risks exist and difficulties have to be expected?
- Which milestones have to be reached and which deliverables have to be produced at what point in time?

In Chap. 8 we have formulated a set of general driving questions for each of the 4EM sub-models. The example discussed here shows more concrete operationalization of those questions with respect to the particular modeling problem. The modeling facilitator prepares an initial set of such questions during process 6 in Fig. 9.1.

There are two alternative views when it comes to defining the problem at hand. One stresses the importance of obtaining a clear problem definition, assuming that it is possible to acquire such a clear definition. The other assumes that clearly defined problems in most cases are illusions. Rather they are detected as the project progresses. This has to do with the fact that problems are different in terms of complexity.

Problem complexity influences the project planning in terms of necessary activities and resources. Three types of problems can be observed:

– *Fairly simple problems*

  These problems are possible to clearly define and they often have a perceivable solution. They do not require the coordination of a large number of different preconditions, activities, actors, and resources.

– *Complex problems*

  These problems have a fairly clear definition. They often have a perceivable solution, but they require the coordination of a large number of different preconditions, activities, actors, and resources.

– *Wicked problems*

  These problems are ill-structured. They have no clear problem definition and there is no way of measuring that the problem has been solved.

In case of simple and complex problems, planning of the project can proceed. Note, however, that the complex problem will need an experienced project manager and extra resources for coordination activities. If the problem is considered wicked, the project should be carried out in three phases:

1. A pre-study phase where 4EM modeling, particularly goal modeling, is used to negotiate agreement to the main scope of the project. This is described in the example above.
2. A negotiation phase, where the actual project is negotiated and planned. Since a wicked problem comprises many unknown factors, the customer must be made aware of them and related risks.
3. A completion phase, where the defined problem is solved as best can be done. Preferably, the project plan should contain a number of evaluation steps, where the results of the project are continuously evaluated and the overall scope is reconsidered before continuing.

9.3 Plan for Project Activities and Resources

At this stage the EM project leader, problem owner, and facilitator plan specific activities to be carried out. This includes the overall number and schedule of modeling sessions, the issues addressed in them (information set 5 in Fig. 9.1), as well as indicating relevant domain experts to be involved in the modeling sessions later (information set 6 in Fig. 9.1). Additional issues to pay attention to at this stage are risk assessment, resource allocation, both for the modeling expert team and for the domain experts, and establishing project groups' overall authority, i.e., mandate to solve the problem.

9.3.1 Project Activities

The exact activities of a modeling project should be set out in a project plan that identifies the modeling activities to be carried out and defines work packages from them. A work package groups together modeling tasks with related content and defines the deadline by which they should be completed, the necessary effort, and the result to be produced. The content relationships between work packages can be used to establish the order in which they should be handled, or whether certain work packages should be completed in parallel. This chronological order is defined in the project plan, which should also define the work package responsibilities. Further general information on project planning techniques and the definition and use of work packages can be found in project management literature.

The project goal determines what modeling activities are required in a project, and therefore also which work packages are needed. This means that it is impossible to generalize for all projects.

9.3.2 Project Organization

The project organization generally specifies what roles are involved in carrying out the project and what tasks and responsibilities these roles entail. Experience from previously completed 4EM projects recommends a project structure for Enterprise Modeling that contains both roles specific to modeling projects and roles that are generally found in project organization. The roles specific to modeling projects include the moderator and the modeling group featuring domain experts and method experts. General project organization roles are the project leader, the steering committee, the quality manager, and the reference group.

In a large-scale modeling project, the steering committee is the project's topmost decision-making body, to which the project managers report. The quality manager's role supports the steering committee by reviewing the project results. The project team may include multiple modeling teams. Each team should be led by a moderator and is also made up of domain and modeling experts. In addition to the modeling teams, there usually is a method manager, who is responsible for method and tool selection and coordination of individual activities. Reasonably large projects need a documentation manager who is responsible for documenting and versioning the modeling results.

In smaller projects, the steering committee is usually omitted. The manager that commissions the project within the enterprise, and the project leader who is in charge of the modeling activities frequently assume these duties. The domain experts involved in the modeling, rather than being specifically assigned to a separate role for the project, perform quality assurance. Tool and documentation management roles are also incorporated into the modeling team.

These project organization roles are briefly introduced below. Further information on general project organization roles can be found in the standard literature on this subject.

- *Project management* in large-scale projects often consists of two project managers: the manager from the commissioning enterprise, often called the internal project manager or customer representative, and the manager of the modeling activities, often called the project manager for modeling.

  Jointly, these two project managers are responsible for:
  - Project planning
  - The day-to-day project management (incl. supervision of time plans, resource consumption, and costs)
  - Reporting to the steering committee

  The *internal project manager* is responsible for and has to coordinate
  - Provision of documents required for the modeling project
  - Selection of domain experts required for the modeling and releasing them from their regular duties to allow their participation in modeling activities
  - Communication of project goals, expected results, and achievements within the enterprise

– Providing facilities and technical infrastructure for the modeling activities in case they are performed within the enterprise

The *project manager for modeling* is responsible for

– Planning and organization of all modeling activities following the selected method
– Reaching high-quality modeling results, e.g., by organizing workshops for presentation and validation of the models and results
– Assigning modeling experts to roles and to modeling activities, and
– Achieving the defined project goals and results.

In small to medium size projects the project manager for modeling may also be fulfilling the role of modeling facilitator.

- The *steering committee* typically includes members from different areas or departments of the enterprise who are involved in reaching the project's objectives or have an interest in the value the project intends to create. This could be heads of departments, budget responsible managers, or employee representatives. The steering committee will typically be responsible for:
  – Supporting and "selling" the project within the organization, i.e., internal communication of project goals,
  – Deciding on the final project plan,
  – Obtaining official acceptance of milestones and deliverables based on the results of quality control measures.
  – Deciding about changes in project plans in case of new requirements and delays in project work,
  – Supporting the acquisition of resources and assigning them to the project, and
  – Deciding about resource allocation
- The quality assurance is responsible for systematically ensuring the quality of project results. This includes:
  – Definition of quality criteria for the different kinds of project results (see Chap. 12 with respect to the quality of enterprise models),
  – Development of a quality plan (which quality result will be evaluated at what point in time according to what criteria?)
  – Documentation of the results of quality control activities,
  – Reporting to project management and steering committee.
- The *reference group* typically consists of domain experts and experienced employees of the enterprise who are familiar with structures and processes in the enterprise. The reference group is responsible for:
  – Supplying domain knowledge, knowledge about organization units involved, expertise, and information,
  – Examining and evaluating the results, and
  – Integration of modeling results of different teams into a consistent whole.

- The *modeling group* are the persons participating in modeling activities, i.e., there can be different modeling groups for different modeling activities depending on the purpose of modeling. The tasks of the modeling group are to:
  - Actively participate in the modeling sessions,
  - Contribute with domain knowledge,
  - Ensuring that the models contain relevant and valid domain knowledge, and
  - Assist the facilitators with structuring and describing the models.

  The composition of the modeling group should meet a number of criteria:
  - There are persons from various parts of the enterprise enabling the broadest range of knowledge and views to be available,
  - The group has adequate domain knowledge,
  - The group has the necessary authority to suggest organizational change and
  - The group comprises enthusiastic, open-minded, and cooperative people.
- The *facilitator's* task is to direct and guide workshops and modeling session, which includes several tasks:
  - Prepare modeling sessions
  - Manage sessions in accordance with the method used
  - Manage the modeling process
  - Make sure that all participants are included in the modeling process
  - Make sure that the goals of the modeling activities are reached
  - Support the modeling group in acquiring knowledge and ideas from each other

Like other types of projects, a modeling project can also be unsuccessful without sufficient resources and skills. The individuals involved must be expressly allowed time to participate. Moreover, provisions with regard to modeling tools, e.g., modeling kit, rooms, IT, and (if applicable) external domain experts, must be organized and made available by the enterprise.

The project managers and participants who are involved in the modeling process must know and understand the goals and expected results of the project. The purpose, goals, and scope of the project must be documented by the time that the project organization and project plan are set, which should also include the allocation of resources (staff, responsibilities, time, money, IT, and other resources). The type of quality assurance with regard to the quality of the results, adherence to milestones, and the validation process must also be defined, generally in a separate quality assurance plan. The outcome of the quality assurance activities should also be documented.

Once the project organization has been established, it should be possible to answer the following questions:

- Who is directing the project, and who is part of the project team?
- Have the initiators, commissioner, other authorizers, committees, and reference groups been identified, informed, and involved?
- Have the modeling group participants been identified and involved?

- Are the necessary resources available?
- Has an appropriate reporting system been defined?
- What modeling sessions should be conducted, when, with what goals?
- What skills and which domain knowledge are required?
- What roles are required for which of these sessions?

The project organization has to be established on the basis of the project goal, which means all of the roles required for the project are filled. The roles that are generally required in participatory modeling are covered in Sect. 9.5. The project plan for the modeling project is created, including the schedule and an estimate of the effort involved. Provision of the necessary resources must be agreed with the enterprise. Tools and other necessary aids must be made available or procured.

A typical mistake in planning for resources in an EM project is to underestimate the resources needed for preparing as well as documenting and reporting on modeling sessions. We suggest distributing effort as follows: preparing for modeling sessions ~40 %, carrying out modeling seminars ~30 %, and documenting/reporting ~30 % of the total effort (Persson 2001). This distribution of resources is only given as an indication; depending on the project's aim and duration they may actually vary by up to 10 %. For example some very short projects might not require extensive documentation and more complex projects might require even more in-depth preparation.

9.4 Plan for Modeling Session

The first modeling session in a modeling project simply *must not fail*. This is the time to show to the participants that it is worthwhile to invest time and effort in participating. At this stage there are no second chance, i.e., there is no chance to come back for a second try after a failure. Every outcome that can be perceived as failure by some modeling participants will significantly hamper the future modeling efforts. Preparing for the first session is therefore of utmost importance.

The objective is to plan a specific modeling session, i.e., to set its overall objective and questions to be addressed (information set 8 in Fig. 9.1). Existing models produced in previous modeling sessions of the project or earlier projects in the organization and/or other supporting information might also be analyzed. The initial list of relevant domain experts (information set 6 in Fig. 9.1) should be analyzed and candidates to involve in the modeling session should be selected (information set 9 in Fig. 9.1).

The modeling facilitator usually needs to obtain additional information to learn more about the organization and the background of the problem at hand *(Process 4 Gather and analyze background information)*. Some of this information can be gathered from documents, e.g., policy documents. Also, essential enterprise data, e.g., balanced scorecard data, can also be useful. However, the most powerful instrument in planning for the session is interviewing the domain experts that are selected to participate in the modeling sessions.

The candidate modeling participants (information set 9 in Fig. 9.1) are interviewed individually in order to learn more about their views on the problem at hand (information set 11 in Fig. 9.1) and to assess the participant's potential contribution at the modeling session (information set 12 in Fig. 9.1). A benefit for the candidate is that he/she is able to learn about the project and the upcoming modeling session in advance. In some projects it is beneficial to interview more people than the participants to be involved in the modeling sessions, because this allows the project team to learn more about the organization and, indirectly, to spread the word about the project and the coming change in the organization.

9.4.1 Setting the Goals for the Session

A modeling session is often one instance of series of modeling sessions, which all have their own goals, that are intended to contribute to the overall modeling project goal. The important thing here is that there *is* a goal for each modeling session. Just gathering a number of people in a room and starting modeling without a clear goal for the session and a plan for the flow of activities within a session will in most cases be disastrous and a waste of effort and resources.

Setting the goal for a modeling session is part of the planning for the overall modeling project. It should be clear what should be produced in the session, which other project results that are input to the session, and how the result of the modeling session is intended to contribute to the overall project.

9.4.2 Selecting the Right Domain Experts to Participate in the Seminar

Domain experts should be familiar with the problem assigned to the project. Sometimes it may be beneficial to have both the "producer" and the "consumer" side represented to broaden the view. In some stages of the project, it may be necessary to associate specialists in certain areas to the project. These specialists may have the role to suggest organizational or IT solutions to satisfy specific goals stated (e.g., reengineering of some business processes, or development of some types of IT solutions).

Who the right domain experts are depends on the goal of the session and which models that are to be produced. For example if a goal model is to be developed the right domain experts are those who are directly involved in, or have knowledge of, decision-making and goal formulation at the pertinent level of the organization, whether it be operational or strategic. If the goal is to restructure a process it may not require involvement by formal decision-makers. In all situations, however, it may be necessary to change members of a group as the discussions and models move from one area to another and require people with different knowledge.

9.4.3 Composing the Modeling Group

The composition of the modeling group, i.e., the participants in a modeling session, is instrumental to the achievement of the goals for the modeling session. It should therefore be carefully composed based on the goals for the session. It is highly desirable that modeling experts have a strong influence on the composition of the modeling group. Otherwise the members of the modeling group will not be able to take full responsibility for the results of the modeling session.

An ideal modeling group has the following characteristics:

- The knowledge represented in the group covers the full scope of the problem domain as well as detail and overview.
- The group is authorized to have an opinion about the problem at hand and to suggest a suitable solution to the problem.
- The number of modeling participants is 4–8.
- The group consists *only* of people that are expected to actively contribute to the modeling work.
- The group consists of people without personal animosity between themselves.

The ideal number of participants is 4–8. If there are less than four people the discussions tend to become less productive because the number of viewpoints becomes too small. If the number of participants exceeds eight some individual participants often tend to become less active. It also becomes difficult for the facilitator to manage the group process. Having more than ten people in a modeling group may work if the facilitator is very experienced and the plan for the session allows the facilitator to manage the session in a rather strict way. Alternatively, two modeling facilitators can support each other during the session and take turns as facilitator and observer. In such situations it is a good idea to plan for frequent short breaks to enable the facilitators to refocus and remedy any problems.

The "direction" of the analysis, i.e., if the analysis concerns the current state of affairs or the future state, also defines requirements for the group's composition. People deeply involved in a process can often describe the current state very well. However, when moving towards the future state, a different type of domain experts may be needed, i.e., visionary and creative people who are able to look at the process from a more holistic perspective e.g., how it relates to other processes and changes outside the organization.

When composing the group it is essential to make sure that the domain experts will be given sufficient time to participate in the session. This is related to the issue of resources, in particular with regard to management support and time resources.

Another aspect to make sure is that the domain experts participate with the intention of actually contributing to solving the problem at hand. For example having people in the group who are there to learn or observe will hamper the modeling process. "Everyone contributes!" should be the motto of a modeling session.

The status or rank of certain stakeholders can also restrict the possibilities of composing a group that represents the best available competency. Some people may sometimes falsely be considered highly competent both by themselves and others. To exclude such persons can sometimes be difficult.

9.4.4 Interviewing Domain Experts

Before planning for the modeling session it is strongly recommended to interview the domain experts individually. In most cases, one hour is a reasonable amount of time to spend on the interview, at least to begin with. In preparation for follow-up modeling sessions it may be necessary to carry out additional shorter interviews, if deemed necessary for preparing a session properly.

The domain experts need to be prepared for what will happen during the session. This is particularly critical in organizations where the employees are not used to modeling in general and particularly to modeling in a group session. Lindström (1999) recommends that before the modeling session each individual modeling participant has to:

- Understand the goal of the modeling session,
- Agree upon the importance of this goal,
- Feel personally capable to contribute to a positive result, and
- Be comfortable with the rest of the team (including the facilitator).

There are several goals with these interviews. They fall into three categories related to the problem at hand, the motivation of domain experts, and the group process.

9.4.4.1 Goals Related to the Problem at Hand

In order to prepare the modeling session in terms of issues to cover, driving questions, etc. the modeling expert needs to understand the views of the modeling participants regarding the problem, particularly, focusing on goals and possible obstacles to achieve the goals. Their views regarding how other stakeholders might think about the problem at hand are also important. This might reveal potential conflicts of interest and also personal animosities between stakeholders and stakeholder groups. If resolution of potential conflicts of interest is essential for solving the problem at hand, driving questions can be posed to the group during the modeling session, in order to make the conflict surface. However, bringing personal conflicts to the surface during a modeling session should be avoided.

9.4.4.2 Goals Related to the Motivation of the Modeling Participants

In order for the goals of the modeling session to be accomplished, the group process should have the highest possible quality so as to capitalize on the fullest potential of the competencies in the group. Therefore, one goal is to prepare the domain experts with regard to what will happen during the modeling session and why. It is also necessary that they understand in what way their particular competency contributes to the goals of the session and of the project, i.e., why they are important. This clarifies what is expected from them during the session and motivates them to participate actively. To ensure motivation, the attitudes of the domain experts towards the modeling method and the participative approach should also be investigated.

9.4.4.3 Goals Related to the Group Process

The personalities in a group govern how the facilitator runs the modeling session. The facilitator will e.g. need to neutralize dominant persons and to encourage more introvert persons in order to accomplish full and consensus-driven participation from everyone. The facilitator will also need to ensure that the models produced are the result of consensus between the views represented in the session. Therefore, the modeling expert/facilitator will try to understand as much as possible of each individual's personality during the interview. She/he will then be better prepared to facilitate the communication between the members of the modeling group.

Below we suggest a sample of interview questions assuming a company named COMP, a division of the company named DIV, and a particular function of DIV named F. It is assumed here that the purpose of the project is to analyze F and suggest different possible improvements.

After an initial round of mutual presentations, the modeling expert should explain the role of the interview and what will happen in the modeling session. Here it is important to pick up any signs of the domain expert feeling uncomfortable and discuss it up front, e.g., starting by saying: "I see that you are a bit uncomfortable with what I say. Can you comment?" In general it is important to make it clear that the information given by the domain expert will only be used to prepare for the session, e.g., for formulating driving questions. It is unprofessional to make remarks in the modeling session about who said what in the interviews. The following questions about the problem at hand could be considered, using our example:

- How would you describe the function F, its role, and current activities within DIV and within COMP?
- Describe some, in your opinion, important issues within F to be addressed in the next 3–5 years.
- Describe some problems currently experienced by DIV with the function F.
- Give some long-term as well as short-term goals of the function F.
- What makes F a necessary function within DIV?
- What are, in your opinion, the current strengths and weaknesses of function F?
- Which opportunities exist in the area of F?
- Which external constraints would you like to mention regarding F?
- Which external trends may influence the operation of F? How?
- Which management should be particularly concerned with the operation of F?
- Which important decisions, with long-range consequences, will we have to make within a year regarding F?

- Do you see any problems in carrying out these decisions?
- Which opinions do you think other stakeholders could have about the problems of F?
- What should we not talk about at the modeling session?

The interviews give the project management and the facilitators an improved view of the persons who will participate in the modeling sessions and of their visions, problems, hopes, prejudices, and fears. This gives the facilitator a possibility to plan how to start the modeling session, how to conduct it, and how to handle possible upcoming situations. The interviews may give some hints on organizing the first modeling session depending on situations and opinions revealed in the interviews.

9.5 Prepare Modeling Session

A detailed plan for the modeling session (information set 14 in Fig. 9.1) is elaborated by analyzing the background material and findings from the interviews. This plan should include specific objectives of the modeling session, specific questions to be addressed, preliminary set of enterprise models to be developed (e.g., goal models, concepts models, actor models), a set of driving questions for starting the discussion, and the expected level of model quality. The modeling facilitator should also assess various risks and scenarios of how the modeling session might develop. For example what are the topics that the participants will not talk willingly, what are the topics that might lead the discussion astray, what can cause conflicts, and how to act in case of a conflict. This should be done in collaboration with the problem owner and project leader. The practicalities of the meeting (information set 13 in Fig. 9.1) should also be organized, which includes location, agenda, travel plans, etc.

The first modeling session should be organized in a way that promotes concentrated work. This may be achieved by convening in a special room not usually used by the participants or even at other premises, e.g., a conference facility. Such a choice of location may provide a more relaxing atmosphere and make interruptions unlikely. Needless to say, mobile phones should be switched off.

Apart from four to eight participants, only a limited number of others should be present:

- One or two facilitators. The number depends on the perceived complexity of the issues to be discussed as well as the number of participants.
- The modeling project leader as an observer who needs an overall knowledge of the modeling work
- A secretary as an observer with the following tasks:
  - To take care of the practicalities of the plastic sheet, arranging coffee breaks, etc.
  - To document the process of the modeling session.

9.5.1 Setting up the Room for Modeling

The room must contain at least one large (3 m × 2 m) wall clear of all decoration, to attach a plastic sheet on. There should be precisely enough chairs and tables for the participants. It should be large enough so that nobody could "hide" or make him or her unavailable. There should not be any distractions such as refreshments, telephones, etc.

9.5.2 Equipment

In the room there should be the following equipment:

- At least one plastic sheet
  - Thick
  - Two meters wide, on a roll
- Pens
- Non-permanent to enable erasure from plastic sheet
  - Medium point
  - At least one for each participant
- Paper
  - Preprinted with components' names
    (a) Each component type has a different color to enable easy identification
    (b) An A4 page cut into four quarters gives a satisfactory size
  - A4 papers of different colors
- Wet rag
  - To wipe off pen drawings from the plastic sheet
- Adhesive putty
  - Two small blobs attached to the back of each piece of paper ensure that these stay attached to the plastic sheet when required while allowing them to be easily transferred
- Scissors
- An overhead projection machine or a beamer connected to a laptop
  - For presenting introduction material and other information necessary to run the session

9.6 Conduct Modeling Session

The modeling session is conducted according to the plans made initially. Here we will not describe details of how a modeling session is conducted. Recommendations of what to do and what not to do are included in Sect. 9.5 and, for example, in Stirna et al. (2007), Sandkuhl and Lillehagen (2008), Jørgensen (2009), Stirna and Persson (2009), and Willars (1999). The tangible outcome of the modeling session are the models produced (information set 16 in Fig. 9.1) and an additional list of actions for implementing the decisions made during the modeling session (information set 15 in Fig. 9.1). Additional intangible outcomes of modeling are participants' improved understanding of the problem area and a firmer commitment to the decisions made (Persson 2001; Lindström 1999).

After the modeling session it is recommended to write minutes of the meeting (information set 17 in Fig. 9.1) which includes the models as in the state were produced at the modeling seminar and action list. At this stage the models should not be more refined because the main purpose of this activity is to send notes to the participants, which might also serve as a reminder of the actions that they have agreed to be responsible for.

In the following, we provide a set of practical tips to help the modeling team to effectively carry out the session.

9.6.1 Introducing the Session to the Participants

A short introduction is to be given of each of the following:

- All those present
- The agenda of the session
- The topic(s) for discussion
- The ground rules for modeling

  These are necessary since these are not self-evident and are necessary for maximal productivity. They explain the accepted social interactions and means of furthering creativity:

  - Everybody participates—no spectators
  - Everybody contributes constructively—differentiate between person and subject matter
  - Everything of importance is written down—talk disappears, the plastic sheet counts
  - Better overexplicit than implied
  - Better half-done here and now than completely brilliant next week
  - Write complete sentences rather than keywords
  - Listen to each other and think individually
  - Build further on each others thoughts
  - Strive for balance and consensus in the result
  - Search after missing threads of thought

9.6.2 Stimulating and Structuring the Modeling Activity

The goal of EM is, of course, not only the Enterprise Model as such. The Enterprise Model is just a description and representation technique. To obtain an improved understanding, to solve problems, and to develop the enterprise we should be directed by a critical and analytical study of the Enterprise Model and its internal relationships. This should be based on good understanding of the principles of EM as they have been presented previously in this book. It is particularly important that relationships between sub-models of 4EM are used as drivers in this work. This may be achieved, to some extent, with the aid of driving questions of the following type:

- Is each goal supported by a process in the Business Process Model? If not, why not?
- Should we then introduce such a process?
- Who in the Actors and Resources Model should be responsible for this process?
- Are they already responsible for a similar process or is there someone else?
- Should we invest in a new resource to help us run this process?
- Does this resource need a new or improved information system?
- Can we identify in the technical and requirements model, the requirements for the information system?
- Are there business rules that may put constraints on the requirements?
- Do we have a common enterprise definition of what these constraints and requirements mean, in the Concepts Model?

By searching for relationships and inconsistencies, and discovering gaps, we can increase our knowledge and understanding of the enterprise. The search for knowledge must be made on an individual and group basis in the context of the situation, given the particular intentions of the participants. 4EM will help you in the right direction, by giving you the graphical, structured representation technique in the form of the Enterprise Model, making the cognitive process of analysis easier. Hence, the lists of driving questions mentioned in previous sections are not complete, but only examples that should be further expanded when applicable.

9.6.3 What to Avoid

There are many pitfalls when one is involved in the communication of ideas between humans, which is what we are dealing with. In the specific case of 4EM these include:

- Avoid beginning modeling with long explanations of abstract concepts.
- Begin with well-known practical or physical activities, processes, or goals.
- Avoid, if possible, creating unstructured models. This does not mean that the initial model must always be structured. It can be done in such a way that at first, modeling components are simply grouped together according to some criteria and relationships are introduced later in the modeling session. In fact, the session often involves idea generation and restructuring iterations.

- Conduct additional restructuring and clarification activities as soon as possible after the modeling session; otherwise a lot the information inherent in the unstructured model will be forgotten.
- Avoid having few-worded formulations of modeling components that are not intuitively understood.
- Do not have goals that do not contribute to the overall objectives of the enterprise.
- All goals must be connected so that they contribute to each other. No loose ends should exist.
- Avoid composite statements that have many in and out relationships so that they do not allow for easy understanding and analysis.
- Try to break down statements to the last point at which they are relevant to the issues at hand.
- Avoid detailing attributes before an overall conceptual structure is established.
- Not all attributes are relevant.
- Do not verbalize what is apparent in the model.
- Avoid having concepts that you are unsure why you have them.
- When choosing particular words, confusion and missing concepts may be avoided by creating new words.

9.7 Analyze and Refine Models

Enterprise Models created at a modeling session usually need further refinement in terms of presentation and layout, as well as content. The result of the modeling session should also be analyzed with respect to the objectives of the session and the project. This either leads the project team to a conclusion that the expected result is achieved and can be presented to the organization (information set 18). Otherwise the team identifies a set of issues for further development and modeling (information set 19 in Fig. 9.1) and proceeds with planning subsequent project activities (process 2 in Fig. 9.1). In many cases information sets 18 and 19 are reports of the project activities.

After the first modeling session, the modeling experts document the models using a computer-based tool (Chap. 5). The first session is often mainly a brainstorming activity. Hence the state of the model is such that:

- It is lacking a clear structure, making it difficult to get an overall picture.
- There are redundant components, for example, there may be two goals stating roughly the same thing.
- There may be missing components
- Relationships are lacking showing how components are connected to each other
- The terminology written by domain experts may be ambiguous.

The overall objective of structuring and analyzing the results of the first session is, therefore, to “make sense of the mess.” It is to systematically go through all the models, components, and relationships and make them presentable as a basis for further deliberation by the participants in the following session. That is, by clarification, abstraction, structure, simplification, derivation, deduction, and induction.

To achieve progress in terms of structure and clarity of the models the following strategies can be useful:

- *Organize the model to make it more readable*

  For instance, crossing arrows should be reduced and grouping of components can be made.
- *Introduce relationships*

  The models are given meaning by drawing relationships so that, if possible, all components in the models are connected to at least one more component. Implicit, undesirable, or overlapping relationships may be discovered and adjusted. Missing components may be discovered. Since the analysts may not have the requisite knowledge, it may be necessary to consult with stakeholders to get a better understanding of the relationships.
- *Clarify terminology*

  Concepts, terms, and abbreviations that are unclear or ambiguous need to be clarified. Domain experts often need to be consulted to explain and define concepts.

After the models produced in the modeling session have been documented it is time to make sure that they live up to expectation and correctly capture what has been modeled, i.e., they need to be accepted by the modeling group that participated in the session. This can be done in at least two ways that we discuss here: by interviewing stakeholders and by organizing walk-through sessions.

Interviewing stakeholders may seem as a feasible way ahead, since it is easier to schedule an interview with a person than to organize a session with several people. Particularly if the people concerned are managers. However, this often proves to cause problems later on. One important purpose of having a walk-through session is, like in participative modeling session, to ensure that different views on the problems are represented in the same room, allowing for quality enhancing discussions between domain experts.

At the walk-through session, the analysts present work done since the first session and the rationale behind the work and enhance the models. The session should aim to achieve all the following:

- Review the work from the first session
- Make corrections and/or additions to the models and descriptions
- Narrow the field of discussion and specify the domain
- Expand previous models
- Suggest further work and future directions

The resulting models from the first modeling session should be presented to the modeling group precisely as it was. To present the refined model to the modeling group requires careful planning. The group must be able to trace the results of their efforts, from the original plastic sheet model through the analysis stage to models presented at the next stage, the walk-through session. They must be able to recognize what they have done in the modeling session. A description must acknowledge and give credit to the first session by a verbal description of the results.

At this stage, models produced by computerized tools have replaced models on plastic sheets. Since it is impractical for up to eight people to gather around a normal sized computer screen, the model should be projected using a beamer. As well as the computerized presentation equipment required, all the equipment necessary for modeling as mentioned in Sect. 9.5 is also needed. This may entail the use of a larger room or possibly two rooms, one for projection and one for modeling.

A large screen allows all the participants to view the computer-generated models. In theory, continued modeling directly on the screen together with a tool expert is possible. However, this is not advised as the focus of the group may move from the issues to be discussed to small improvements and/or technical finesses of the modeling tool.

The presentation is a balancing act. The analysts must actually do an analysis, while at the same time not discarding the group work that has been. When interpretation, change, or deletion is done, it must be explained and justified. This is to ensure that the group will continue to be motivated to contribute. Otherwise, credibility of the analysts and eventually the models is lost.

The results of the first walk-through should be a validation and adjustment of the models being discussed.

Sometimes the modeling project is very small. In fact, sometimes one modeling session is enough. In most cases more sessions are needed to achieve the modeling project goals. Then the process starts all over with preparations and carries through to validation of models.

9.8 Present the Results to Stakeholders

The modeling project ends with presenting the results to the problem owner and relevant stakeholders. A part of this presentation is decision making on how the results should be implemented or taken up by the organization. It might also be that the stakeholders identify issues that are not resolved and require further development (information set 19 in Fig. 9.1).

The EM process we have outlined ends when the problem owner and the involved stakeholders feel that they have a result that can be implemented. In practice the EM project results will most likely serve as input for another development project, including an IT or IS development project.

The EM process described in this section may appear easy to conduct on the outset. In reality, however, there are many challenges to succeed and pitfalls to avoid, particularly in the project preparation phase (processes 1–6). Much of this knowledge is related to organizational and social issues and hence is not easily formalizable.

9.9 Change Management in Enterprise Modeling Projects

Enterprise modeling projects, particularly in development situations, typically go through a series of modeling sessions where modeling of the current state of the problem is followed by definition of change requirements. These change requirements are the basis for modeling future state models, which are then used as "blueprints" for development of, for instance, business processes and/or information system.

9.9.1 Modeling and Analyzing the Current Situation

As a rule, all 4EM sub-models are required to comprehensively model the current situation. Each sub-model is developed in an iterative process, which may include the following steps:

- Modeling starts in a moderated modeling session. Additional sessions may be required for extensive processes or structures
- The results of the session(s) are documented in the chosen modeling tool
- The models created with the tool are presented at a workshop with the participants from the initial modeling session(s) and checked for factual accuracy
- The models are enhanced in workshops of this kind until they reach a state of elaboration that the modeling group and the project manager are comfortable with moving onwards to implementation of the model.
- The relationships between the various sub-models are reviewed and expanded if necessary

9.9.2 Setting Out Change Requirements

Modeling the current situation will have identified the processes, structures, systems, or rules that must be changed in order to remedy the problems that have occurred. There often are several possible ways how changes can be made, and conflicts between enterprise goals often become clear in the goal/problem model. This means that the urgency and priority of the set goals must be decided here before creating a future state model, and an agreement must be reached as to which of the viable potential changes should be chosen. If it is not possible to decide which potential changes are the most suitable ones based on the goal priorities, multiple versions should be developed in the stage of future state modeling. The result of this step, which generally takes place in a joint workshop involving a representative of the commissioning party, the project leader is to obtain an agreement as to which versions should be developed in future state modeling.

9.9.3 Creating Future State Models

The future situation that should be brought about in order to remedy the observed problems is generally defined based on the actual situation. This step therefore mostly involves refining the models of the actual situation so that they describe future processes, structures, systems, rules, and concepts. Models need only be completely recreated in the event that changes are required due to the introduction of completely new processes or structures in the enterprise, or due to radical alterations to processes or structures.

This step produces a description of the enterprise's future situation in the form of a future state model. The future state models can then be used as a "blueprint" for organizational change or as part of the specification of requirements for any necessary software developments.

Chapter 10
Supplying the Modeling Project with Competent Modeling Experts

Human knowledge and competence is a critical resource for achieving the goals of EM. There are two reasons for this:

– Models contain human knowledge about an organization in its current or envisioned future state. We need domain experts who contribute this knowledge.
– The knowledge of domain experts has to be captured and structured in enterprise models, which contribute to the EM goals. We need modeling experts who are able to do this.

The competency of the modeling expert is a critical resource in EM application. Modeling experts are responsible for the effective adoption of a chosen method and for the project to reach its goals using the assigned resources. In the following, the necessary competency of experts in a modeling project is described.

10.1 Core Competences in Relation to EM Project Activities

Figure 10.1 depicts three levels of method expert competence that are developed with growing experience.

- Ability to model, which means that a person is able to construct an Enterprise Model which is syntactically correct according to the used EM language and that the model in a reasonable way reflects the domain and problem in question.
- Ability to facilitate modeling sessions, which means that a person is able to lead a group of domain experts in creating/refining an Enterprise Model and to do it in such a way that the group's knowledge and abilities work together to create a high quality model.
- Ability to lead EM projects towards fulfilling their goals and making the best of the project resources.

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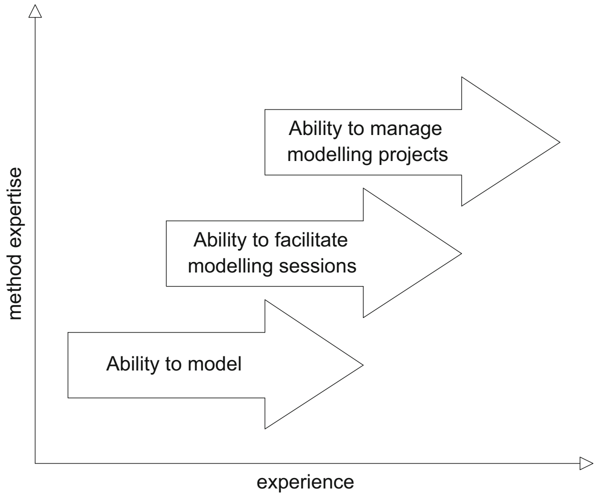

Fig. 10.1 Core competences of EM in relation to experience (Persson 2001)

The list of relevant competences that are useful for acting at each level can potentially be very long. We claim that in order to target the *main* challenge of the EM process, which is to produce an EM outcome that is fit for its intended use, we need to define a set of essential core competences that target the quality of the outcome of EM. In the following we describe the core competences that our research has yielded so far. They fall into two distinct categories:

1. Those related to modeling itself, i.e., the ability to model and the ability to facilitate participatory modeling session. These competences are at the heart of modeling and
2. Those related to setting up and managing EM projects.

10.2 Competences Related to Modeling

The *ability to model* involves making use of the chosen EM language to create and refine enterprise models. The resulting models should reflect the discussion in the modeling session and focus on the problem at hand. Knowing how to use modeling tools for documenting and analyzing the modeling result is also included in this ability. One important, and sometimes neglected, aspect is the ability to create a readable model, because they tend to become large and graphically complex.

Since we advocate a participatory approach to EM, the *ability to facilitate a modeling session* is essential. Facilitation is a general technique used in group processes for a wide variety of purposes, also within EM (see further, e.g., Zavala and Hass (2008) and International Association for Facilitators (IAF) http://www.iaf-world.org). This ability is very much based on knowledge about the effects of modeling, the principles of human communication and socialization (especially in groups), as well as the conditions of human learning and problem solving (cognition). For Enterprise

Modeling, some of the more important aspects of this competence are to condense and capture important ideas, to pose questions that trigger discussion, to listen, to summarize and generalize, as well as to drive the discussion towards fulfilling the goals of the EM session.

For both of these abilities we want to highlight the fact that the competence requirements are quite different if EM is used to capture the current situation compared to designing a future situation. In the latter case the ability of the EM practitioner will be geared towards drawing out the creativity of the domain experts and to guide that creativity towards the goals of the session.

10.3 Competences Related to Managing EM Projects

In order for the models to be fit for their intended use, the EM practitioner needs the *ability to select an appropriate EM approach and tailor it in order to fit the situation at hand.* Sometimes that choice is restricted by the requirements of the context of use, as, e.g., is the case when EM is used in an IS development project that uses a particular method and tool-set. In other cases the choice of an EM approach is up to the EM practitioner. Based on her/his knowledge about the problem at hand, the requirements on the EM result, the preferences and modeling skill level of the modeling group, and the context in which EM will be used the EM practitioner will have to choose an appropriate approach. The professional EM practitioner will have a "tool-box" of potential methods for different purposes that she/he is able to use. Independently of whether the EM practitioner has the choice of approach, the approach often needs to be tailored to fit the situation at hand and she/he will then need to be able to assess the consequences of any changes made to the approach.

As discussed before, in participatory EM the *ability to interview involved domain experts* before the EM session is critical. In this situation the social skills of the EM practitioner are essential, such as, e.g., ability to listen, ability to read body language. In a discrete way the EM practitioner needs to ask the domain expert what should be talked about in the modeling session and also try to find out what topics should be avoided and why.

For EM to have effect in its context of use, it needs to be focused towards a particular goal or problem. This pertains both to the overall EM project level and to each EM session. The *ability to define a relevant problem* that is feasible to model based on the information that the EM practitioner can obtain is, therefore, important. This ability is very much related to the ability to interview domain experts. In this ability the capacities to conceptualize, to generalize, and to assess the relationships between different problems are included. An essential aspect of defining the relevant problems is the ability to spot hidden agendas, which builds both on the practitioner's previous experience but also on her/his social skills and ability to "read between the lines" in a conversation. Unidentified hidden agendas can potentially cause problems later on in the EM project. Assessing the complexity of a problem is also part of defining a problem. Problem complexity is a heavy influence on the planning of the project both in terms of activities and resources. It can be argued that it is impossible to define a clear problem on the outset and that it will change as the project proceeds. This is true, but in order for the project to become operative at least a “working problem” is needed.

In planning an EM project and an EM session, the *ability to define requirements on the results* are essential in order for project/session goals to be achieved. These requirements relate to the models that are to be produced as well as what is to be achieved by these models. Sometimes the requirements have to do with the process itself. For example by involving certain stakeholders and having them listen to what other stakeholders have to say in a participatory EM session, certain change decisions can be made less dramatic for the organization. The EM practitioner should also keep in mind that the models produced is the tangible result of modeling, but equally important is the intangible result—participants’ changed thinking and understanding of the problem.

The *ability to establish a modeling project* is critical in order to create the most beneficial conditions for the EM project. Favorable conditions will increase the chances of obtaining the desirable effects of EM. Conditions involve resources in terms of time and competence (domain as well as EM practitioner competence) as well as authority for EM project participants to act freely and make decisions within the project definition. This ability is essential in any project.

The result of modeling will be used for a specified purpose. In order for that purpose to be fulfilled the users of the result need to understand it and its implications. This means that the modeling practitioner will have to present it in oral and/or written form to them. Depending on the target audience, certain aspects of the result will need to be emphasized or toned down. For example presenting project results to a group of managers, the detailed data structure of the supporting IS can be omitted. This requires an ability *to adjust a presentation of project results and issues related to them to various stakeholders.*

An EM project is a signal to the organization that change of some kind is imminent. This means that various stakeholders will try to influence the EM practitioner so that their own goals will be those of the EM project. To *navigate between the wishes of various stakeholders while upholding the EM project goal* is, therefore, a critical competence. More about the challenges involved in tackling this problem can be found in Kaarst-Brown (1999).

EM projects typically deliver a solution to a business problem. The solution usually consists of an organizational design proposal (which might include an IT solution) reflected in Enterprise Models. A partially intangible outcome of the EM project is the supporting set of decisions and commitment to implement the solution. Example issues to consider are: would the solution appear to be inappropriately bureaucratic, democratic, authoritative; what kind of implementation activities are needed, etc. An ability *to assess the impact of the modeling result and the modeling process in the organization* is therefore needed to drive the modeling effort towards a solution that has a high probability of being implemented within the organization.

Table 10.1 Matching of EM process steps to core competences (Persson and Stirna 2010)

Ability	Process									
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
To model							X		X	
To facilitate modeling sessions							X			
To interview involved domain experts					X					
To define a problem	X		X			X			X	
To define requirements on the results	X	X	X							
To establish a modeling project	X									
To adjust presentation of project results						X				X
To navigate between the wishes of stakeholders while upholding a defined project strategy	X	X			X		X			X
To assess the impact of the modeling result and the modeling process in the organization	X	X				X			X	X

In Table 10.1 the core competences are summarized and mapped to the process steps defined in Fig. 9.1.

10.4 Different Purposes of EM Require Different Competencies

In this section we describe how the core competencies described in the previous section come into play depending on the purpose of EM.

10.4.1 Develop Visions and Strategy

Ability to model, including assessing and improving model quality according to the EM purpose. In addition to the core abilities to model and to facilitate modeling sessions, this EM purpose also requires specific modeling abilities to model on a high level of abstraction where initially the enterprise model is not internally connected and may appear to be consisting of "small islands." The main challenge here is to guide the modeling work towards a certain direction. This might be hard because a part of strategy development is to allow the group to explore different options to a certain degree. The facilitator, however, needs to have the ability to see a certain "path" in the models and steer the modeling participants from drifting off course, for instance, by discussing peripheral problems and defining goals that are plainly unrealistic. This situation requires the practitioner to deal with a large degree of uncertainty while demonstrating confidence to the participants in the group.

Regarding competencies related to setting up and managing modeling projects the following specifics should be paid attention to:

Ability to select an appropriate EM approach and tailor it in order to fit the situation at hand. For strategy development there exist a number of suitable development approaches that the modeling practitioner needs to be reasonably knowledgeable about. The modeling participants might often be familiar with a specific modeling language and notation. Importing a strategy development approach into EM in most cases implies defining new "inter-model" links with the existing components in the enterprise model and/or defining synonyms among modeling components. This requires deep knowledge about the meta-models and intentions of the involved methods.

Ability to define a relevant problem. The ability to define a relevant problem goes hand in hand with the ability to facilitate. The problem might be defined relatively vaguely, e.g., to find the real problem. Nevertheless the EM practitioner should have the ability to define at least general boundaries for it.

Ability to navigate between the wishes of various stakeholders while upholding the EM project goal. Deciding on the direction of an organization influences an organization more than short-term decisions. Therefore, the risk of having to deal with various hidden agendas from stakeholders is imminent. Also, these stakeholders often have an influential position in the organization. This means that the modeling practitioner needs to be listening and diplomatic while demonstrating that she/he is the person in charge of the EM project. Taking this role requires experience and knowledge about how organizational cultures function as well as patience, an agreeable personality, and a firm but pedagogical way of communicating.

Ability to assess the impact of the modeling result and the modeling process in the organization. Being able to assess the impact of a vision or a strategy requires some experience from both successful and unsuccessful processes of implementing strategies, since the degree of uncertainty can be quite high.

10.4.2 Design/Redesign the Business

Ability to model, including assessing and improving model quality according to the EM purpose. To fulfill this purpose, the EM practitioner should be able to assess that the models have enough quality to be implemented under the conditions that exist or will exist in the business at hand. This requires some previous experience from being involved in, e.g., implementing processes in an organization. One important aspect here is to be able to assess not only the practical implications of change but also the cultural implications of change.

Ability to facilitate participatory modeling sessions. When designing/redesigning the business one of the main challenges is to avoid polishing the current way of thinking and working. The EM practitioner should be able to support the creativity of the group while maintaining a critical view on the resulting models.

Specific competencies related to setting up and managing EM projects are as follows:

Ability to interview involved domain experts. Following the previous discussion, the EM practitioner should be able to assess the ability of potential modeling participants to think creatively and out of the box and to make sure that some people in the group are also “critical thinkers”.

Ability to define requirements on the results. Often projects like these require that different types of models are developed. The EM practitioner should, therefore, be able to define how the whole project sticks together and how each model contributes to bigger picture. Changes in the target area of the project could also influence other areas of the business. This means that the requirements on the result must be related to an even bigger picture that constitutes the surrounding organization and sometimes partner organizations. Requirements must be defined such that the result can be implemented afterwards. Putting this complicated “puzzle” together requires a high level of experience and skill from the EM practitioner.

Ability to establish a modeling project. An important aspect of establishing an EM project with this purpose is to negotiate authority for change. Both the EM project leader (EM practitioner) and the modeling group/s involved must feel that they are authorized to make design decisions that take into account the goals and constraints of the project. This means that the EM practitioner must be able to identify which authorities are needed, identify the involved decision makers and negotiate the proper authorities. Sometimes it happens that decision makers go back on what they have approved, and then the EM practitioner will need to be able to either negotiate maintained authority or redefine the scope of the project.

Ability to navigate between the wishes of various stakeholders while upholding the EM project goal. All processes that involve change will cause different kinds of resistance in the organization. Therefore, the risk of having to deal with various hidden agendas from stakeholders is highly possible. This means that the modeling practitioner needs to be listening and diplomatic while demonstrating that she/he is the person in charge of the EM project. Taking this role requires experience and knowledge about how organizational cultures function as well as patience, an agreeable personality, and a firm but pedagogical way of communicating.

10.4.3 Develop Information Systems

Ability to model. The specifics in relation to this purpose primarily focus on assessing and improving model quality according to the EM purpose of developing an IS. More specifically, the enterprise model should be created in such a way that it is possible to implement in a system. This might require increasing model formality. In this context the EM practitioner should understand the use of the models in the IS development project, e.g., how Concepts Model can be used as input for developing a database schema. Ultimately, the EM practitioner should have some experience from IS development projects, preferably from an operative point of view.

Ability to facilitate participatory modeling sessions. This purpose requires the ability to guide the modeling effort in such a way that a balance between the IT and business aspects is ensured. If one of the aspects dominates the other, the resulting solution risks being unsuitable for the organization.

Regarding competencies related to setting up and managing EM projects, the following specifics should be paid attention to:

Ability to select an appropriate EM approach and tailor it in order to fit or be docked to the IS development process and its specific development methodology and (often) tools. In principle many modeling languages and tools can be used for this purpose and most often modeling language of one sub-model in the enterprise model can be replaced with another modeling language as long as the inter-model links remain intact. For example 4EM Goals Model notation in principle can be replaced with another similar notation, and Concepts Model changed to UML Class Diagram. The modeling practitioner should be able to perform such a method engineering task.

Ability to define requirements on the results. Modeling practitioner should be able to assess how models are used in the IS development process and when the model is complete enough to proceed to IS development activities.

Ability to establish a modeling project. This EM purpose means that EM is used in a IS development project and perhaps not seen as a project in itself, but rather a set of intertwined activities. The modeling practitioner should be able to understand the IS development methodology and design EM steps in a suitable way.

10.4.4 Ensure Acceptance of Business Decisions

For the EM purpose the main success criteria is that the decisions made during modeling and reflected in the model are accepted and taken up by the organization.

Ability to facilitate participatory modeling sessions. The facilitator should make sure that the group reaches consensus and real decisions that can be implemented in the organization. Furthermore, the facilitator should also make sure that the participants perceive the enterprise model as documentation of the decisions and the decisions as real allocated to real people for implementation.

Concerning competencies related to setting up and managing EM projects, the following are of relevance:

Ability to select an appropriate EM approach and tailor it in order to fit the situation at hand. All kinds of modeling tricks can be necessary, including breaking the methodology rules, modeling notation, and using unconventional approaches. The modeling practitioner should be able to assess the impact of such actions on the modeling results and the process.

Ability to interview involved domain experts. This EM purpose might be associated with hidden agendas that need to be uncovered. Finding out how decisions are made in the organization and how they are implemented also is crucial. The modeling practitioner should have good listening skills because these issues can seldom be addressed with a straight question.

Ability to define requirements on the results. In this case the acceptance and the consensus could be seen more important than the model quality. Hence, it might sometimes be purposeful accepting low model quality if the group agrees with the decisions made.

Ability to navigate between the wishes of various stakeholders while upholding the EM project goal. This is particularly important because the project usually covers a broader group of stakeholders than is possible to involve in modeling directly.

10.4.5 Maintain and Share Knowledge About the Business

For this purpose it is important to understand that sometimes existing models are used as input and sometimes models are created for the purpose of depicting how the business is carried out. In the latter case the modeling is about capturing the current state of affairs and ways of working.

Ability to model, including assessing and improving model quality according to the EM purpose. The models that are created for this purpose have a specific target, which is to convey a message and also to instruct a diverse group of stakeholders. This means that the understandability of models is essential, which in this case is a critical aspect of model quality together with correctness. For the EM practitioner this means that the ability to become knowledgeable about the characteristics and needs of the target groups is important. Listening and communication skills are essential here.

The following specifics should be paid attention to concerning competencies related to setting up and managing EM projects:

Ability to select an appropriate EM approach and tailor it in order to fit the situation at hand. In this case, the modeling language should either be familiar to the stakeholders or be simple enough to understand without prior knowledge of the language. The EM practitioner should have enough knowledge about modeling languages to be able to balance quality aspects such as correctness of the models in terms of state of affairs of the business with the quality aspect of understandability.

Ability to define requirements on the results. This ability relates, again, to the understandability of models. Also, in order to be able to properly define the requirements, the EM practitioner should have some knowledge relating to organizational learning. This is further discussed under the ability to assess the impact of the modeling result below. One important aspect of this ability is setting up for maintenance of models, because the business changes and the models should change accordingly. This means that the EM practitioners need to be knowledgeable about different tools that can be used to document and maintain models as well as be able to set up a feasible maintenance process. More on what is needed to keep models "alive" is available in (Stirna and Persson 2008; Wesenberg 2011) and on using Active Knowledge Models in organizations see (Lillehagen and Krogstie 2008).

Ability to adjust a presentation of project results and issues related to them to various stakeholders. Presentation of the resulting models is one of the key issues for this purpose. Sometimes the models themselves may not be the best way to present the organizational knowledge and some alternative ways of presentation must be devised. Providing background information and connecting models to this can be one potential approach. Another approach could be to develop simulations based on the models. The ability to understand the conditions under which the models/information makes sense to the intended stakeholder groups is essential here. Pedagogical knowledge is also helpful, together with knowledge about how different media can enhance the message that is being conveyed.

Ability to assess the impact of the modeling result and the modeling process in the organization. The ultimate desired impact of fulfilling this purpose is that organizational learning is created. To lead a modeling project with this purpose, the EM practitioner should preferably have some knowledge and experience from fields that address organizational learning, such as, e.g., Knowledge Management.

10.4.6 Use EM to Analyze and Solve a Specific Business Problem

EM projects with this purpose are usually quite short and compact in time, e.g., they should be done within a week. More about what happens in early phases of EM is available in (Persson and Stirna 2010). For this purpose the modeling competencies do not have specific areas or concerns, but competencies related to setting up and managing EM projects have to include the following specific issues:

Ability to select an appropriate EM approach and tailor it in order to fit the situation at hand. In this case simple EM languages and notations should be preferred because there will be no time to familiarize the participants with the modeling approach. We recommended using 4EM with relaxed notation. Also, using the approaches that the organization already has should be preferred. The EM practitioner should be able to find out what the organization has in terms of existing approaches and assess how it can be used in an EM project.

Ability to interview involved domain experts. Interviewing needs in this context to follow a tight schedule, since time for planning is usually very restricted. The interviews should, however, not be done in a haphazard way, i.e., the EM practitioner should be able to follow a predefined interview script and keep the schedule.

Ability to define a relevant problem. Even in short projects such as these the problems put forward by the domain experts can be quite large and many. The modeling practitioner should be able to find the relevant problem/s in a cluster of problems.

Ability to define requirements on the results. In this situation there are often very strict constraints in terms of time and other resources. For example there may only be time for one modeling session. This requires the modeling practitioner to be realistic in terms of what can be achieved and to communicate this to the problem owner, especially in cases, where the resource constraints put at risk achieving the expected result.

Ability to assess the impact of the modeling result and the modeling process in the organization. Since the EM project happens so quickly in the organization, the difficulty is to make sure that someone will actually take up the result and implement it. This needs to be addressed in the project negotiation and planning phase, for example, by inviting modeling participants that can support implementation.

Chapter 11
Adoption of Enterprise Modeling

Organizations usually begin using EM within the context of a development project of some sort, where an outside vendor and/or consultant provides the method and tool usage competence. If an organization uses EM sufficiently frequent it may be motivated to develop in-house EM competence and to acquire and adopt an EM method. This chapter discusses the process of acquiring an EM approach. Acquisition of EM tools is addressed in Chap. 5.

The chapter begins with a discussion about what it means to adopt EM in an organization, i.e., to support continuous improvement. Afterwards an overview of the adoption process and its different phases is provided. These are then addressed in turn. A short note on training of modeling experts is also included.

11.1 Supporting Continuous Organizational Improvement with EM

The reader is here reminded of the two main reasons for using EM:

- To develop the business. This entails developing business vision, strategies, redesigning the way the business operates, developing the supporting information systems, etc.
- To ensure the quality of the business, focusing on: (1) sharing the knowledge about the business, its vision, and the way it operates, and (2) ensuring the acceptance of business decisions through committing the stakeholders to the decisions made.

In Chap. 9, EM as a project was discussed. Typical EM activities are summarized in Table 11.1.

In this chapter we take one step up from EM projects and consider them to be part of an organizational strategy to use EM for supporting continuous

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Table 11.1 Activities in EM (Stirna and Persson 2012b)

Define scope and objectives of the modeling project
Plan for project activities and resources
Plan for modeling session
Gather and analyze background information
Interview modeling participants
Prepare modeling session
Conduct modeling session
Write meeting minutes
Analyze and refine models
Present the results to stakeholders

organizational improvement. The EM lifecycle can then be outlined according to the following steps, which is also depicted in Fig. 11.1.

1. Something triggers the need to investigate a potential change in the organization. This trigger can be a business opportunity, a challenge, a problem, or a symptom of a problem. A choice is made to use EM in the investigation and potentially also to design a change to business operations and/or the IT systems that support business operations.
2. The EM project is initiated and executed according to the process described in Chap. 9.
3. The implementation of the resulting models is planned and executed and the models now become part of the day-to-day business processes.
4. Continuous organizational improvements are made. EM could support some of these improvements. Changes of greater importance will most likely cause the process to start over from step 1.

The outcome or effect of the implementation of models is very much dependent on the following two aspects:

- How the EM project is planned and executed (Chap. 9). Managing modeling and model quality is one aspect here (Chap. 12) as well as the many facets of managing the EM project as a whole.
- How the implementation and continuous improvement of the resulting models is planned and executed over time.

Effectively managing quality throughout the project will ensure that the intended effect of modeling and the resulting models will materialize, not only from a short-term perspective but also long-term. In the following we will address two critical issues for succeeding: managing triggers (see Fig. 11.1) and establishing mechanisms for managing continuous organizational improvement using EM.

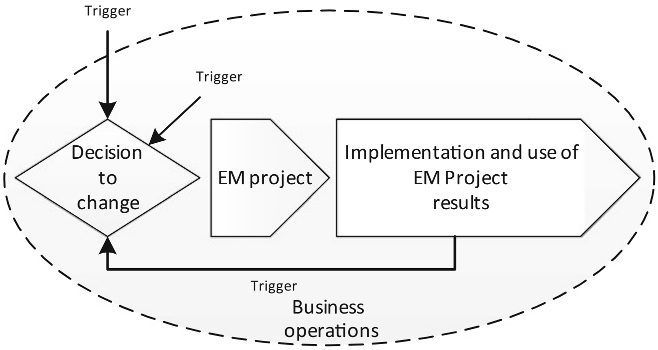


Fig. 11.1 EM in the context of continuous improvement (Höglund and Persson 2012)

11.1.1 Managing Triggers: Acting on Symptoms or the Real Root Cause

In order to ensure that the process of continuous organizational improvement serves the purpose of making the organization fit to take on its challenges and to prosper, it is essential to act on the "right" signals/triggers. This implies that the analysis of triggers needs to get enough qualified attention, as a basis for making decisions about starting a change process. This will ensure that the EM project rests on a firm ground already from the start. We want to start the EM project for well-grounded reasons and with a goal that will effectively improve business operations. To illustrate this point, we describe two real life cases, one successful and one less successful.

11.1.1.1 A Successful Case: Getting at the Root Causes

A construction vehicle supplier (Company A) with workshops for repair and maintenance all over Europe wastes time and money. Some 5–10 administrators in each region are involved, on a daily basis, to handle incorrect invoices. This is due to invoices stating the wrong amount and/or receiver. After correcting the errors, they finally send the correct invoices. Too many people are involved in correcting errors, customers as well as administrative staff. This causes irritation and dissatisfaction for everyone involved, but most serious problem is that no value is created.

Nobody can state the "one and only" root cause to the problem, so a problem analysis, using EM, is carried out to find the root causes to the problem. In order to involve the right participants a stakeholder analysis is also made. A group of five primary motivated stakeholders are selected to carry out the problem analysis, using goal and problem modeling. A modeling facilitator guides the process.

In contrast to the visible symptoms the following severe root causes are identified in the analysis. They are supported by hundreds of post-its on a big plastic sheet on the wall, well sorted/related to each other:

1. The processes and their interfacing objects are not well defined. One aspect is mixed value-chains where, e.g., a vehicle all of a sudden became an invoice in the same process. Also, the input/output objects for governing and supporting processes are not enough specified, meaning that the repair workshop process is not quality controlled.
2. At the customer reception the rules and policies to conform to are too broad and complex and not easily accessible so the receptionists hardly adhere to them.
3. The way to measure and reward responsible actors is in severe conflict, e.g., the workshop and service contract managers' KPIs are not aligned. Rather they are in conflict.
4. There is a lack of functionality and data accessibility in the IT support and there are also a variety of different systems in use. All in all, the IT support does not support the processes.

A number of walk-through sessions are then organized, involving stakeholders with the role to criticize the model; in such sessions, important stakeholders who have not been involved in creating the models are invited to discuss and criticize the models. This increases the quality of the analysis and invokes broad participation and commitment to invest and solve the key problems, i.e., it paves the way for the coming steps of successfully improving the business operations. The four root causes become the basis to set a distinct purpose for the following modeling project.

11.1.1.2 A Less Successful Case: Acting on Symptoms

In an international high-tech company (Company B) a number of problems are experienced in the existing order process. The problems mainly concern work overload, long lead-time, and quality problems.

No systematic problem analysis is made. The process is initially not described in relation to its context, so the interfaces to other processes are not included in the first modeling workshops.

The purpose of the first analysis is unclear, meaning that the needed level of detail is not indicated. Substantial time and resources are spent. The project finally makes a proper problem analysis and finds the sources of the main problems. They are located in processes before and after the order process, which was initially the focus of the analysis.

The modeling project is expanded to include the whole process from sales to delivery, thus including the order process.

The analysis finally results in (1) demands for IT development targeting enhancements to the interfaces between existing IT systems and (2) formulation of process interface agreements between the main processes.

No modeling method is used from the start. Later an EM method is used, both in order to identify and define the context of the process and to identify the process interfaces. Based on a concepts model, the terminology is aligned between the processes, thereby minimizing misunderstandings and as a basis to update the requirements on data availability in the IT support. However, by then the company has spent a large amount of resources not getting anywhere in their efforts to solve the problem.

11.1.1.3 Lessons Learned

Already when we are very young we stress our parents by asking the question "WHY?" until we think we have a good enough answer. Only then we are pleased. This behavior is natural to us as humans and is one of the most important and easy to use "tools" in problem analysis. Therefore, the main lessons that we learn from the above cases are:

- The situation that initially triggered the need for change must be clearly identified, and as soon as possible too. Otherwise valuable time and resources will be wasted. Acting on symptoms is like not asking the question "WHY?" enough times to understand the problem at hand.
- It is essential that the project manager or consultant involved arms herself/himself with sufficient arguments to justify why investments should be made in problem analysis *before* the EM project is initiated and planned.
- It is advisable to use a proven easy-to-use method, for instance goal/problem analysis following the 4EM method.

11.1.2 Establishing Mechanisms for Continuous Organizational Improvement Using EM

When a future state process is implemented following a 4EM project, a responsible process owner is in control. Measurements are in place and used for continuous follow-up, subsequent rewarding of good process performance, and identification of triggers for continuous improvement of organizational operations. New opportunities and threats emanating from external or internal sources will challenge or ask for attention and potential new developments, some needing support from EM.

The complete "map" of existing enterprise models will function as important input to future improvement projects. This way unnecessary modeling work can be avoided. Even if the organizational context has changed slightly, the existing models will provide a good starting point. For more on reuse of models in various contexts, see Chap. 13.

Since models will be extensively reused, it is essential that their quality is high (see Chap. 12). The reuse of models will also require good tool support (Chap. 5) that enables change management of models.

Company A (Section "A successful case: getting at the root causes") is a positive example of an organization where continuous improvement using EM is in "the spine" of all employees. What differentiates this organization is that:

- There is a defined process intended to support continuous improvements, where one of the initial phases is conducting Enterprise Modeling using a similar approach as 4EM.
- The enterprise culture and leadership supports continuous improvement.
- All employees are treated as experts in their role.
- The personnel is loyal and proud of the company and their own work.
- A problem is always turned into a possibility.
- Working in teams is encouraged.
- "Right from me" is a well-established attitude of all personnel. This means that people make sure that what they deliver is correct and follow a high standard of quality.
- There is an established arena for dialogue/control/support, where all improvement activities are prioritized, are followed up, discussed, supported, and visualized.
- There is an awareness of the fact that change may take time and is done in small controlled steps.

The effect of adopting this approach, where Enterprise Modeling has an important role, is that the process of continuous improvement is kept alive and that external and internal triggers for change are properly analyzed and acted upon. Company A has proved to have a high degree of satisfied customers. It has also proved to have a high resilience in difficult times. For instance, in one of the latest financial crises many companies decided to lay off personnel. In Company A, on the other hand, the employees showed their loyalty by accepting a 4-day working week and a subsequent loss of salary of about 10 %. During the crisis the company involved their personnel in training activities. When the crisis decreased everyone was ready to start again but with an even better capacity.

11.2 Overview of the Adoption Process

In the previous section, an example was given on how Enterprise Modeling can become an integral part of an organizations' continuous improvement work. In this section we provide an overview of the process of adopting an EM method as part of such an improvement approach. In the following sections, the different steps of the adoption process are discussed in turn.

Despite the advancements in the areas of modeling methods and tools, their impact in practice is largely dependent on how an EM method is adopted and institutionalized. In practice EM usage often follows the phases of initial interest, pilot project, and subsequent institutionalization. The most challenging is the final one because at this stage the organization should presumably have enough competence to perform modeling without external support. In cases when this is not so, modeling struggles to make positive impact and is gradually forgotten. Therefore, the process of adopting a method should be given the proper attention and resources, in order to be reasonably successful.

The general process of adopting an EM method in an organization consists of the following phases:

- Deciding that an EM method should be adopted as part of the organization's set of institutionalized methods
- Selecting a suitable method
- Implementing the method

11.2.1 Deciding that an EM Method Should be Acquired and Adopted

The decision to adopt an EM method as a part of the organization's set of institutionalized methods often originates from the organization having been involved in projects where external consultants have used EM for purposes described in Chap. 2. This often generates an interest, particularly if the results from such projects have been successful, and a decision to acquire and adopt a method may follow.

11.2.2 Selecting a Suitable Method

A method for EM consists of modeling language, modeling process, and modeling tools. Since the selection of tools is extensively addressed in Chap. 5, the focus here will be on the language and the process.

11.2.2.1 Selecting a Modeling Language

The core of EM is the modeling language because that determines which aspects of a certain problem that can be addressed.

In most cases a certain problem to be addressed can be modeled by using several EM languages/notations. Even within one modeling language the modelers often define "dialects" and sub-notations, i.e., they add elements of secondary notation such as comments, groupings of modeling components, as well as include modeling components from other languages.

The choice of modeling language is to a large extent dependent on the purpose for which EM will be used. The more specific the purpose, the more specialized the language can be. A broad range of intended purposes makes it more difficult to find a language that perfectly fits all purposes. However, as was previously pointed out, there is often room in a language to make adjustments to fit the situation.

When an organization decides to adopt EM as a general way of working and not only for carrying out a specific project, it may be appropriate to select more than one language to cater for intended purposes. For example, using EM for developing visions and strategies and as a general problem-solving tool can require a different level of formality compared to using EM for developing information systems. As a general rule, languages originally intended for developing information systems, e.g., UML, are often more difficult for non-modeling-experts to understand and work with, which suggests that they may not be the optimal choice for problems less formal.

In cases where more than one language is selected, the issue of integration between the languages comes into play. For example, process models are part of both 4EM and UML. In projects dealing with information systems development, decisions need to be made which models will be used in the more business oriented part of a project, where understandability is essential, and how these will be used in the more systems oriented part. Adopting more than one modeling language also influences the choice of tools (Chap. 5), more specifically computer-based tools. One issue here is how models created in one tool can be integrated with models created in another tool.

11.2.2.2 Selecting a Modeling Process

A general process for carrying out an EM project is described in Chap. 9, reflecting a participatory approach to modeling. Although this is the recommended way of working, a less participatory approach can be appropriate under specific circumstances, e.g., if the organizational culture does not allow for different views and opinions being expressed in a group setting. Some steps in that process can then be omitted and some may be added. This means that an organization may adopt more than one general modeling process. In any case they should be documented and made easily available to the organization in order to support the modeling experts and business stakeholders in their work and to standardize the process between specific projects. Such standardization will save time for modeling experts. It will also familiarize business stakeholders with the modeling process and by that make them feel more secure in their participation throughout the various projects that they will be involved in. The introduction of newly employed modeling experts into the way of working of the organization will also be smoother if the process is documented and easily available.

11.2.3 Implementing the Method

As indicated, implementing a method in an organization is the most difficult and time-consuming part of the adoption process. There are many issues that need to be addressed in the process, e.g., how to acquire a method, whether or not to adapt the chosen method, acquiring competent modeling experts, acquire modeling tools, and starting to use EM. Also, evaluation and making adjustments to the implementation should not be neglected. The acquisition of EM tools is discussed in Chap. 5 and will, therefore, not be further discussed here.

11.2.3.1 Acquiring a Method

An EM method consists of a modeling language and a modeling process. Some methods, like 4EM, come with a predefined modeling process (Chap. 9) but most methods do not. Therefore, the process of acquiring a method should also include selecting one or more ways of working, both in terms of the overall process of carrying out an EM project and in terms of ways of working within a project. For example, will participatory modeling sessions be used or not. The chosen ways of working will most certainly influence which competence will be needed. More regarding modeling competence can be found in Chap. 10.

EM languages can be commercially available or they can be research based. When acquiring a modeling language it is important to consider its long-term sustainability, in addition to the fitness for purpose as discussed in Sect. "Pilot Projects." Commercially available languages come at a price but on the other hand they may be more widely accepted and their long-term development is taken care of by the supplier. The ownership of the method is in such cases clear. Research-based languages may very well be suited for their intended purpose(s) but the organization needs to ensure that they have been tested properly and that the method documentation is freely available.

11.2.3.2 Adapting the Method

Sometimes adaptation to the method needs to be made, particularly if the chosen EM method is intended to integrate with other methods, e.g., systems development methods. However, it is advisable only to make the really necessary adaptations in the beginning. After a few pilot projects (see Sect. "Pilot Projects") an evaluation can be carried out and further adaptations can then be introduced, if necessary. However, too many local adaptations to a method will make the method more difficult to maintain over time. It will also cause problems and additional costs in terms of adaptation of computer-based tools.

11.2.3.3 Acquiring In-house Modeling Competence

Most probably the organization will not have competent EM experts among its employees. This means that they will have to be hired. The different levels of EM competence (see Chap. 10) should be considered here, i.e., ability to model, ability to facilitate modeling session, and ability to lead modeling projects.

It should be noted here, that in order for an organization to be able to handle modeling projects on their own, the last two abilities are critical. Unfortunately it may be difficult to hire people who already have these abilities, because they take a long time to acquire. Hiring people on the highest level of competence may even be impossible. In those cases the organization may start out with a few simple projects with less experienced modeling experts that are hired from outside.

An alternative to hiring modeling experts is to train employees who have shown an interest in EM and let them start working with some simple modeling projects, preferably under the supervision and mentorship of external experienced consultants. These projects should be evaluated from a competence perspective. Additional training activities can then be initiated based on the evaluation.

Since modeling expertise takes a long time to build it is essential to allocate resources for competence assessment and development during a number of years. Also, planning for continuous exchange of experiences and mentoring between modeling experts will decrease the vulnerability of competence since it can help easing the dependence on individual modeling experts and allow individuals to develop from one competence level to the next.

11.2.3.4 Pilot Projects

When an organization starts to carry out its own modeling projects, some pilot projects should be initiated that are designed to test the modeling language, the modeling process, the modeling tools, as well as the modeling competence. Evaluation criteria should be carefully defined. The series of pilot projects should be selected to reflect the different purposes for which the organization intends to use EM.

Most probably the organization will need to hire consultants to supervise the pilot projects and also to set up and carry out the evaluation.

11.2.3.5 Evaluation and Adjustment of the Method

In order to ensure that the chosen method will be useful over time, the organization also needs to document it and to organize its maintenance.

The maintenance of the method entails not only updating the documentation when the method evolves over time (and it probably will) but also setting up an evaluation process targeting modeling projects that are carried out in the organization. Criteria for selecting the modeling language and modeling process should be used in the evaluation, together with evaluation of the outcome of modeling projects.

Based on the result of the evaluation, different adjustments to the method may be needed. However, care should be taken so that these are not made hastily and frequently because it will cause unnecessary uncertainty and instability in the organization. It is advisable that any adjustments are based on at least 2–3 projects and that they are documented properly and also communicated to the organization. The communication aspect is particularly important, since people tend to stick to old habits.

The evaluation can also show that the competence of method experts needs to be enhanced. Different training activities and exchange of experiences between method experts should then be initiated.

11.3 A Short Note on Training of Modeling Experts

It is clear that participatory EM is a complex process that requires knowledge and skills. This is something that takes time and a lot of extensive practice to acquire. The following quote from an interview with an experienced modeling expert illustrates the problem:

> "*We interviewed 73 or 74 potential facilitators. Out of these we chose 15 who we thought were at least reasonably good. Towards the end we had seven left. This is the real situation. We lost some on the first level. They didn't really have the ability to model. Some we lost on the second step. They didn't have the ability to facilitate modelling sessions. Then we lost some because … well, all facilitators are exhibitionist prima donnas … but some had too many co-operation problems.*"

The question is then, how modeling experts can become skilled. It is self-evident that training to become a skilled participatory EM method expert involves acquiring knowledge that is provided in the literature or by taking courses. However, most of the training must be focused on practice, in order to become more and more skilled.

It can be difficult to organize "learning by doing," with feedback loops in a systematic and practical way, for a large group of people. A complicating factor here is that the person being trained needs to be subjected to a variety of situations, in order to be prepared for future assignments. Also, since the situation in real projects is often sensitive, there is no room for critical mistakes. This means that the number of skilled participatory method experts increases very slowly.

A practical way is to work together with more experienced facilitators. Novices should never facilitate alone, since the errors made during modeling will negatively influence the outcome of the process where modeling is used. With reference to the maturity levels of method experts, a common mistake that novices make is that they believe that just because they have learned to master a modeling language, they will be able to carry out a participatory modeling process.

11.4 Organizational Structure Supporting EM: The Modeling Department

In the previous sections of this chapter, we have discussed the activities that lead to adopting an EM approach in an organization. The result of these activities should be a pool of competent employees that can be used in EM projects, which in many cases may require creating a supporting organizational unit dedicated to modeling—a modeling department. The following roles should be considered for inclusion in a modeling department:

- Facilitator—as discussed in Chap. 10, the modeling facilitator leads and advises the modeling participants during modeling sessions.
- Method expert—organizations that have been more successful in using EM all had one or several persons who were very knowledgeable about the modeling method (or several methods) used in their organization. They were also very enthusiastic about the modeling way of working. Their enthusiasm also motivated their colleagues' support and engagement in modeling. We call them "method experts" while actually "method champions" would be more correct. Often these people have been the first in their organizations who tried to "sell-in" the modeling way of working to their organization. Another responsibility of method experts is to be responsible for the development and maintenance of the modeling method used and if necessary integration with other methods and approaches used.
- Tool expert—in order to use an EM method efficiently, a modeling tool is needed and, hence, the organization should also have in-house competence concerning the modeling tool(s) used. For example, the different integration possibilities with other tools and configurable information systems, presentation possibilities on the web, collaboration support, tool versions and upgrades, etc. are in the competence area of the tool expert. Depending on the actual methods and tools used and background of the people involved, the method and tool expertise can be combined and fulfilled by the same person(s).
- Model maintenance and presentation expert—modeling maintainers are required if the company wants to keep their business models up to date. In larger organizations where many different EM activities take place at the same time, modeling facilitators may not have the time to fine-tune the models, for instance, to the levels of presentation quality required for publishing the models on the intranet. Hence, the modeling department may include staff experienced in documenting models for various purposes—e.g., for presentation, for inclusion in reports, requirements specifications, etc.

Building of a modeling department depends on the organization's intentions regarding the long-term use of Enterprise Modeling. If the organization wants to model without external consultants or keep models "alive," then it has to develop its own in-house EM competency. Such a task cannot be accomplished "over night"—time is needed for the personnel to learn the EM method, to develop modeling skills, to develop in-house modeling guidelines and procedures, as well as to accumulate experience. An organization planning to do this should also be aware that developing and sustaining a modeling department requires considerable resources.

Chapter 12
Quality of Enterprise Models

EM usually leads to organizational change and/or development. In some cases this change can be implemented without initiating bigger change projects or the introduction of IT support. In these cases the different models developed might be used only for documentation purposes. In the majority of the EM projects, the models created will be continuously refined, improved, and transformed and, hence, they need to be of high quality.

This chapter discusses the notion of model quality and introduces selected techniques for model refinement.

12.1 Fitness for Purpose: A Basic Quality Criterion

The quality of enterprise models produced in different projects differs depending on the project objectives and the purpose of models. According to Persson (1997a, b) the main criteria for successful application of EM are that:

1. The quality of the produced models is high,
2. The result is useful and actually used after the modeling activity is completed
3. The involved stakeholders are satisfied with the process and the result.

Larsson and Segerberg (2004) have investigated whether the quality criteria for data models defined by Moody and Shanks (2003) are applicable to enterprise models and proposed several modifications to the original criteria. The resulting quality criteria for EM are:

- *Completeness*—the degree to which all relevant facts of the problem domain are included in the enterprise model.
- *Correctness*—refers to how well the enterprise model conforms to the rules of the modeling technique.

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_12

- *Flexibility*—is defined as the ease with which the enterprise model can cope with changes in the modeling domain.
- *Integration*—refers to the degree of consistency between the different sub-models that constitute the enterprise model.
- *Simplicity*—refers to the degree of minimal use of modeling constructs for presenting knowledge in the enterprise model.
- *Understandability*—is defined as the ease with which the concepts and structures in the enterprise model can be understood by the stakeholders.
- *Usability*—is defined as the ease with which the enterprise model can be used for its intended purpose.

What quality criteria are relevant and how strictly they are to be followed depends on the purpose of modeling or goals of modeling according to (Krogstie et al. 2006; Krogstie 2012). The remainder of this section discusses a number of generic purposes of modeling with respect to what quality criteria they require.

If the purpose is to develop vision and strategies, the main quality requirements are understandability, correctness, simplicity, and flexibility, which are the key factors supporting efficient communication among stakeholders.

If the purpose is to design/redesign the business and or information system, the enterprise model presents an organizational and IS design and hence models should comply with quality requirements in terms of completeness, correctness, flexibility, integration, and usability. Referring to the choice of the modeling language in this case, the understandability for a broad range of stakeholders might be reduced by the need to use a language that allows reaching a higher degree of completeness, correctness, and integration.

If the purpose is to create, maintain, and share knowledge about the business, the main quality requirements are correctness, integration, understandability, and usability. Special emphasis should be put on ensuring that the models are understandable for the target audience without extensive training in a particular modeling approach and language.

In some projects EM is used only as a problem-solving tool and the models are only used as documentation of the discussion. In such cases the main quality requirements are correctness, flexibility, and understandability.

12.2 Basic Principles of Modeling

There are a number of basic principles of modeling addressing syntactic, semantic, as well as pragmatic demands on the proper creation of process models proposed in (Becker et al. 1995). They are also applicable to enterprise models. There principles are:

- *The principle of accuracy*—the model complies with the corresponding excerpt of the real world.

- *The principle of relevance*—modeling constructs should be included in the model with a purpose, not all reality should be represented in the model. Which information is relevant for a model depends on the intended use of the model.
- *The principle of economical efficiency*—the costs of modeling should not exceed the intended benefit, i.e. Enterprise Modeling should not be used for addressing trivial problems that can be resolved otherwise.
- *The principle of clarity*—models should be presented legibly and clearly, without more constructs than necessary
- *The principle of comparison*—models created with different modeling techniques should be comparable at least to some extent.
- *The principle of Systematic Structure*—if several models are created they should be connected in some structure in order to show how they contribute to the overall purpose of modeling.

12.3 Improving Enterprise Model Quality

This section presents several practical tips how to improve model quality. Much of this is related to using the modeling method and the language as intended; hence many more suggestions for each 4EM sub-model can be found in Chap. 8. The main focus of this section is on recommendations applicable to the enterprise model as whole.

12.3.1 Unambiguity

Ambiguous models are difficult to understand and to use. Hence we should strive towards unambiguity. Ambiguity is mostly induced by formulations of the modeling components. In Chap. 8 we have given several suggestions, e.g., starting goal formulation with "The goal is. . .". Another aspect of ambiguity is lack of concrete detail and decisions that can be taken up and implemented. E.g. it sometimes happens in modeling seminars that the stakeholders discuss the problem and the solutions on a too high level of abstraction and omit specific details. As a result, the model is too vague or too "kind" and deals with the problem at hand on a superficial level without proposing concrete description of what needs to be done. In this case one solution is to identify concrete actions that need to be carried out and who will be responsible for them. They can be modeled as business processes and individuals, respectively. Such questions normally make the discussion more realistic and lead to concrete decisions concerning who is doing what, why, and how. Without this, the risk is that the modeling seminar ends up with a model resembling something coming from a textbook—correct but lacking company specific details and hence not useful for further development activities.

12.3.2 Model Flexibility and Stability

An enterprise model should be built in such a way that minor changes in the domain area do not force major changes in the model. In other words, it should be possible to add or remove some elements from the model without major changes or restructuring the rest of the model. In many cases the way the model will evolve is hard to predict and the modeling participants should not worry about this—after all modeling on the plastic wall allows for changes, reasonably easily. Flexibility becomes a more significant concern in later stages of modeling and when the modelers are starting to think about the subsequent development stages. Even at these stages, changes still occur but making them is more cumbersome. For example, the goal structure in Fig. 12.1—goal 3 is supported by three other goals addressing the manufacturing process. We can also consider that there are other ways of cutting costs, e.g., by reducing the number or business travels. This leads us to conclude that these three goals are about a certain solution area for goal 3—the manufacturing process in which case we can define a new subgoal 4 (Fig. 12.2). There could be more ways to optimize the manufacturing process than the three subgoals 4.1, 4.2, and 4.3, consequently we can assume that the GM fragment in Fig. 12.2 is more stable than in Fig. 12.1.

12.3.3 Homogeneity

A modeling component is said to have a high degree of homogeneity if the real life occurrences it represents are very similar to one another and display the same kinds of properties and relationships. In principle homogeneity can be seen as similar to cohesion—the degree to which an element contributes to a single purpose, commonly used in Object Oriented (OO) design. That is in OO design we should strive towards high cohesion because classes with low cohesion have many unrelated responsibilities and are difficult to understand, maintain, reuse. They also need to be changed very often. More on the principle of high cohesion is available in (Larman 2004). Cohesion as a principle can also be applied in EM, especially for assessing concepts models, but we believe that homogeneity is a more suitable principle because of the different perspectives that enterprise models represent. Homogeneity normally is not a target on its own—instead it contributes to factors such as flexibility, simplicity, understandability, and, in turn, usability.

For example, Fig. 12.3 shows a goal formulation that potentially contains several goal statements. Modeling components that are formulated in this way often are elicited in modeling sessions because stakeholders are not aware of this principle and may write fairly long statements. It is the responsibility of the modeling facilitator to notice such issues and refine the modeling component. In this case the initial formulation is decomposed into two subgoals (Fig. 12.4).

In concepts modeling homogeneity is usually improved by introducing generalization/specialization hierarchy. Consider concept 6 “Product” in Fig. 12.5 has two

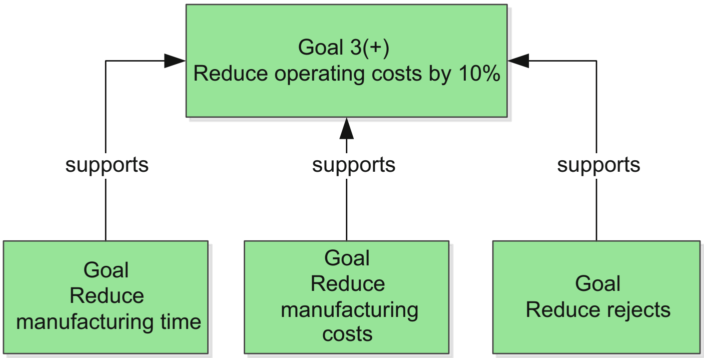


Fig. 12.1 Unstable goal model

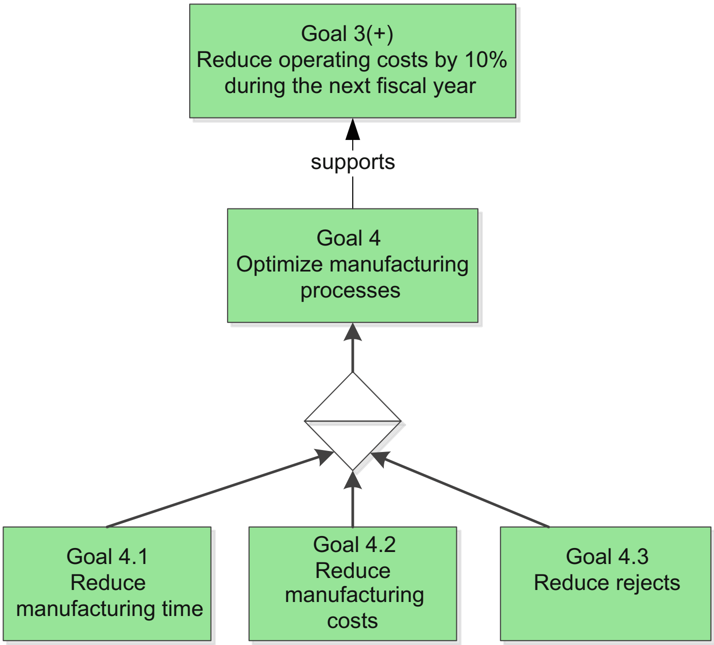


Fig. 12.2 More stable GM fragment, achieved by introduction of Goal 4 refined by AND/OR decomposition structure of subgoals

sub-concepts "product with engraving" and "standard product." Without this specialization concept "product" would have to represent both kinds of products—with engraving and standard. This would mean that a number of other modeling components such as rule 6 and process 13 would have to be connected to it, but they would only apply to some products. In this case the "product" would be nonhomogeneous. The specialization shown in Fig. 12.5 increases the overall homogeneity by having a clear purpose for each concept:

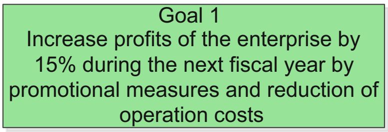


Fig. 12.3 Nonhomogeneous formulation of a goal

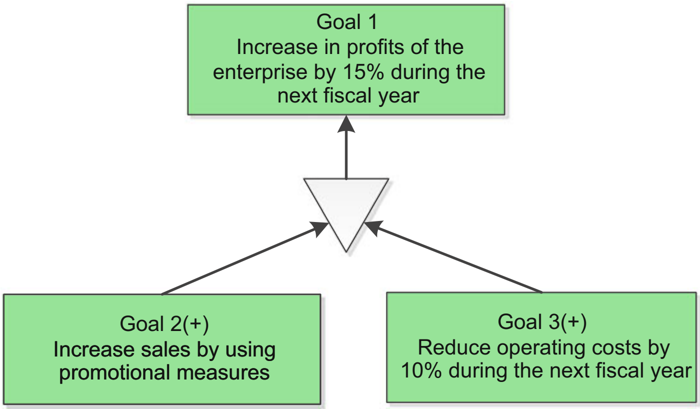


Fig. 12.4 Overall homogeneity of goals is improved

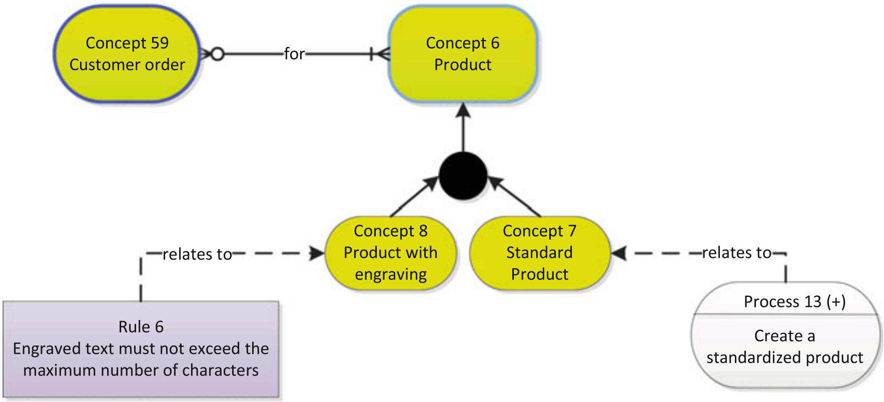


Fig. 12.5 A fragment of CM showing specialization of a concept and inter-model links

- Concept 6 "Product" is used for representing the common properties for all products, such as having purchased.
- Concept 7 "Standard product" represents all standard products.
- Concept 8 "Product with engraving" represents all custom made products with engraving.

12.3.4 Completeness and Scope

All relevant knowledge of the problem domain should be represented in the model. Models should not include aspects that are not relevant to the problem domain. While these are straightforward principles of modeling, there are several issues we would like to point out.

An enterprise model always has a scope that is determined in the preparatory stages of the modeling project. The scope serves as delimitation to what is important for modeling and what is not. There sometimes is a misconception that EM somehow leads to (or even requires) modeling the entire enterprise. In reality, this is seldom the case. Each EM activity usually has a fairly specific and sometimes quite narrow scope, which helps the modeling activity to achieve results of value to the stakeholders and to the company. Determining the scope may, however, be tricky because of the following issues:

- The customer or the problem owner might not know or recognize what the real problem might be (blurred scope).
- There could be disagreement among stakeholders about what the scope really is (multiple scopes) and the modeling activity first needs to establish a consolidated scope.
- The real scope might be covered, in which case the modeling team has to deal with hidden agendas.
- The scope may often change during modeling because the participants learn new knowledge about the problem and want to extend, narrow, or shift the scope.

In cases of blurred scope or multiple scopes, we recommend arranging a short modeling session focused on setting the scope for the EM project. This might also be useful when dealing with hidden agendas. For example, Fig. 12.6 shows a group of stakeholders modeling business problems of their company. This was part of the first modeling session of the project and the purpose of this session was to analyze the current problems (there were quite a few) and to set the scope for the project.

Completeness reflects to which degree all relevant facts of the problem domain are included in the model. In practice the challenge is twofold: (1) the problem domain (scope) might not be clear (this we have discussed above); (2) there might not be enough time and/or stakeholder interest to elaborate the model to the level of completeness required for the next development activity. That is, stakeholder time is valuable and hence it might be difficult or too costly to engage them in modeling relatively simple or well-known aspects of the solution. Even if these aspects are needed for implementation, e.g., modeling attributes in the CM or certain corporate procedures in the BPM, the stakeholders may perceive such a task to be too trivial participatory modeling. In such cases the participatory approach should be substituted by other modeling techniques (e.g. modeling based on interview results

Fig. 12.6 The modeler in discussion with the stakeholders of the company (enterprise model is visible in the background as initial version on plastics and as electronic version)

or consultants modeling these aspects in a consultant-driven mode) and presenting the resulting model to stakeholders in a walk-through modeling seminar.

In summary, the desired level of completeness depends on the project objectives and should be determined in the project initiation stages.

12.3.5 Integration

Enterprise models address the problem being modeled from different perspectives. This multi-perspective view on the problem domain is one of the key strengths of EM. Hence, integration is a factor that significantly contributes to understandability and usability of the model. Each sub-model should be connected internally and with other sub-models. Some guidance for integration can be derived from the meta-model of 4EM, for instance:

- There must exist at least one goal in the GM, one process, one external process, one information/material set in BPM, one concept in CM, and one actor in ARM. This is based on the basic principle that an organizational design should be functional and without at least rudimental designs in each of these areas this would not be the case.

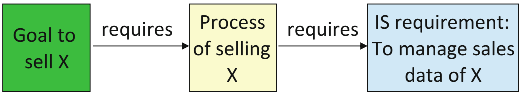


Fig. 12.7 A simple line of reasoning from goals to processes and to requirements

- Every Information or Material Set in the BPM must be related to a concept in the CM. The motivation for this rule is that information and material are part of the conceptual structure of the company.
- Every process must be motivated by at least one goal from GM in some decomposition level. The rationale for this rule is that processes should deliver business value defined by goals, and that there should not be processes that the company does not need.
- Every process must be related to at least one ARM role, which is responsible for or performs that process.
- Every information system goal and requirement must be related to at least one goal or business process. These relationships aim to establish the alignment between the business design and the information system.

Models should complement each other, i.e., what we discuss in one sub-model should also be addressed in other models. For example if the Goal Model heavily deals with concepts such as sales, different types of products, and customers then these would have to be defined in the Concepts Model, and there would have to be business processes managing these concepts, etc. The inter-model links should establish a clear line of reasoning. In simple cases it might be rather obvious, see Fig. 12.7, showing one-to-one correspondence between a goal and a process and a requirement. Such cases are rather easy to discuss and it is also easy to develop corresponding inter-model links here.

This is however not always as explicit as discussed above. In other cases there might be business goals that address crosscutting concerns relevant to a specific solution and hence they may motivate several processes or a certain way a process is designed. For example, Fig. 12.8 shows a goal "to facilitate knowledge sharing during project delivery." Such a goal cannot realistically be implemented by a process named "facilitate knowledge sharing." Instead, the process of project delivery needs to be designed in such a way that it facilitates knowledge sharing. Sub-processes that incorporate knowledge sharing activities should then be linked to the goal in order to show the support.

12.3.6 Simplicity and Complexity

Simple models are more understandable. They are also easier to improve, maintain, and reuse. The guiding principle recommends using as few modeling constructs as

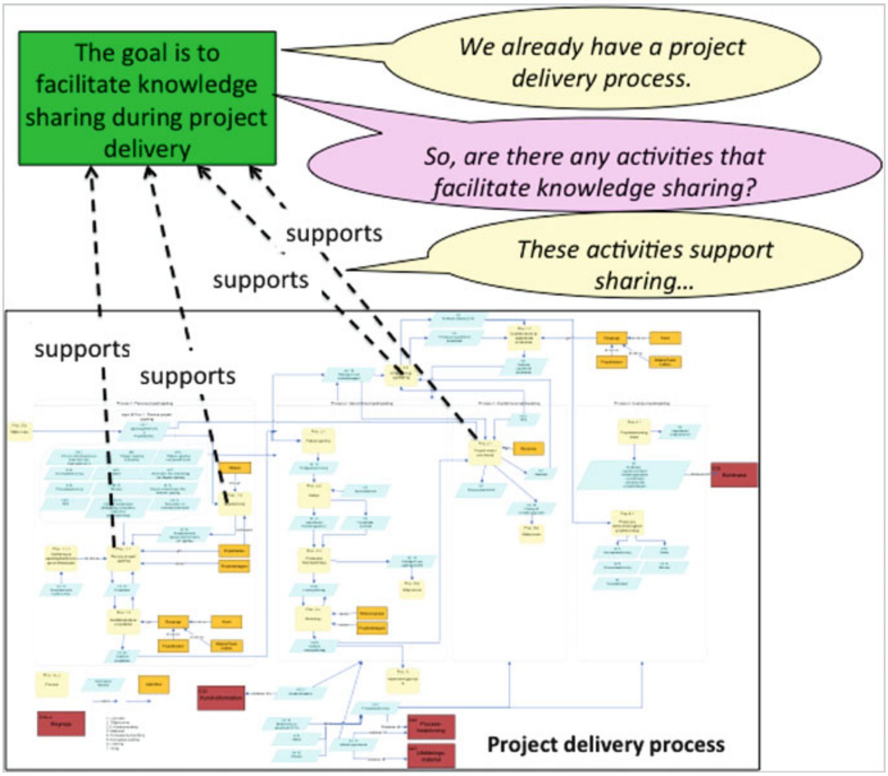


Fig. 12.8 Goal supported by several activities in the BPM

possible. While this principle seems to be almost universally applicable, in practice many models are complex or at least appear to be complex. They contain a large number of components, relationships, and decomposition schemas. This is probably so because modeling, and especially Enterprise Modeling, is called upon in situations when the problem and their solutions are not trivial. The invariance of modeling is that complex problem domains probably lead to complex models at least on some refinement level, as the following situations shows.

Example case: We were modeling business processes for certifying public transport operators at a municipality. The stakeholders had no prior experience with business process modeling. After two modeling workshops they started to raise concerns about the way of working—the model representation of the procedures at this department seemed very complex to the stakeholders. And, indeed, they were—the model was six A4 pages long and two pages wide, containing several iterations and many information sets. "Why are you (method providers) doing this in such a complex way?"—one of the stakeholders asked. She was somewhat surprised when we replied—"but this is the way your department actually works". We then explained the model step by step. Only after this the stakeholders realized the actual complexity at their workplace and started to look for alternatives of making this *business process simpler and more efficient. The resulting model contained considerably fewer activities and information sets and the stakeholders found that two actors did not need to be involved in the process at all.*

What we can learn from this case is that complexity as such is not harmful and can lead to improvements of the overall design. But unnecessary complexity needs to be dealt with because it hampers understandability.

Complexity is in practice influenced by a number of factors—visually perceivable and project related. Project related factors are the following:

- The complexity of the problem domain. Some domains have more stringent requirements for formality and level of detail for solutions to be specified, which requires a more complex model. See example quote below.
- The novelty and difficulty of the project objectives. There seems to be some evidence suggesting that without experience from a particular application domain, people tend to develop more complex models. This might also be related to the fact that they are unaware of what is truly important and at what level of detail the models should be developed.
- The purpose of the models. The models that are intended for information system development or configuring an ERP system will need to be more rich in detail (and, hence, more complex) than models that are used for sharing knowledge about the way of working within the company or for capturing a brainstorming session.

"The complexity of the project is ***difficult to foresee in advance****. If you have done similar projects in the past in the same department, then you already know what to expect. You know how they work and what are their main problems. But if you have a completely new problem in a place you have never been, then it is very difficult to estimate the complexity beforehand. Even if the objective and your task look simple in the beginning, you never know what might surface once you start working. . . .the* ***complexity can increase very rapidly****.*

Then, of course, we have projects of modelling [a certain telecommunications equipment] and procedures associated with them. Those are very complex because the equipment is very complex and it needs to be modelled in great detail." (Interviewee 8, p.306, in Stirna 2001*)*

Among factors influencing complexity visually, is the number of modeling components, relations, sub-models, schemas and model fragments, as well as structure and symmetry of the model. According to our experience it is the latter—model structure and visual appeal that often influence the perceived complexity and, consequently, understandability of a model. For example, Fig. 12.9 (below) shows three models with various degrees of structure. Model A visually appears the most complex because it lacks an overall structure. Model B has an overall structure of sequence and model C has an overall tree structure which probably makes these seem less complex than A.

An additional factor influencing perceived complexity and consequently reducing understandability is disregarding common layout principles. For example

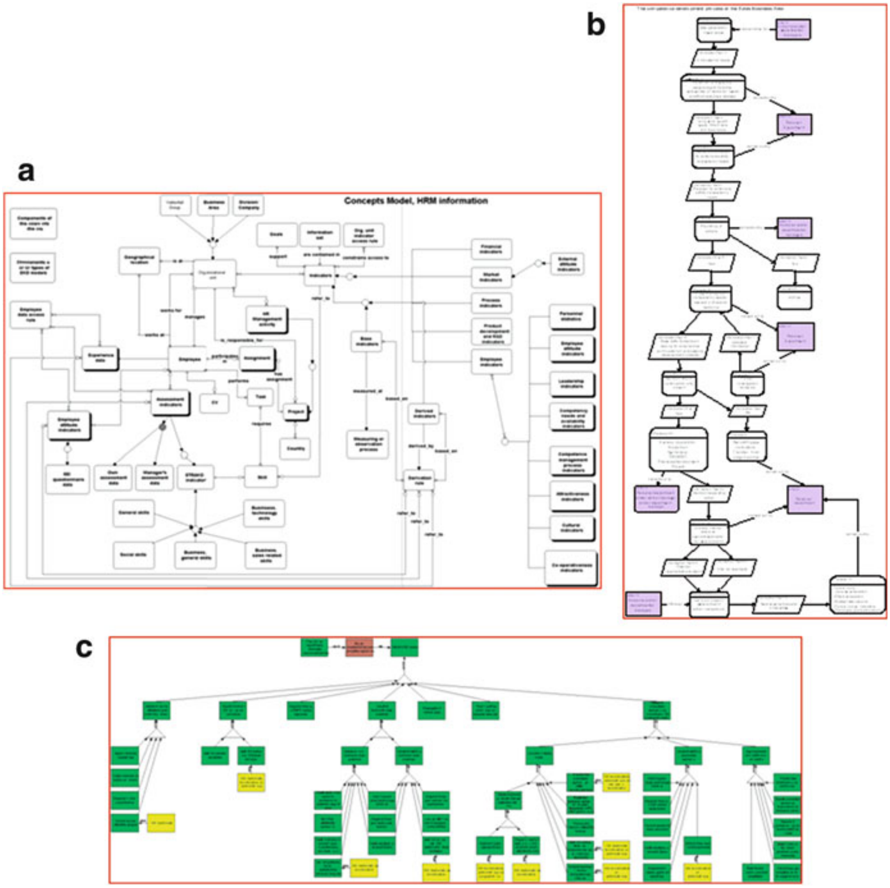


Fig. 12.9 Various degrees of structure

process models are normally built from top to bottom or from left to right; in concepts models the more significant concepts are placed in the middle of the diagram. In goal models more strategic goals are usually placed on the top and operational goals below. The "supports" relationships usually point upwards or horizontally. Figures 12.10 and 12.11 show the same model fragment in two layouts—one does not follow this principle; the other does.

If these common principles are abandoned, the models are difficult to read and analyze. In projects involving inexperienced modeling participants, these principles might also need to be explained, e.g., that placing more strategic goals on the top of the model has certain semantic meaning even if the relationships are not yet defined.

Experience of the modelers and the modeling facilitator are perceived to have some influence on complexity according to findings reported in Moody and Shanks (2003). This might be related to the lack of skill in fact gathering or facilitation.

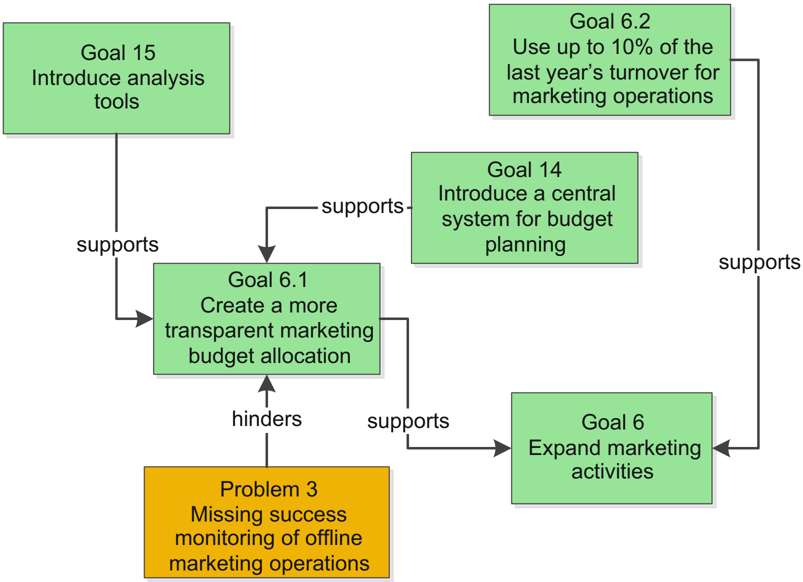


Fig. 12.10 A GM fragment that does not follow common layout principles

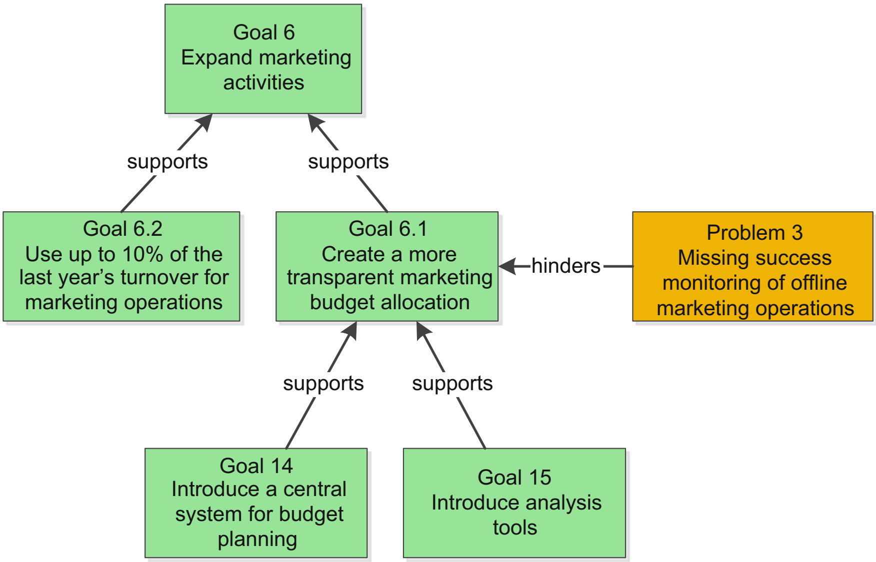


Fig. 12.11 A GM fragment following the principle of placing more strategic goals above operational goals

As a result, the models are less complete. There can also be a lack of skill in making models graphically appealing. Our experience shows that it is mostly the skill of the modeling facilitator that allows avoiding unnecessary complexity or impractical simplicity.

Chapter 13
Reuse of Enterprise Models

Enterprise Modeling projects create a great deal of models. They have various purposes, which have been previously discussed. Some are created only to capture a particular idea or document the discussion of the stakeholders. But the majority of models are created in a design situation and once completed they reflect good solutions and best practices for dealing with a specific business problem or corporate intention. As a result they have a value that extends beyond the boundaries of the project that created them. This value needs to be captured, i.e. packaged in a form that facilitates sharing, and then used when appropriate. Individual projects considering only their own goals may not have the need to reuse models or to design reusable models, but the company as a whole has to work efficiently and capitalize on past success by reusing models.

For example, Fig. 13.1 shows a Concepts Model of a human resource management system of a large utility. This model contains several best practices and solutions that can be applied in other contexts and organizations for similar purposes. There are more, but in order to exemplify, we have shown two parts of the model addressing the following questions:

– What are the indicators for assessing an organizational unit?
– What are the indicators for assessing an employee?

This model was created in a change management project and later implemented in the company. What makes it interesting for the purposes of this chapter is that it contains best practices, represented by model fragments, which can also be applied elsewhere. In this case we have highlighted the indicators for measuring organizational units and employees that can be reused in other contexts and organizations. However, this cannot be done by simply taking this model and applying it elsewhere, because only parts of it would be applicable, i.e., the knowledge in this model needs to be captured and stored. During the task of capturing and storing the knowledge, we deal with the following challenges:

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_13

- *How to remove specific material, which is either out of date, too specific to the project that created it or confidential?*

  Models first serve their primary purpose; the purpose to reuse often comes afterwards, for instance when the model proves to be useful. As a result, some work is required to make the model reusable by making it independent from other parts of the enterprise model, and by generalizing it to a *reasonable* level of abstraction.
- *How to ensure that the stakeholders in the new setting consider applying the reused model?*

  This is not so much about the NIH syndrome (Not Invented Here), as about the need for them to learn another model, the context in which it was created, and often also somebody else's way of thinking. Reuse may also appear somewhat contradictory to the overall approach of the participatory way of working that ensures stakeholder creativity and commitment. Hence, there is a need to incorporate the reuse-based way of working in the modeling and design/development process of the organization.

In summary, to address these challenges the company needs an approach to knowledge reuse focusing on two core issues:

How to deal with reusable models, i.e., *how to capture them, package them, and store them in a repository?*

How to incorporate model reuse in the modeling and design/development process?

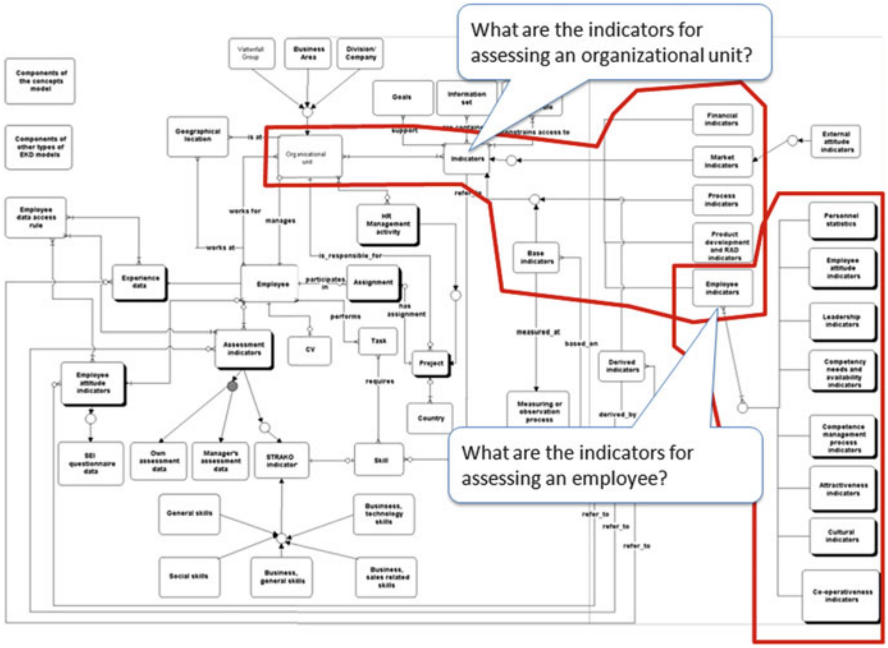


Fig. 13.1 A concepts model showing potentially reusable parts

There are several useful and not mutually exclusive principles to knowledge reuse, such as:

- *Best practices*—a concept used in knowledge management in order to capture and share good solutions and lessons learned which are of value to the organization (c.f., for instance, O'Dell et al. 1998).
- *Frameworks*—a concept used in software development for providing building blocks for implementing generic functionality of a software system. A framework usually contains working code that needs to be changed and/or extended in order to fit specific application requirements. Examples of software frameworks are code libraries, tool sets, and application programming interfaces. The framework principle is also used in organizational setting as *Enterprise Architecture Frameworks*. These frameworks usually offer generic guidance for creating and managing enterprise architecture as well as for the form in which an enterprise architecture should be described. Examples of EA frameworks are the Zachman Framework (Zachman 1987) and TOGAF (The Open Group 2011).
- *Reference models*—are a system of models used to define concepts in a certain domain. The aim of reference models typically is to unify and integrate the body of knowledge in a certain area. Reference models are not directly seen as standards but they often have a significant role in developing them. Reference models are frequently used for managing an established set of best practices and commonly available solutions. A notable example of using reference models for business process management is provided in (Scheer and Nüttgens 2000).
- *Patterns*—a concept for capturing and presenting proven reusable solutions to recurring problems initially used in architecture and later adopted to information systems analysis, design, programming, as well as organizational design.

The common principles of these approaches are (1) modularization of a knowledge chunk (reusable knowledge artifact of value) and (2) providing structure for managing and using the knowledge artifacts. In this chapter we take a closer look at patterns, because this principle has proven to be useful in various EM related contexts before (see, for instance, Rolland et al. 2000; Persson et al. 2008).

13.1 The Pattern Concept

In the process of capturing, packaging, storing, and sharing knowledge, we are frequently faced with questions such as: how should this piece of best practice or experience be represented, is it of any value, what can it be used for, when can it be used and by whom. These questions address the two main aspects of a knowledge artifact—what is the problem it addresses and what is the solution it provides. Alexander (1977) defined such problem–solution pairs as patterns—*"a problem which occurs over and over again in our environment and then describes the core of* *the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice.*" Following this definition, pattern-based approaches have established themselves in software programming, software design, data modeling, and in systems analysis (see, e.g., Coplien and Schmidt 1995; Gamma et al. 1995; Fowler 1997) with the common objective to capture, store, and communicate reusable artifacts, such as fragments of code or diagrams. For example, in object-oriented systems we are sometimes faced with the need to restrict the instantiation of a class to only one object. The solution to this design problem is known as a Singleton pattern being part of the so-called Gang of Four (GoF) Patterns, documented in (Gamma et al. 1995). There are numerous pattern collections available in books, incorporated in corporate reuse libraries, and on the Internet. A reasonable starting point for investigating the world of patterns for information system development is The Patterns Home Page (http://hillside.net/patterns) maintained by The Hillside Group.

The pattern concept has been further extended and applied in organizational development and knowledge management under the term organizational patterns (Rolland et al. 2000; Prekas et al. 1999). By organizational patterns we mean "generic and abstract organizational design proposals that can be easily adapted and reused in different organizational situations." According to this principle patterns have been successfully applied in a number of projects for knowledge sharing purposes.

13.2 The Pattern Template

There is no general agreement among pattern developers about what patterns should look like and how pattern templates should be structured. In practice we can see simple templates with a few fields, fairly elaborated templates consisting of many fields as well as no templates at all in which case patterns are represented in free flowing text. Many patterns, especially in the information systems (IS) development domain, extend textual descriptions with graphical models, e.g., UML Class Diagrams, Event Driven Process Chains, and workflow models connected to executable IS components. For knowledge management purposes patterns may also include multimedia content, which in some cases is helpful to capture more tacit knowledge than plain text is capable of doing.

The EKP approach (Bubenko et al. 2001) used in the ELEKTRA project and in the Riga City Council initially suggested a very extensive template with a large number of fields aiming to cover many aspects of the knowledge artifact (see Table 13.1). This template comprises almost all possible fields imaginable for describing patterns. It was found too complex, but it is included here to depict the full range of potential aspects to include in a pattern. In later application cases the template was tailored according to the wishes of the user organizations and most commonly only the following fields were used—name, problem, context, and solution.

Table 13.1 The pattern template proposed by the EKP approach

Name of field	Description
Name	Each pattern should have a name that reflects the problem/solution that it addresses. Names of patterns are also used for indexing purposes
Problem	Describes the issues that the pattern wishes to address within the given context and forces
Context	Describes the preconditions under which the problem and the proposed solution seem to occur
Forces	Describe the relevant forces and constraints and how they interact or conflict with one another and with goals we wish to achieve by implementing the solution
Solution	Describes how to solve the problem and to achieve the desired result. Solution describes the work needed. It can be expressed in natural language, EKD models, drawings, multimedia sequences, etc. Solution can be backed up with references to other knowledge sources and other patterns
Rationale	Explains why the solution presented in pattern is appropriate in relation to the forces, context, and problem
Consequences	Describes what the context should be after applying the presented solution, in terms of positive and/or negative effects
Related information	Relationships to other organizational patterns, related documents, Web resources, or information systems. These knowledge resources can be located either within the organization or outside
Known applications	Describe where the pattern has been applied
Authors	Creators of pattern and their contact information
Also known as	Presents aliases of pattern
Examples	References to specific application cases of the solution presented in the pattern. This field can include references to specific models, organizational designs, as well as success stories and lessons learned
Usage guidelines	Presents a set of usage tips to the potential user of the pattern about how the pattern can be tailored to fit into particular situations or to meet specific needs of an organization. Guidelines aim to give an idea of how the pattern can be tailored to create a specific business solution
Type	Describes the type of the pattern (e.g., goal, business process, concept, etc.). This field is used for structuring the knowledge repository and for searching purposes
Domain	Describes the business or activity domain for which the pattern is applicable to. Examples of domains are customer servicing, performance indicators, restructuring, organizational policies, etc.
Keywords	A few keywords are defined for each pattern in order to facilitate search and retrieval

13.3 The Structure of Patterns and the Concept of Pattern Language

Individual patterns usually address relatively atomic problems, i.e., on a granularity level where it is not rational to further decompose the problem into subproblems. To find a solution to a larger problem, several patterns need to be reviewed, possibly tailored, and combined as well as extended with designs specific to the current application project. Hence, a good pattern collection should comprise a structure showing how the individual patterns contribute to a larger problem. The term used for such a structure is *pattern language*. Alexander (1977) explains: *"As in the case of natural languages, the pattern language is generative. It not only tells us the rules of arrangement, but shows us how to construct arrangements—as many as we want—which satisfy the rules."* Figure 13.2 displays a pattern language in the form

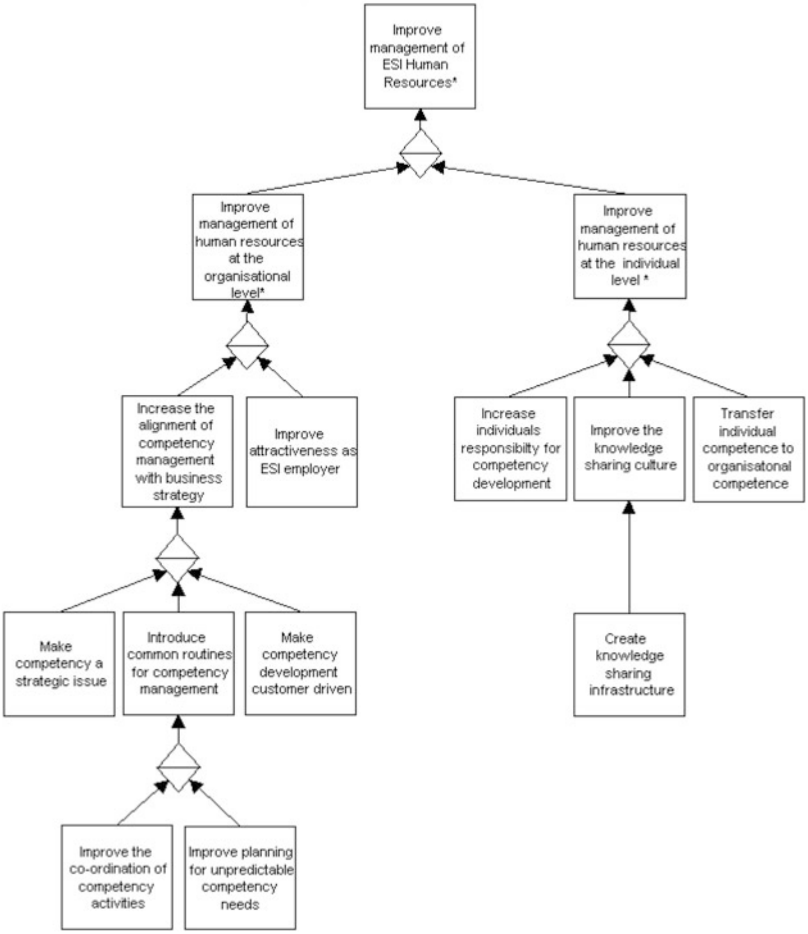


Fig. 13.2 An example of a pattern language for human resource management (Brash et al. 1999)

of goal hierarchy. It shows the different subgoals that need to be combined in order to achieve the top goal: "Improve management of ESI human resources." In fact, this can be seen as a description of design intentions (modeled as goals) for relevant reusable fragments in the Concepts Model presented earlier.

Patterns may have various types of relationships between them, for example, sub- or super-patterns depending on which way the refinement hierarchy is seen, hyperlinks indicating related concepts and patterns, as well as binary links with user-defined meanings. The choice of links used depends on the nature of connection between patterns and the intended use of the pattern language. Furthermore, modern pattern languages are usually represented by a web interface, which allows linking with other relevant information sources that are not captured in the pattern format such as: glossary, picture gallery, and contact directory.

13.4 Knowledge Reuse with Patterns

There are two dimensions of reuse—*design for reuse* and *design with reuse*; see Fig. 13.3. Both need to be addressed by the EM process and by the organizational structure supporting modeling. Without explicit organizational support knowledge will only be used sporadically and at best we can speak of so-called salvage reuse—

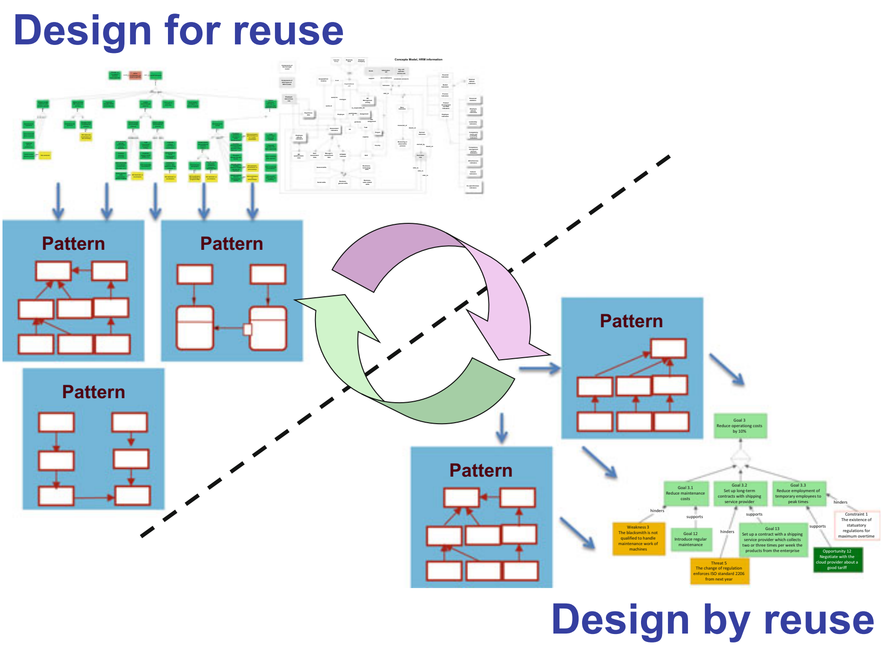


Fig. 13.3 The two dimensions of reuse

modeling experts sift through old models in order to see if some solutions in them can be useful for the current project.

By design *for* reuse we mean the systematic process of identifying valuable solutions in existing or newly created models and creating reusable components, i.e., patterns, from them.

By design *with* reuse we mean the process of creating new organizational designs, enterprise models, by identifying existing patterns, adapting the solutions, and integrating them with the new solutions created in the project.

In the remainder of this section we will discuss the pattern creating process and modeling with the use of patterns.

13.4.1 The Pattern Creation Process

Most often, patterns emerge from some existing EM project or positive experience that some experts consider worth generalizing and sharing with others. The pattern development process presented is based on the ELEKTRA pattern development process (Brash et al. 1999), which has been later refined in the project EKLär (Persson et al. 2008). The steps proposed here should be seen as general stages in the process of moving from a specific good solution to a pattern applicable in similar cases. These steps are:

1. Elicit candidate patterns
2. Evaluate the suitability of each candidate and the collection as a whole
3. Document and store each candidate pattern
4. Verify each pattern

13.4.1.1 Step 1: Elicit Candidates

The objective of this step is to have list of potentially useful patterns and to describe each candidate pattern in sufficient detail to allow proceeding with its evaluation.

The elicitation process can be divided into sub-steps. First, each candidate pattern must be elicited and its name must be defined. Then, the essential components of its template must be filled in, namely: the problem tackled by the pattern, the context in which the pattern is applicable, and the solution proposed by the pattern to solve the problem. No specific ordering needs to be followed when describing each component; their description is made in natural language and links to existing enterprise models can also be established.

Eliciting patterns from existing 4EM models

The initial source of knowledge is the repository of existing models. These can be models created in one or several EM projects. In principle any model that contains a valuable solution to a problem and is of adequate quality can be considered in this process. The following tips for analyzing models can be used:

- *Patterns as processes:* A sequence of processes describing how a business goal is successfully achieved as well as measured in terms of Information Sets.
- *Patterns as hierarchies of goals:* A Goal Model may be a pattern in that it reflects the business experience in successfully defining and understanding its (or a part of its) goal hierarchy.
- *Patterns as concepts:* A Concept Model showing how the business has successfully designed the concepts of the domain.
- *Patterns as relationships between actors and roles:* showing the dependencies between roles, their goals, and business processes they are associated with.
- *Patterns as enterprise models:* Enterprise models showing a subsystem of the business. It may contain any combination of 4EM sub-models.

Eliciting patterns through creation of new 4EM models

It is traditionally assumed that patterns should not contain large model fragments because this reduces their understandability and cohesion, which in turn inhibits reuse. Hence, new models may need to be created especially to represent the solution proposed by the pattern. This can be done:

- based on new insights and experiences gained, and from new evaluations of business practice,
- when existing models are too detailed or specific, or
- when models do not clearly relate to or solve specific problems.

Additional information sources may also be used for creating patterns such as existing patterns in the repository (including the obsolete ones), business documentation, and information system designs.

13.4.1.2 Step 2: Evaluate Suitability

The potential patterns obtained as a result of step one need to be evaluated by domain experts so that their further development can be decided upon. The following criteria should be considered:

Usefulness with respect to

- *Triviality*: The degree to which the pattern addresses a problem that is of little importance to the business because the problem or solution is obvious.
- *Implementability*: The extent to which the pattern is thought to be practical and implementable as well as compatible with business strategies; trade-offs should be taken into account.
- *Confidentiality:* If the pattern discloses confidential or sensitive business information and pattern creation and sharing would compromise any confidentiality commitments, then the pattern creation is probably not justifiable.

Quality with respect to

- *Complexity*: The complexity of a pattern can be estimated by considering the number of domain concepts and ideas it contains. In general, patterns should not be overly complex because this will most likely make the application cumbersome.
- *Generality*: This concerns the abstraction level of the problem and proposal solution. We have found out in the evolution processes of patterns, that experts do not appreciate guidance on an abstract level without concrete examples and specific guidelines how to apply the solution in their organization (see, e.g., Rolland et al. 2000). Hence, the level of generality should not be too high. But it should not be too low either, because in that case the applicability will be low.
- *Understandability*: This refers to the ease with which a pattern can be comprehended by the intended users.
- *External compatibility*: The extent to which the pattern can be used by other users (projects or companies). This is influenced by the extent to which the pattern takes into account factors such as national or organizational culture, relevant technologies, and market conditions.

Cost influenced by

- *Level of experience required for its use:* This is influenced by the need to involve external experts.
- *Economic feasibility of the proposed solution:* This refers to the expected cost of implementing the proposed solution.

We suggest that the aforementioned criteria are discussed in a workshop setting with pattern authors and other relevant domain experts. The decision to further elaborate the pattern is based on the consensus achieved in the workshop.

13.4.1.3 Step 3: Document Pattern

At this stage the pattern template needs to be completed and the pattern extended with information about related patterns, documents, contributing authors, and hyperlinks to other relevant information sources. A part of this process might be adjustment of the pattern template according to the purpose of patterns and intended target audience.

The pattern also needs to be stored in the pattern repository and related to other patterns in the pattern language. This might also require establishing links between patterns and some additional design artifacts such as code, Web services, or information system modules.

13.4.1.4 Step 4: Verify Pattern

After a pattern has been fully documented and stored in the repository it should be verified by a broader group of the domain experts to ensure that the applicability and usefulness really is to the level envisioned by the pattern authors. This process can produce valuable feedback for improving existing patterns as well as serve as stimuli for creating new patterns.

13.4.2 Use of Patterns in EM

EM is a creative process and in this book we have advocated for the advantages of the participatory way of working. Creativity is contagious and fun for most people. But with respect to efficiency, creativity should not overshadow past successes. Good and proven solutions should therefore be used when appropriate. In Object-Oriented analysis and design, patterns become a common medium for transferring knowledge. In EM and business design in general this is not the case, at least not yet. There are companies that include patterns and knowledge reuse in the consulting services they offer. The challenge that we are facing is how to integrate reuse of patterns with the participatory way of working. Here we would like to propose the following dos and don'ts:

> Patterns should *not* be used if the purpose of the modeling session is to capture the existing situation in the company, e.g. to identify problems, change goals, or any other specifics of the organization. The goal in these cases is really to analyze the situation and not to arrive at a model as quickly as possible.
>
> Patterns should *not* be used if the purpose of the modeling workshop is to capture ideas and/or develop the vision for the company. The main focus in these cases should be arriving at something that the stakeholders consider valuable and worth pursuing. In such cases past experiences and best practices of other organizations can be discussed, but the main focus should be on developing the organization's own.
>
> Patterns should be used if the purpose of the modeling session is to develop a concrete solution to a specific business problem. In this case the modeling facilitator should plan before the session for relevant patterns to use, at what points of the session the need might arise, and how to present the patterns to the participants if they are not familiar with them. It might be quite difficult to foresee how the session will evolve, but experienced facilitators are able to do this. What we would like to caution against is to present the patterns to the stakeholders as a matter of fact, which is contrary to the philosophy of participatory modeling that every idea in the model is discussed and that the model is owned collectively.
>
> Patterns should also be used after the modeling session in the process of refining the model. In this case the refinements should be presented to the stakeholders together with the patterns used. This can further enhance the stakeholder understanding of the model.

13.5 Examples of Pattern Use

As discussed earlier, one of the challenges is to capture good and potentially reusable solutions in the existing models in order to support design for reuse. Considering the A4Y case presented in Chap. 8, there are quite a number of models. Some of the solutions are probably applicable in other cases as well. Consider the model fragment in Fig. 13.4; its main purpose is to elaborate on the measures for expanding marketing activities (goal 6) by defining a number of subgoals.

Goal 6.1 deals with creating a more transparent marketing budget allocation. In principle we can imagine that this is a problem that other companies also face and that the solution here might be potentially useful. Therefore we have created a new pattern (see Fig. 13.5).

Note that in the pattern we have introduced one more goal 1.3 aligning marketing activities with the business strategy. This goal was not in the goal model we used as source for the pattern because this is what we did in the A4Y business development project. However, when developing patterns we have to consider more general application cases that do not have the same development situation in the background. The example pattern in Table 13.2 is simple and presents only common knowledge. It is included here only for example purposes. Patterns this simple are seldom useful as reported in (Rolland et al. 2000; Persson et al. 2008).

Another dimension of pattern application is design by reuse—using existing patterns in order to make enterprise model more efficient and useful. For example, in the A4Y case we have modeled a simple purchase order for several products; see Fig. 13.5.

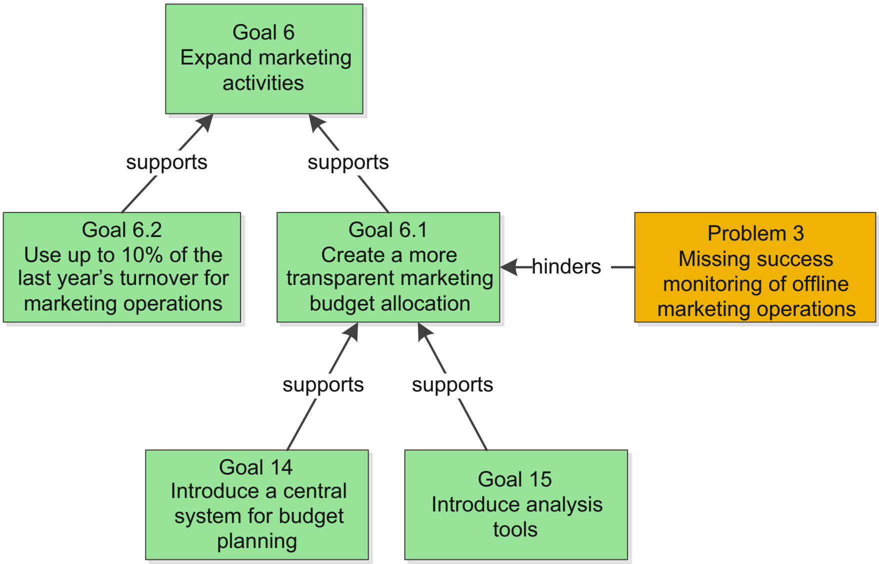
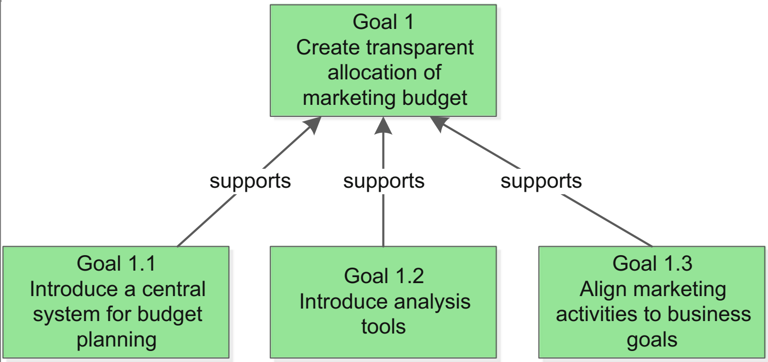


Fig. 13.4 A goal hierarchy addressing how to expand marketing activities

Fig. 13.5 Customer order modeled at a conceptual level

Table 13.2 A pattern based on the goal model of the A4Y case

Name	Transparent allocation of marketing budget
Problem	How to allocate marketing budget in an efficient and transparent way
Context	When company is in the process of change towards more efficient marketing and sales operations
Forces	Marketing success is difficult to monitor Different marketing actions may overlap
Solution	In order to create marketing budget in transparent way the following should be considered: – Introducing a central system for budget planning which would allow oversight of the planned costs for all marketing activities – Introducing analysis tools in order to see the results of the marketing activities such as, for instance, Google Analytics – Align marketing activities to companies business goals in order to be more efficient and cost effective 

From a conceptual point of view this model is satisfactory. But from the point of view of IS design and implementation, there is one problem—in reality it is possible to order more than one item of the same product, i.e., we need to specify quantity of the products ordered. We should consider that quantity is not attribute of a product because products are being sold on several orders with various quantities, and it is not attribute of a customer order because there can be several products ordered, each with different quantity. The solution to this is known as order line and is part of an analysis pattern for modeling an order (Fowler 1997); see Fig. 13.6.

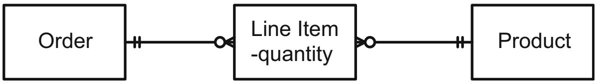


Fig. 13.6 The general principle of using order, order line, and product

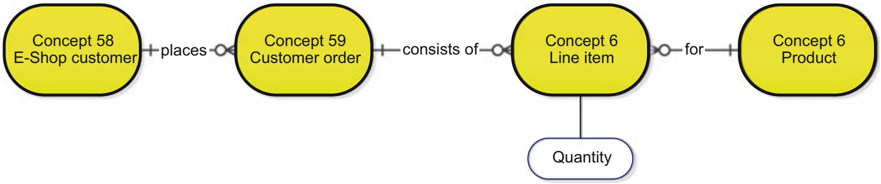


Fig. 13.7 Customer order with line item modeled explicitly

This pattern suggests introducing a new entity Line Item with attribute quantity. Applying this pattern to our model we would also have to introduce such a concept (see Fig. 13.7).

13.6 Advanced Case of Pattern Application at Kongsberg Automotive

Patterns have also been used beyond their initial purposes of managing reusable knowledge. Their characteristics of high modularity and cohesion have made them useful for configuring executable services, thus essentially making patterns *executable*. This section presents how Kongsberg Automotive AB, Sweden, used patterns from 2006 to 2008 within the EU-FP6 project MAPPER (Model-adapted Process and Product Engineering) for supporting collaborative engineering in networked manufacturing enterprises by capturing reusable organizational knowledge with Active Knowledge Models (AKM) (Lillehagen and Krogstie 2008). MAPPER developed c.a. 20, so-called task patterns, which included process, product, organization structure, and resources for specific recurring organizational tasks, c.f. (Sandkuhl and Stirna 2008) for more details. The significant aspect of the MAPPER project is that the patterns developed were linked to IS components in the METIS tool and the AKM platform, which made the organizational solutions achieved by applying executable patterns. The more or less instant transition from a pattern to a running system was one of the advantages of the MAPPER approach. Figure 13.8 shows a pattern for establishing a material specification on the left and a functioning workflow system the behavior of which is defined by the pattern.

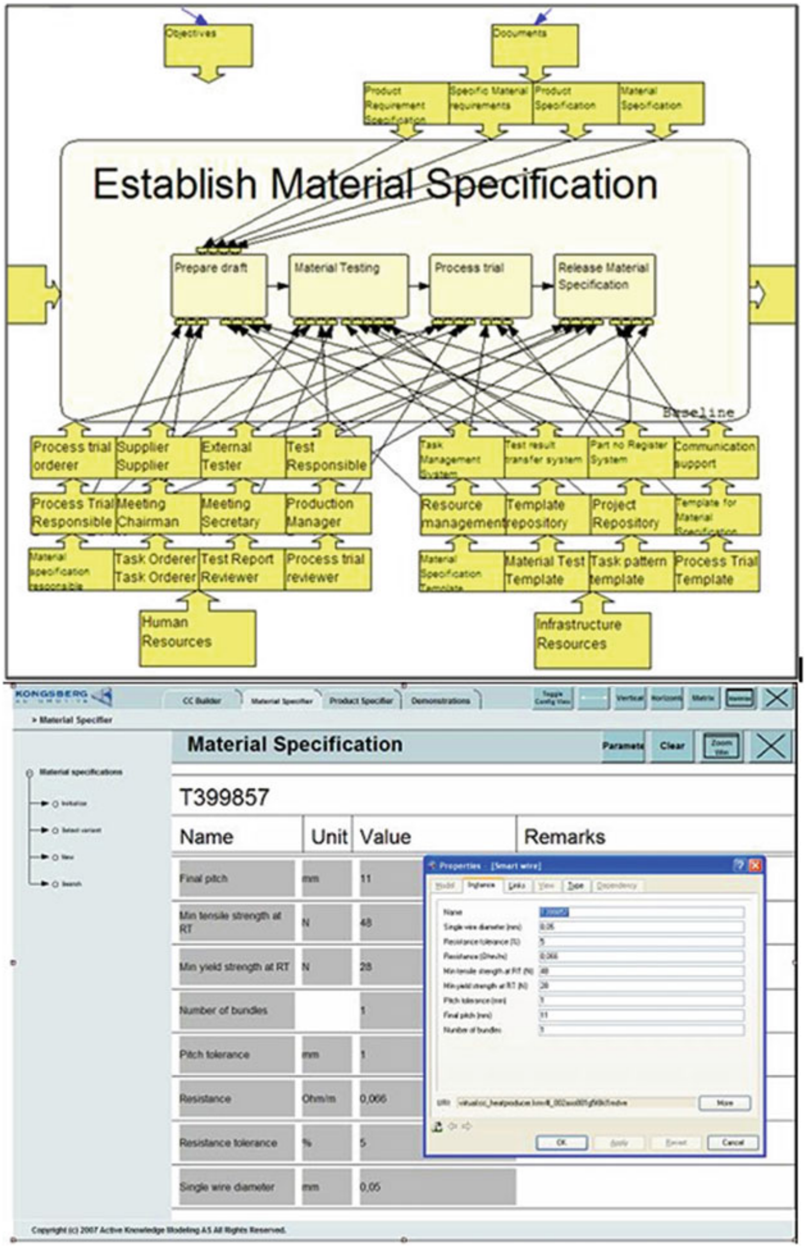


Fig. 13.8 A pattern in the Metis tool (*above*) and executed in the AKM platform (*below*)

After the MAPPER project the AKM approach was commercialized by the Norwegian company Commitment AS, but it is too early yet to see if the approach will be a commercial success.

Chapter 14
Selected Enterprise Modeling Approaches

Enterprise modeling approaches have been the subject of discussion and development in industry and academia during at least 30 years. Many approaches with different characteristics have been proposed and published; the 4EM method introduced in Chaps. 7–9 of this book is just one of them. This chapter briefly introduces some of these existing EM methods and compares them with 4EM. The purpose of this chapter is neither to provide an exhaustive list of approaches or methods nor is it to include all possible details and aspects in the comparison of 4EM with other methods. The intention is rather to show that 4EM in many aspects is a typical or exemplary modeling method, i.e., it is easy to switch from 4EM to another method, since many concepts and perspectives used in 4EM also are available in other methods.

This chapter will discuss selected EM methods. Each of the methods will be presented in a separate section covering the following aspects:

- Origin/History: what is the origin of the approach and the history of its development?
- Purpose: what is the main purpose the method was developed for and is used for in practice?
- Elements of the approach: which of the elements of a method are provided by the approach, i.e., does it include a predefined modeling process, a notation, and/or an explicitly defined meta-model?
- Model example: an illustrative example of a model developed with the approach under consideration is presented for most of the approaches.
- Perspectives: what views or modeling perspective does the approach offer and are these perspectives comparable to 4EM?
- Further readings: recommended literature and sources for additional information

The approaches selected for this section by intention represent different focus areas in Enterprise Modeling.

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_14

- Active knowledge modeling (Sect. 14.1) aims at supporting work in enterprises with executable solution models which can be updated while working in order to always reflect the current status of enterprise knowledge.
- ArchiMate (Sect. 14.2) is an established standard of the Open Group including a formal modeling language.
- ARIS is an acknowledged approach to process modeling consisting of general notation rules, different functions, and a set of views on single parts of an enterprise to model (Sect. 14.3).
- Design and Engineering Methodology for Organizations (DEMO) (Sect. 14.4) is an EM approach based on ontological foundations with an emphasis on capturing and modeling the operation of an organization in a way that is independent from implementation.
- Multi-perspective enterprise modeling (Sect. 14.5) originates from information systems development and promotes the codesign of information systems as complex IT-artifacts with the organizational system to be supported.
- Open model initiative (Sect. 14.6) aims at creating a community sharing models, modeling tools, and knowledge about modeling, which is similar to open source software communities.

14.1 Active Knowledge Modeling and C3S3P

14.1.1 Origin/History

Active knowledge modeling (AKM) and many concepts and ideas attributed to this approach are based on work in Scandinavia in the beginning of the 1990s. One of the most important contributors to the approach, Frank Lillehagen, used early versions of active knowledge modeling in 1990 in automotive and aerospace industries and founded the company Metis which developed tool support for AKM. From 2000, the development of AKM was supported by a number of European research projects, which also contributed to the growth of the AKM community. Tool support, modeling notations, and method support are still under continuous development and used for industrial and public sectors and application domains.

The concepts and methods support for AKM, supporting holistic design and continuous modeling and execution, is based on work in several EU projects from the area of networked and extended enterprises. An extended enterprise is a dynamic networked organization, which is continuously designed and executed as scope is expanded to reach a certain objective using the resources of the participating cooperating enterprises. In order to support solutions development for extended enterprises, the EXTERNAL project developed a methodology for extended enterprise modeling, which initially was named SGAMSIDOER. This methodology was further developed towards a solution delivery process denoted C3S3P, which was used in the ATHENA (http://www.athena-ip.org/) and MAPPER projects. The latest version of the methodology is published in the book "Active Knowledge Modeling of Enterprises" (see Further Readings Sect. 14.1.6).

14.1.2 Purpose

The purpose of the approach is to develop active knowledge models, i.e., models which actively support roles and work processes in enterprises. These models can be updated while working in order to always reflect the current status of enterprise knowledge. Active knowledge models neither represent traditional "as is" nor "to be" situations, as they go beyond the scope of "to be" models by providing the actual implementation of the "to be", the so-called solution model. Execution or enactment of such solution models requires an appropriate tool support capable of generating workplaces or work flows from models. In various industrial projects, the Metis tool or its successor Troux Architect™ was used for this purpose and extended for model execution.

Active knowledge modeling combines and extends approaches and techniques from enterprise modeling and enterprise architectures. The knowledge needed for performing a certain task in an enterprise or for acting in a certain role has to include the context of the individual, which requires including all relevant perspectives in the same model. Using the knowledge is applying different reflective views on the knowledge model. *Enterprise knowledge modeling* aims at capturing reusable knowledge of processes and products in knowledge architectures supporting work execution (Lillehagen and Karlsen 1999). These architectures form the basis for model-based solutions, which often are represented as active knowledge models (Lillehagen and Krogstie 2008). Krogstie and Jørgensen (2004) identify characteristics of active models vs. passive models and emphasize that "the model must be dynamic, users must be supported in changing the model to fit their local reality, enabling tailoring of the system's behavior".

14.1.3 Elements of the Approach

The AKM approach consists of a predefined modeling process, i.e., the C3S3P method, a number of best practices for active knowledge modeling and so-called model templates for different application domains, which are offered as part of the tool support. Examples of such model templates are CPPD for collaborative product development or ITM for IT management activities.

The C3S3P method distinguishes between seven phases called Concept study, Scaffolding, Scoping, Solution modeling, Platform integration, Piloting in real projects, and Performance monitoring and management. The C3S3P phases roughly include the following:

- Concept Study: pre-studies are performed to investigate whether EM is a suitable and accepted way of developing executable solutions for the networked enterprise
- Scaffolding[1] aims at creating shared knowledge and understanding among the participants of the project about the scope and challenges of the project.
- Scoping: creation of executable models supporting the networked enterprise for a defined scope including all relevant dimensions required, like process, product, organization, or IT systems
- Solutions Modeling: refining the scoping model by integration personnel, product structures, document templates, and IT systems required for using the enterprise model in an actual project
- Platform Configuration: configure the solution models for use in the networked or extended enterprise by connecting the enterprise model to the platform used (see (Johnsen et al. 2007) for details on the MAPPER platform)
- Platform Delivery: encompasses the roll-out of model-configured solutions
- Performance Improvement by capturing indicators for process and product quality and using adequate management instruments.

14.1.4 Model Example

Active Knowledge Modeling and the C3S3P method do not include one specific modeling language or notation, but emphasize the need to represent mutually reflective views (see "perspectives" below) in such a way that the users of active knowledge models are supported in model use and enactment processes. Thus, a number of domain-specific modeling languages have been developed, like the Collaborative Product and Process Development (CPPD), which has a focus on manufacturing industries. Figures 14.1, 14.2, 14.3, and 14.4 show an excerpt from an active knowledge model developed for automotive industries in the research and development project MAPPER (see Johnsen et al. 2007). The purpose of the figures is to give an impression of what active knowledge models and typical notations look like.

Figure 14.1 shows the process, organizational roles, and IT systems required for "develop new test method," which is a task in automotive product development defining what test procedures for new materials to be used in specific product parts. The model excerpt visualizes in its center the process perspective of developing a new test method. The process flow consists of the steps "Check real need for new test method,," "prepare draft," "evaluation of test method concepts," and "release

[1] The term scaffolding indicates the intention of this phase to create a firm structure supporting the development of a solution without making this structure a part of the solution—like in construction projects where the scaffold supports the construction of a building.

new test method." These process steps are connected with typed relations, which are depicted as arrows. Usually, the type of relation is displayed by using a textual label. This is not shown in the figure in order to keep it readable. Above the process flow, objectives and documents which are input to the process are shown. The arrows indicate relationships between processes, roles, systems, and documents or objectives.

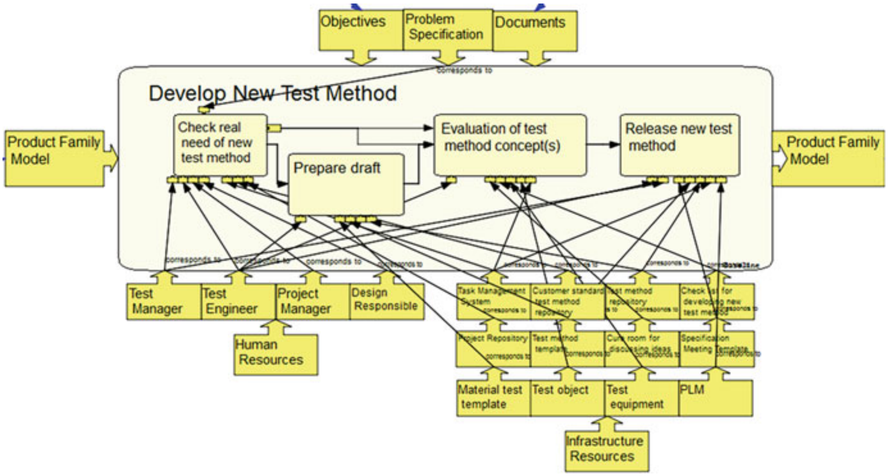


Fig. 14.1 Active knowledge model fragment for "develop new test method"

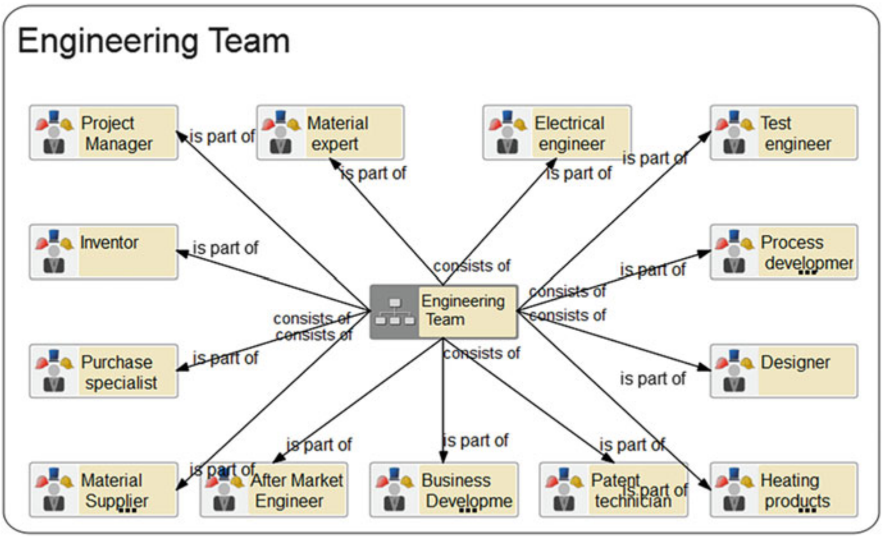


Fig. 14.2 Fragment of the organizational sub-model

Below the process flow, the roles involved in the process are included (grouped at the left hand side) and the IT systems and tools are shown. The symbols used for roles, infrastructure resource, and documents are so-called process mechanisms, which basically serve as a proxy for the actual modeling element. Each process mechanism is linked by a specific relationship type to the actual modeling element.

Figure 14.2 shows an excerpt from the organizational model. In the center, the organization unit “Engineering team” is depicted. The different roles of the engineering team are grouped around this organization unit.

In Figure 14.3, a small part of the product model is shown. It shows the functional structure of a component to “deliver thermal seat comfort” which is broken down into its functional sub-components. On the right hand side of the figure, a number of relations are shown which lead to components implementing the functional subcomponent. These implementations are not included in the picture.

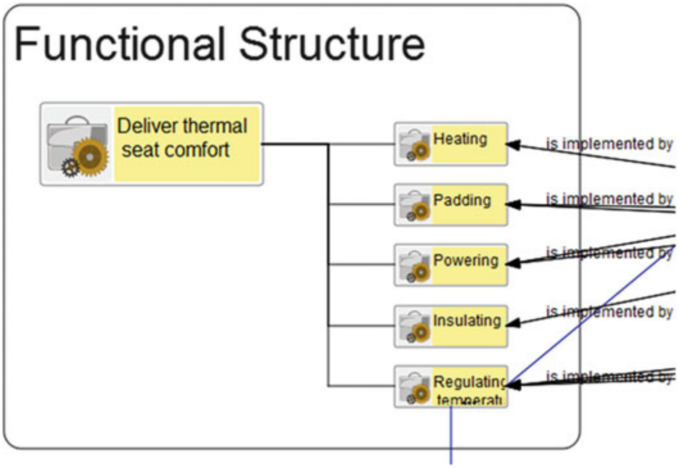


Fig. 14.3 Fragment of the product sub-model

Fig. 14.4 Model element types of MEAF

Figure 14.4 shows other modeling element types available in this domain-specific modeling language. The visual modeling language applied was MEAF (METIS Enterprise Architecture Framework), which is an extension of the Generic Enterprise Modelling language (GEM).

14.1.5 Perspectives

AKM and the C3S3P method support the use of different perspectives when developing active knowledge models, but what perspectives to use is not generally standardized; it depends on the model template applied and the modeling purpose. However, there is a recommendation in AKM to follow the POPS* best practice. This best practice recommends to always evaluate at the beginning of a modeling project whether the following perspectives should be included in order to address all aspects of the problem at hand (Lillehagen 2003):

- The process perspective (P) captures the work processes and tasks in the networked enterprise,
- The organization perspective (O) includes all roles involved in the processes and their skills and competence profiles,
- The product perspective (P) focuses on components, configuration possibilities, and dependencies of the product under consideration,
- The systems perspective (S) includes the IT systems supporting work processes and product development,
- Further perspectives (*) depend on the requirements of the enterprise under consideration and can include business objectives, customer requirements regarding the products, or key success factors.

These perspectives are mutually reflective, i.e., each perspective influences content and meaning of the other perspectives, which is captured in relationships and dependencies between the elements of the perspectives.

Table 14.1 Comparison of 4EM perspectives and AKM

4EM perspective	AKM perspectives according to POPS*
Goals and problems	Not explicitly defined. Can be added as “further perspective”
Business processes	Process perspective
Actors and resources	Organization perspective
Concepts	Not explicitly defined. Can be added as “further perspective”
Business rules	Not explicitly defined. In many model templates either represented as attribute/specification of business process or relationship types
Technical components	System perspective
Not included in 4EM	Product perspective

Table 14.1 shows which perspectives in 4EM and in POPS* have similar or comparable meanings. 4EM does not contain an explicit product perspective. Product structures and related concepts can in 4EM be modeled in the concept model.

14.1.6 Further Readings

The following book contains a collection of all relevant information regarding active knowledge modeling:

- Lillehagen F, Krogstie J (2008) Active knowledge modeling of enterprises. Springer, Berlin, Heidelberg

The scientific foundations and the practical relevance of active modeling are subject to continuous improvement, for example by Frank Lillehagen at Commitment AS (Lysaker, Norway) and John Krogstie at the Norwegian University of Science and Technology (Trondheim, Norway).

14.2 ArchiMate

14.2.1 Origin/History

ArchiMate is a framework for describing enterprise architectures as well as tasks in enterprise architecture management. Based on the experiences from the first development projects between 2002 and 2004, Archimate has been established as a standard of the Open Group. Archimate is considered as a formal modeling language understandable by enterprise stakeholders.

14.2.2 Purpose

The focus of Archimate lies on capturing and visualization of value-added domains as well as existing interdependencies an enterprise is confronted with. ArchiMate supports modelers to address those stakeholders who lack domain-specific expertise. Additionally, models created with ArchiMate are suitable for automated analyses.

14.2.3 Elements of the Approach

This section describes the ArchiMate framework with its core concepts, different functions, and the enterprise layers distinguished in ArchiMate. The section is concluded with a short overview to implementation and migration extensions. Each layer is illustrated with an example from a case study.

The main architectural layers, representing the core of ArchiMate, are *Business*, *Application,* and *Technology*. Each layer has certain elements that are used to illustrate the domain-specific architecture. Additionally, there exists a class model of available elements, i.e., lower levels elements that provide support in the form of either services or functionalities for elements of higher levels.

- Since the *Business* layer is the top level, it is responsible for modeling the entire course of business, e.g., interaction processes between customers and the enterprise.
- One level below, the *Application* layer supports the Business layer by setting the focus on application services and the implementation of processes of an enterprise.
- Last but not least, the *Technology* layer provides the infrastructure required to use the application services of the Application layer. Moreover, relationships between software and hardware are modeled on respective layer.

The notation of ArchiMate differentiates between three types of elements: *Active Structure Elements* (Subject), *Behavioral Elements* (Predicate), and *Passive Structure Elements* (Object). Each and every element of the architectural layers outlined above is assigned to one of these types. *Active Structure Elements* are able to perform an action. In contrast, *Passive Structure Elements* are applied to a certain behavior that is defined by *Behavioral Elements*. In general, Passive Structure Elements represent either information or data objects.

Figure 14.5 provides an overview of existing elements and their assignment to different layers. The *Structural Concepts* include all Active Structure Elements as well as the passive Business and Data Objects that are applied to support operative processes of an enterprise such as applications and business functions. In contrast, the *Informational Concept* includes those passive elements that manage interdependencies between operative processes and business goals. Finally, every Behavioral Element belongs to the *Behavioral Concept*.

The following section introduces the different layers and show examples from a case study.

14.2.4 Business Layer

The Business layer mainly involves those elements applied in organizational structures. Moreover, products as well as services assigned to strategic levels belong to this layer. In general, business processes and especially value-adding processes represent the core elements of the Business layer.

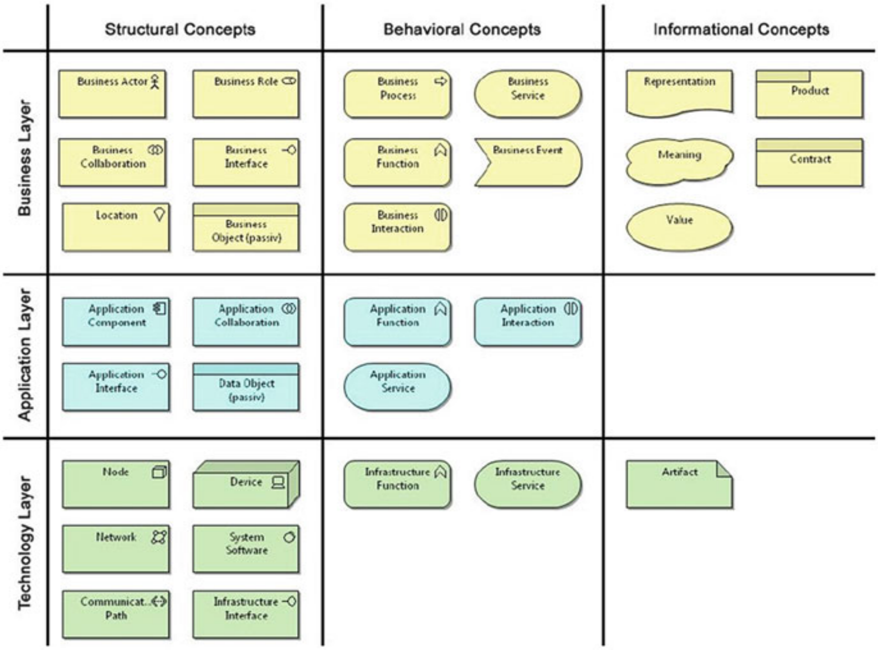


Fig. 14.5 ArchiMate main elements (Josey et al. 2013)

According to the structure illustrated in Fig. 14.5, there are six different structural concepts, five behavioral concepts, and five informational concepts. The concept of *Business Actors* correlates with the concept of *Business Roles*. Nevertheless, there is an important difference. The Business Actor represents an organizational unit that is able to either execute an action or show a certain behavior which is assigned to a Business Role. Business Actors are introduced whenever an individual person, department, or business unit needs to be modeled. In contrast, in case of illustrating a capacity that is able to execute a certain business process or function, Business Roles are applied. Taken together, Business Actors represent an identity of an organizational unit whereas a Business Role signifies a role in an enterprise linked to at least one task.

In the case of scenarios where two or more Business Roles are needed in order to perform an action and retrieve a certain behavior, so-called *Business Collaborations* are applied. These define a joint capacity achieved by the collaboration of roles. Another element, the *Business Interface*, represents an interface for business services and the corresponding environment. A distinction is made between *provided* interfaces, that make a specific functionality available, and *required* interfaces, that are in need of a defined function. Additionally, for the purpose of managing a spatial distribution of aforementioned elements, ArchiMate 2.0

introduced a *Layout* element. Last but not least, there are passive *Business Objects* that are not able to perform a certain action. Instead, they are used to constitute different object types that are either written, read, or created by other elements.

Besides presented structural concepts, there are different behavioral concepts such as *Business Processes*. These describe procedures that need to be adhered to in order to create products or services. A business process does not list particular details regarding the sequence of steps. Business Processes are invoked by elements of the Business layer that belong to the behavioral concept. An additional element of the behavioral concept is the *Business Service* that performs a specific service. A distinction is made between *internal* and *external* business services. The former is not applied directly by customers. Instead, these provide a function inside an enterprise. In contrast, external business services are consumed by customers. Regardless of whether internal or external, business services are offered by the Business Interface.

Business Functions are responsible for clustering elements according to defined criteria, e.g., supplies, competence, or knowhow. *Business Events* describe an incident occurring either inside or outside an enterprise environment. They are able to both invoke and interrupt a business process. Furthermore, there are elements defining the behavior of business collaboration elements, so-called *Business Interactions*. In contrast to Business Process and Business Function elements that are executed by a single Business Role, Business Interactions characterize at least two different roles.

Finally, there are several informational concepts, e.g., *Representations* illustrating information a business object consists of. In order to have an increased intelligibility of an actual task a business object or representation has, *Meanings* depict the purpose of respective objects in detail. *Products* as another concept represent either a certain product or a service of an enterprise where a customer needs to be able to acquire it. Moreover, contractual conditions to be observed by participating parties can be modeled; a correspondent agreement is modeled as *Contract* in formal, juridical, or informal way. Service level agreements (SLA) can be specified inside the contract. *Values* reflect the utility of both products and services. Furthermore, values can represent a financial value. An example for a Business Layer Model is illustrated in Fig. 14.6.

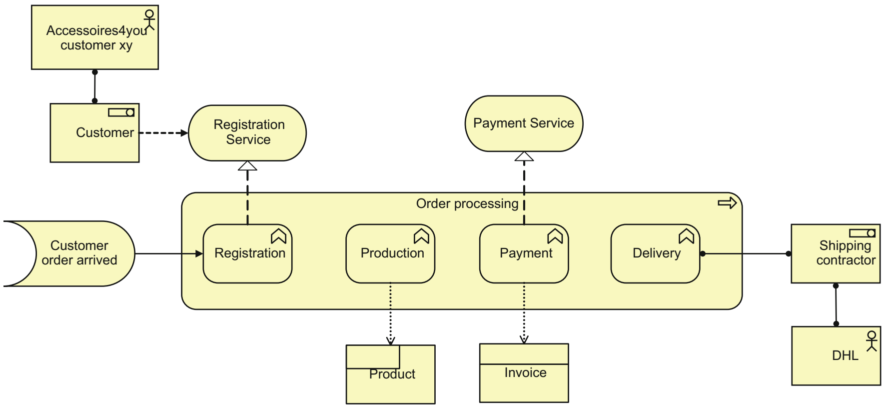


Fig. 14.6 Business layer model example

14.2.5 Application Layer

The main function of the Application layer is support of the Business layer with several application services. Business processes, functions, as well as interactions make use of these applications in order to fulfill their responsibility or task. As a consequence, this architectural layer considers the enterprise from the perspective of services needed for the realization of every process of the Business layer.

A distinction is made between structural and behavioral concepts on this layer. From the structural perspective, th*e Application Compon*ent is the primary element representing a modular, universally usable, reusable, and exchangeable component of a software system. The functionalities are encapsulated and made available via one or more interfaces. An *Application Interface* provides an application service for the involved environment. A distinction is made between *provided* interfaces that grant access to a function and *required* interfaces, which are in need of a function. Similar to the business collaboration elements of the Business layer, there is an *Application Collaboration* element that aggregates at least two Application components in order to fulfill a certain task. In addition to aforementioned active elements, there is a passive *Data Object* which is subject of operations or applications. Data objects represent the realization of Business objects on the Application layer.

Beyond the presented structural concepts, there are three different behavioral concepts. Firstly, *Application Function*s cluster the performance achieved by Application components. Application functions represent the internal behavior whereas the external behavior is outlined by at least one *Application Service*. These Application services reveal the behavior of Application components in order to make these available for the environment and especially provide support for the Business layer. Last but not least, *Application Interactions* describe the behavior of Application Collaboration elements, i.e., the collective behavioral pattern of several Application components is expressed. Figure 14.7 illustrates an example of an Application Layer Model.

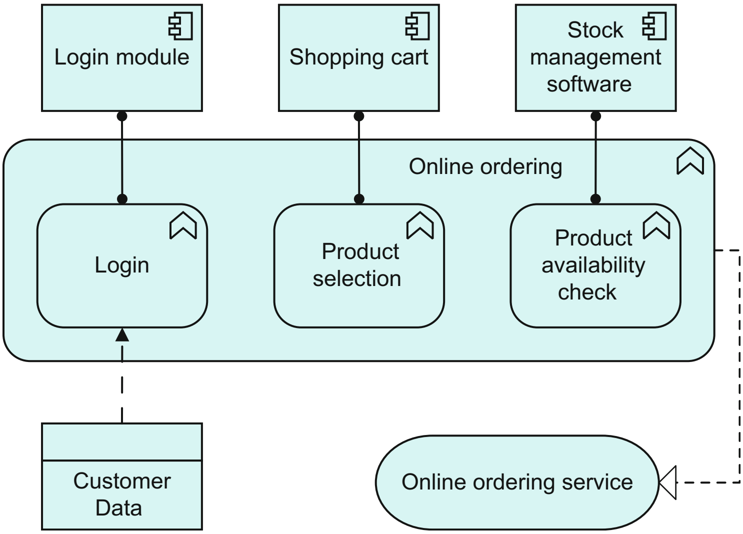


Fig. 14.7 Application layer model example

14.2.6 Technology Layer

The Technology layer provides elements for modeling services regarding the infrastructure, e.g., those being essential to run applications of the Application layer. Accordingly, several devices such as computers, servers, and operating or database systems belong to the Technology layer (Fig. 14.8).

Similar to aforementioned layers, a distinction is made between structural, behavioral, and informational concepts. Introducing the structural concepts, a *Node* represents a system resource that is used in order to save, edit, and execute *Artifacts*. Moreover, Nodes are applied to model a holistic runtime environment, e.g., a database server. For the purpose of describing a Node more in detail, the related elements *Device*, representing a physical arithmetic unit, and *System Software*, a software component running on a Device, are introduced. More precisely, the processing power as well as memory capacity of Devices are used for storing and processing Artifacts. However, a Device might represent an independent element not being related to a specific Node. In contrast, System Software represents the environment an Artifact is executed on. In general, there exists a peer-to-peer connection between a Device and the Software System. However, this element might be applied as a middleware acting as a mediator for two applications. *Infrastructure Interfaces* either provide access for Nodes and Application components to other Nodes (*provided* interface) or define an interface another Node requires (*required* interface). Furthermore, an infrastructure service might be made available for the environment it is located in. A *Network* is, as the term implies, a physical medium of communication that gives some indication of the kind of connection two or more Devices have. Accordingly, a Network is able to have several subnets and realize *Communication Paths* which are communication channels via Nodes and have the ability to exchange data.

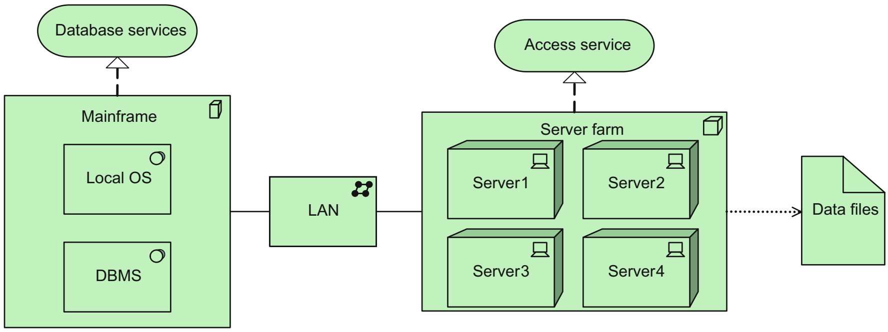


Fig. 14.8 Technology layer model example

Corresponding with Functions of aforementioned layers, the *Infrastructure Function* clusters behavioral elements of the Technology layer. Internal behavioral characteristics of a Node, which are invisible to the outside, are defined by Infrastructure functions whereas *Infrastructure Services* represent the external behavior. Accordingly, Infrastructure services make functions available for the environment in order to provide access, e.g., for applications components.

Artifacts are a physical information units belonging to the informational concepts. As mentioned above, Artifacts are either created or edited during both software development and execution processes of a system. In general, an artifact represents a specific element of concrete scenarios such as documents, scripts, or executable data. An Artifact is applied for the realization of Data objects and Application components or is related to several Nodes.

14.2.7 Relationships

ArchiMate offers a set of relationships that connect single elements and create cross-layer dependencies between the layers described above. In general, three types of relationships can be classified. *Structural Relationships* are used for describing the structural coherence between single elements. *Dynamic Relationships* represent dependencies between concepts, often time-based. The last type, *Other Relationships*, contains all relations that cannot be allocated to one of the first two categories (Josey et al. 2013, p. 51).

Structural Relationships consist of seven subtypes. One of the most commonly utilized relationships is the *Association*. It can be used when no more specific type can be found. *Access* represents the access to business or data objects. *Used By* models the usage of services and the access to interfaces. *Realization* connects an unspecific, logical element with a more concrete one for its actual implementation. *Assignment* links Behavioral Concepts with Structural Concepts and roles with concrete actors. *Aggregation* illustrates that an element groups several other elements. Here, every element can be part of multiple aggregations. *Composition* indicates that an element consists of a number of other elements. In contrast to an

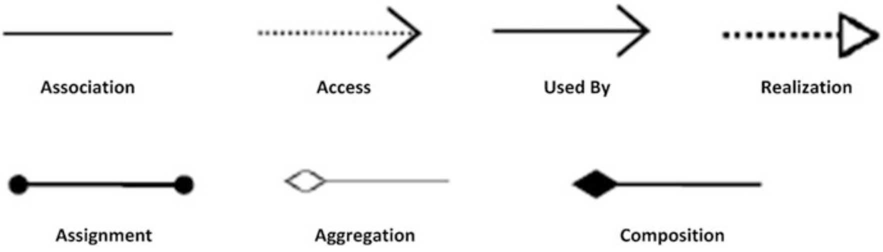


Fig. 14.9 ArchiMate structural relationships

Fig. 14.10 ArchiMate dynamic relationships

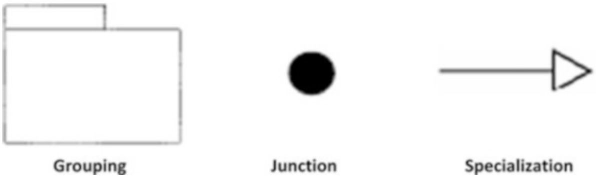


Fig. 14.11 ArchiMate other relationships

aggregation, every element can only be part of one composition (Josey et al. 2013, pp. 51–53). Figure 14.9 illustrates the seven sub-types for the Structural Relationships.

Dynamic Relationships can only be subdivided into two types (Fig. 14.10). The *Flow* represents an exchange between elements, e.g., the exchange of information and data. *Triggering* describes casual or temporal dependencies between elements (Josey et al. 2013, pp. 53–54).

The group of Other Relationships contains three relations (Fig. 14.11). *Grouping* indicates that elements, from the same type or different types, can be collected by using a common characteristic. *Junction* applies for connecting relations of the same type. *Specialization* illustrates the fact that one element is a special form of another one (Josey et al. 2013, pp. 54).

14.2.8 Motivation Extension

This extension adds motivational concepts to ArchiMate. These concepts can be used to justify the way of how the enterprise architecture is designed. For instance factors that influence the enterprise, its behavior, and design are considered to find

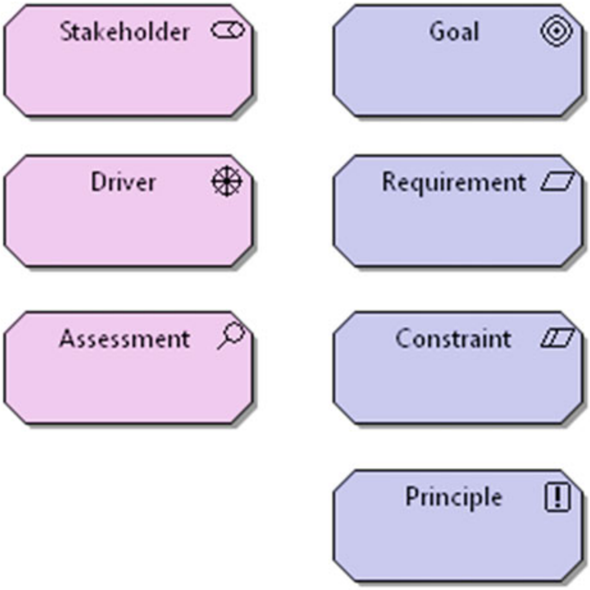


Fig. 14.12 ArchiMate motivation extension elements

arguments for architecture design decisions. These influencing factors can be *stakeholders*, *drivers,* and *assessments* (Fig. 14.12).

Stakeholders are all economic groups that are involved in the respective enterprise in any way. Thus, they are interested in the success of the architecture design process and its outcome. Stakeholders are able to set, change, and emphasize goals. A *Driver* is used to represent specific influences on the enterprise that cause changes in the organization. These can be internal ones like stakeholder interests or external ones like legislation changes. In order to identify and understand the drivers, an *Assessment* for each of them has to be conducted. That way, strengths, weaknesses, threats, and opportunities concerning single driver scopes can be revealed (Josey et al. 2013, p. 60).

The other dimension of motivational concepts is represented by the parameters of goals, requirements, constraints, and principles. They complement the influencing factors mentioned above.

A *Goal* expresses a state intended by a stakeholder (Josey et al. 2013, p. 60). Through adequate setting of goals, drivers can be influenced in a positive way. *Requirements* are challenges that have to be met to realize a certain goal (Josey et al. 2013, p. 61). That way, they represent the initial situation in the process of target compliance. A *Constraint* describes an unalterable restriction that applies during the whole realization process, e.g., time or budget restrictions (Josey et al. 2013, p. 61). Finally, a P*rinciple* is a general guideline that has to be adhered to during the realization of set goals. In contrast to requirements, they are more abstract and hence they have to be implemented by specific requirements before using them in architecture design.

For modeling relations between single motivational elements and their relations to the core elements, ArchiMate provides three different types of relationships (Fig. 14.13).

Fig. 14.13 ArchiMate motivation extension relationships

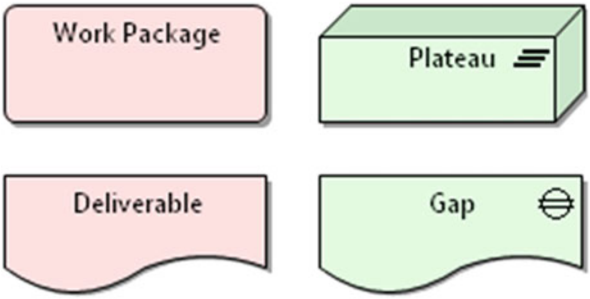


Fig. 14.14 ArchiMate implementation and migration extension elements (Josey et al. 2013)

The A*ggregation* expresses the subdivision of an element into multiple sub-elements which together build the superior element (Josey et al. 2013, p. 61). *Realization* models the aspect that one element is realized by another one, e.g., a goal can be realized by a principle, a constraint, or a requirement. *Influence* shows a relation between two elements, in which one has influence on the other. It is distinguished between positive and negative influence.

14.2.9 Implementation and Migration Extension

The Implementation and Migration Extension provide elements that can be used for, as the name implies, implementation and migration of an architecture. With the help of this extension, modeling projects, supporting programs, or project management aspects can be approached (Josey et al. 2013, p. 65).

The extension contains four concepts: Work package, Deliverable, Plateau, and Gap. A central concept is the *Work Package*. It embodies a defined set of actions that are necessary to complete a certain goal within a given time frame. Each work package produces a *Deliverable*. The implementation of the desired architecture is such a deliverable, whereas deliverables usually have much smaller scopes; a software product and a report are deliverables too. A *Plateau* represents the single intermediate stages during the architecture development process. As this process is incremental, every architecture state from the initial situation to the final architecture is depicted by a plateau. The last concept, the *Gap*, describes the differences between two consecutive plateaus, i.e., it contains all modifications that were made to create a new architecture stage from an older one (Fig. 14.14) (Josey et al. 2013, p. 66)

Table 14.2 Comparison of 4EM perspectives and ArchiMate

4EM perspective	ArchiMate 2.0 layers and objects
Goals and problems	ArchiMate motivation extension elements (goal, constraint, driver, requirement)
Business processes	Business layer (process)
Actors and resources	Business layer (actor, role, product, contract)
Concepts	Not explicitly defined.
Business rules	ArchiMate motivation extension elements (Principle)
Technical components	Application and technology layer (component, function, service, interface)

14.2.10 Conclusion

ArchiMate offers an enterprise architecture modeling language to the user. It offers a holistic approach, covering the whole organizational structure of an enterprise. This is achieved by dividing the architecture development into three layers—Business, Application, and Technology—which built on each other with Business as the highest level. The modeling process is enriched by extensions that add additional factors like motivational or implementation aspects.

Compared to 4EM, ArchiMate uses a different modeling approach. While 4EM divides the modeling into several sub-models, each covering a different perspective on the enterprise and its organization, ArchiMate structures the enterprise into three separate layers, each combining various perspectives. Furthermore, ArchiMate provides modeling elements, which are central in 4EM (goals, constraints, etc.), only as extensions to the main framework. Nevertheless, after a complete and detailed implementation, both methods should deliver similar results.

To conclude, ArchiMate may serve as an alternative to 4EM. Due to a different modeling approach, it may be applicable in situations where 4EM is not appropriate. On the other hand, 4EM in many Enterprise Modeling projects has advantages compared to Archimate, for example, if participatory modeling is required or ill-structured problems have to be addressed (Table 14.2).

14.2.11 Further Readings

The following pocket guide provides a nice entry point to ArchiMate literature and summarizes the most important concepts and ideas:

1. Josey A et al.; The Open Group (2012) ArchiMate 2.0—A pocket guide. Van Haren.

14.3 ARIS

14.3.1 Origin/History

ARIS (Architecture of Integrated Information Systems) has its origin in the academic research of Prof. August-Wilhelm Scheer in the 1990s. Scheer was during many years with the Saarland University in Saarbrücken (Germany), which still has strong research groups in the area of ARIS and its related techniques. ARIS offers a methodological framework and different approaches and tools for analyzing processes and other aspects of enterprises (see below). Scheer successfully converted these methods and tools into commercial products, which currently are in the product portfolio of Software AG. ARIS and EPC (see below) are widely used in industry as means for business process modeling and management.

14.3.2 Purpose

The ARIS approach (Scheer and Nüttgens 2000) includes general notation rules, different functions, and a set of views for enterprise modeling which often are depicted as the “ARIS house” (see below). Furthermore, ARIS provides a methodological framework to support process modeling activities, which also offers the possibility to describe the dynamics of the business processes. A modeling language known as Event-driven Process Chains (EPC) is part of ARIS. EPC are widely used in industry and supported by a large number of modeling tools.

14.3.3 Elements of the Approach

The following section describes the ARIS framework with its general notation rules, different functions, and the set of views used during modeling. Each view is illustrated with an example from the A4Y case study (Chap. 7). The section is concluded with a short introduction to the ARIS phases (so-called description levels) and the ARIS House. The core modeling language approach used in ARIS are Event-driven Process Chains (EPC). Figure 14.15 illustrates the basic notation of EPC.

The main components for the purpose of describing business processes are events and functions. The former is a passive element and characterizes the occurrence of a defined state that has an influence on the further process. An event is able to trigger a function inside as well as outside a company. However, functions perform a change in the state of a certain object. In other words, an active conversion from an input to an output is realized.

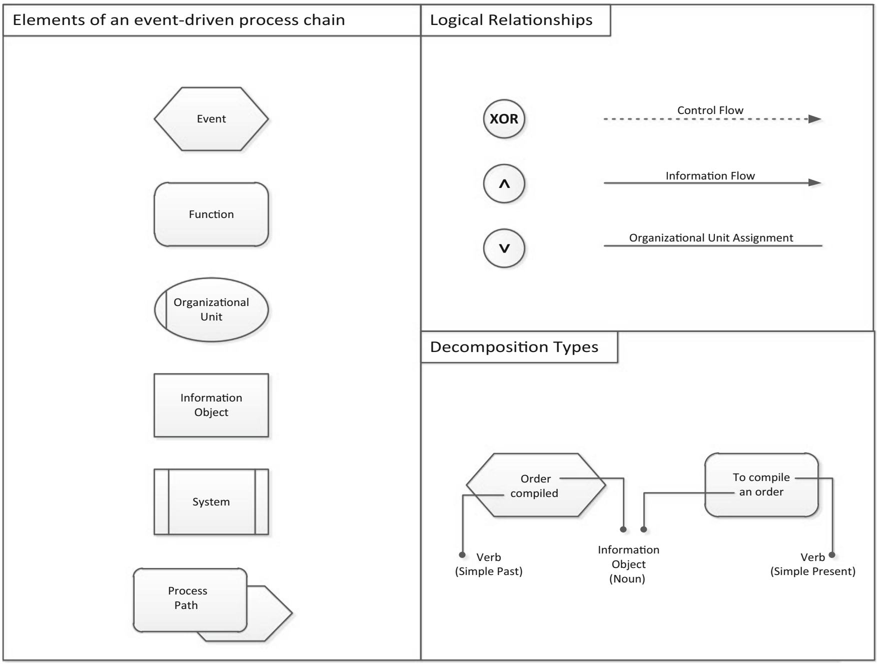


Fig. 14.15 EPC notation overview

Aside from the two main components event and function, EPC use additional elements such as information objects, organizational units and systems for modeling organizational structures, IT systems, and documents of information sets. Last but not least, an element serving as a navigation aid, the so-called process path, is used for the purpose of showing the connection to other processes.

Logical relationships and different types of connectors support the modeling of business processes. *Information flows* represent a relationship between functions and either input or output data upon which the function executes a read, change, or write operation. *Control flows*, however, create a chronological sequence as well as interdependencies between functions, process paths or logical connectors.

ARIS distinguishes between four different views:

- *Function View:* ARIS distinguishes between two possible representations: function tree and goal diagram. A function tree is responsible for indicating the complexity and hierarchy of objects and corresponding relationships. In comparison, the goal diagram defines different business goals and creates a hierarchical structure among these.
- *Data View:* This view contains two content perspectives: information and data. The elements of this view are usually modeled by using entity-relationship models (ERM) with their components: Entities, Attributes, and Relations.

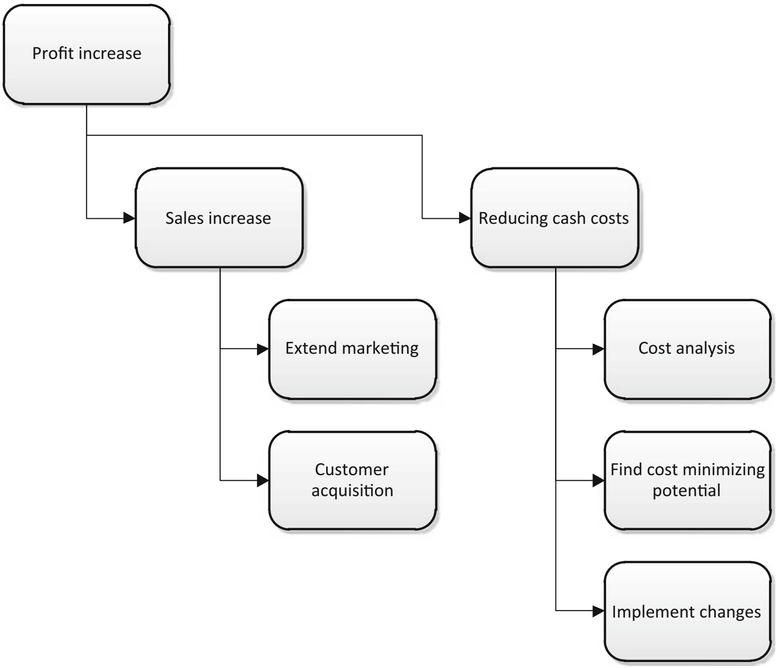


Fig. 14.16 ARIS function tree

- *Organization View:* The organization view of ARIS focuses on the organizational structure of an enterprise describing how the parts of the enterprise, the organizational units, are organized and how they are related to each other.
- *Control Process View:* This view captures connections between events and functions representing the flow of the process. In contrast to the static functional and data models, the control view focuses on procedural (time-based, logical) aspects describing coherences of functions.

14.3.4 Examples

This section presents some examples for the different ARIS views. The purpose of the examples is to illustrate the ARIS notation. Figures 14.16 and 14.17 show examples from the function view: function tree and goal diagram.

As already indicated above, the data view in ARIS primarily relies on entity-relationship models (ERM), but adds additional components and modeling possibilities to ERM. Figure 14.18 shows an example data model for a product from the A4Y case study.

An enterprise's organization can be divided into the organizational structure on the one hand and the operational structure on the other hand. The organizational

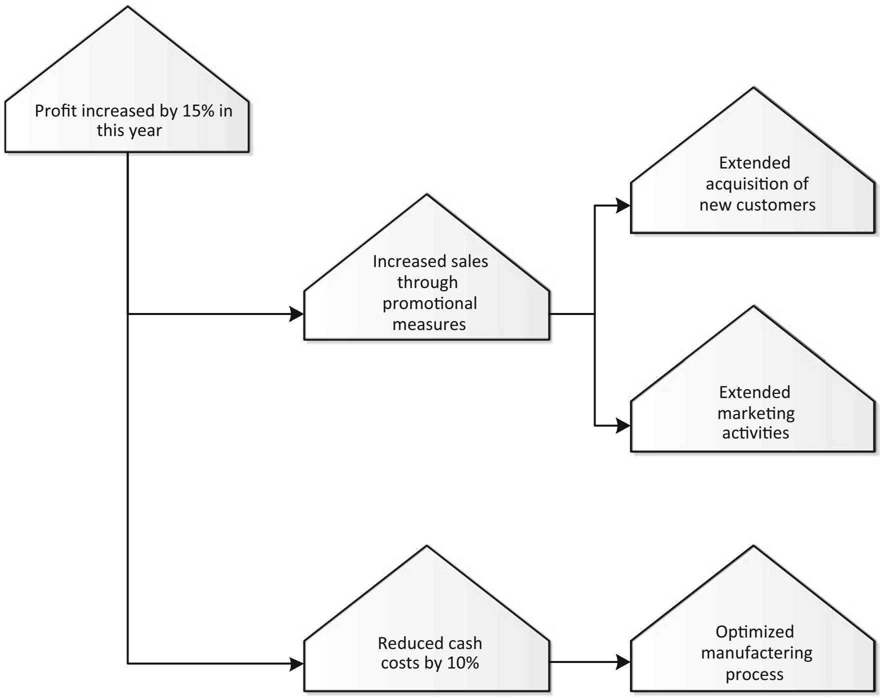


Fig. 14.17 ARIS objective diagram

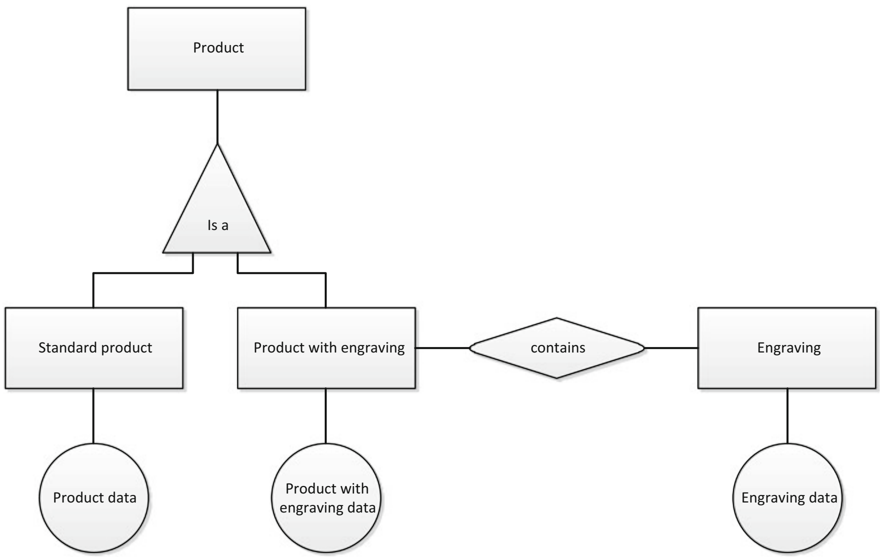


Fig. 14.18 ARIS data view

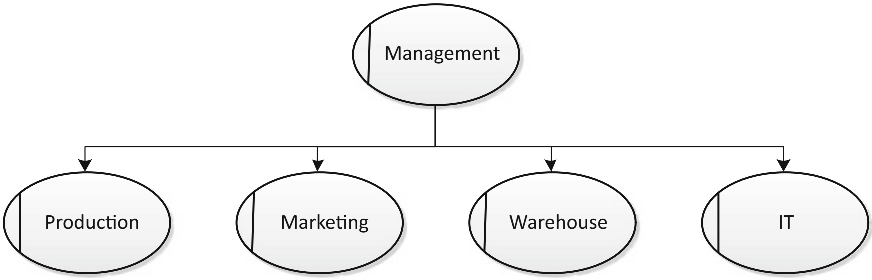


Fig. 14.19 ARIS organization view

structure describes how the parts of the enterprise, the organizational units, are organized and how they are related to each other. The operational structure describes how tasks and processes are allocated to organizational units and sets timeframes as well as facilities. The organization view of ARIS focuses on the organizational structure of an enterprise. Therefore, it can be subdivided into particular positions or subunits. Figure 14.19 shows an example model depicting the top level organizational structure of the case study enterprise.

14.3.5 Control (Process) View

In contrast to the static functional and data models, the control view focuses on procedural (time-based, logical) aspects describing coherences of functions. In general, the basic version of EPC is applied in order to model a consistent process flow with basic elements such as functions and events. Figure 14.20 shows an excerpt of an EPC.

Furthermore, the ARIS framework uses description levels and the ARIS House as illustration of the overall approach:

- *Description levels:* ARIS provides three phases of the modeling process called description levels that are used to depict the typical course of a software project (requirement definition, design specification, implementation).

The ARIS House: The ARIS house contains the four views and the description levels in order to provide an illustration and overview of the general ARIS approach. The ARIS House approach is depicted in Fig. 14.21.

14.3.6 Perspectives

ARIS provides an approach to model the architecture of integrated information systems within enterprises. Through its division into different views, it covers all organizational parts that are involved in the information system design and usage.

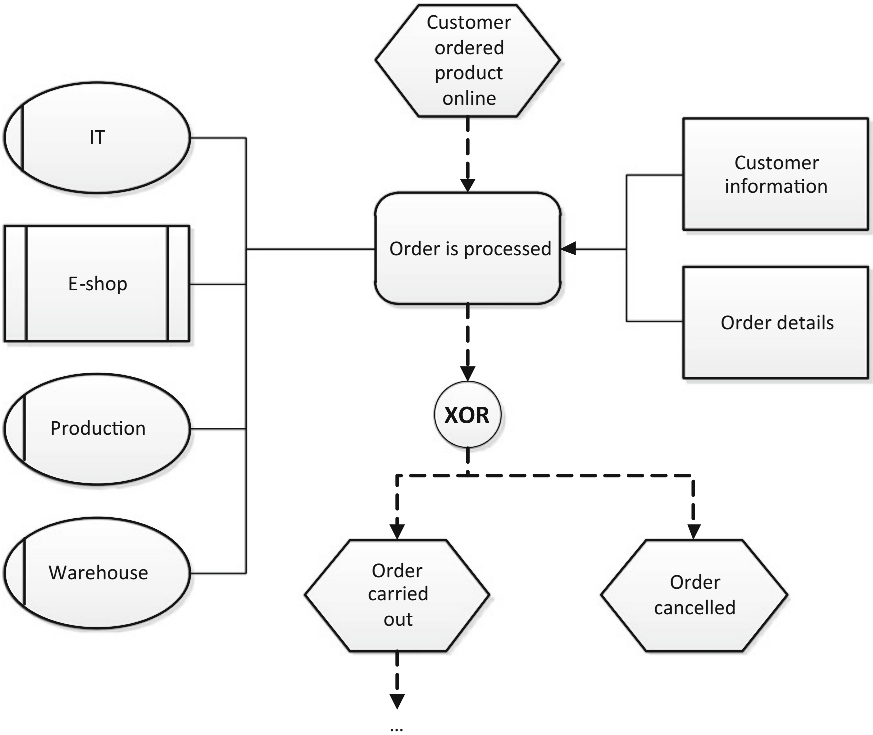


Fig. 14.20 ARIS control view

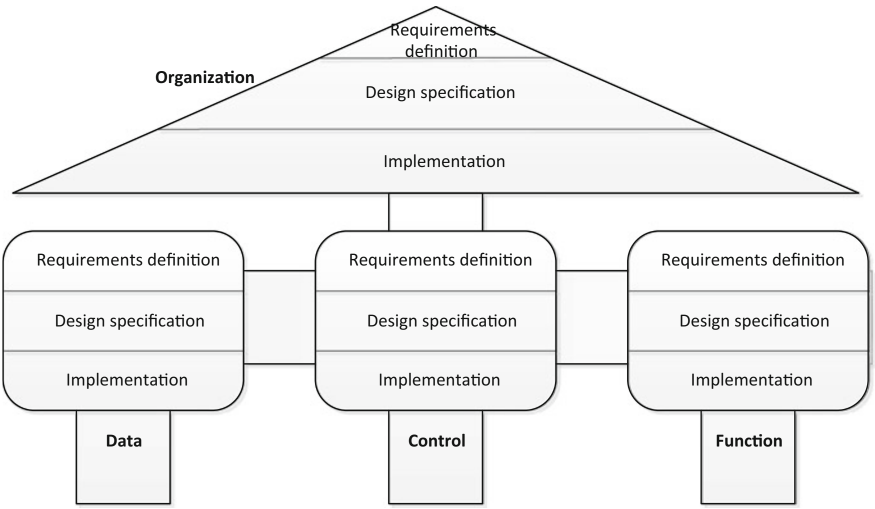


Fig. 14.21 ARIS house

Table 14.3 Comparison of 4EM perspectives and ARIS

4EM perspective	ARIS views and EPC concepts
Goals and problems	Function view (goal diagram)
Business processes	Function view (function diagram, EPC)
Actors and resources	Organization view (e.g., organizational chart, organizational unit, person)
Concepts	Not explicitly defined as a view. Can be partly be captured with the Data View (ERM)
Business rules	Control view (EPC)
Technical components	Not explicitly defined as a view. Can be captured in EPC.

The three consecutive description levels reflect the typical course of a software development project. Many aspects of ARIS can also be found in other Enterprise Modeling approaches.

One of the similarities between ARIS and 4EM is to reduce complexity in the modeling process by using different sub-models, which in ARIS are considered as views and in 4EM as perspectives. However, the purpose and the content of the sub-models are different, as illustrated in Table 14.3. The most important difference is probably the focus of ARIS on control flows (as modeled by EPC) whereas 4EM considers all perspectives as equally important.

14.3.7 Further Readings

Scheer A-W, Nüttgens M (2000) ARIS architecture and reference models for business process management. Springer, Berlin, Heidelberg

14.4 DEMO

14.4.1 History

The Design and Engineering Methodology for Organizations (DEMO) is an EM approach for capturing, representing, and analyzing business processes and transactions.

DEMO is based on the theoretical foundations that stem from the Language Action Perspective (Flores and Ludlow 1980). The concept of analyzing what people do when communicating and how that influences the information system specification was a significant innovation at that time, which influenced a number of theoretical contributions to the area of information system engineering.

DEMO originally was an acronym for Dynamic Essential Modeling of Organizations. It was developed at the Delft University of Technology by Professor Jan Dietz (1996). The current version of the DEMO is denoted Design and Engineering Methodology for Organizations as published in (Dietz 2006). DEMO is being further developed and maintained by the Enterprise Engineering Institute, The Netherlands, and over the years has built a community of researchers and practitioners under the auspices of the CIAO! Network (http://ciaonetwork.org/).

14.4.2 Purpose

The purpose of DEMO is to offer an EM approach based on sound ontological foundations. A particular emphasis is on capturing and modeling the operation of an organization in a way that is independent from implementation. The resulting models can be called Enterprise Ontologies. This in turn contributes to the enterprise model adhering to the following quality criteria as defined in (Dietz 2006): coherent, consistent, comprehensive, concise, and essential.

14.4.3 Elements of the Approach

DEMO is based on the theory for performance in social interaction proposed in (Dietz 2006), called the Ψ-theory. According to this theory organizations are social systems consisting of humans or subjects in which case it is of particular importance to consider their interaction. The subjects perform two kinds of acts:

- Production acts (P-acts). P-acts are used to model how the subjects contribute to bringing about the goods or services that are delivered to the environment.
- Coordination acts (C-acts). C-acts are used to model how subjects enter into and comply with commitments towards each other regarding the performance of P-acts.

The effect of performing a C-act is that both parties involved—the performer and the addressee of the act—get involved in commitments about the bringing about of the corresponding P-act. Both act types occur as steps in a generic coordination pattern, called transaction (see Fig. 14.22).

A transaction (shown in upper right corner) has three phases:

- The order phase (O-phase), during which the initiator and the executor negotiate for achieving consensus about the P-fact that the executor is going to bring about. The main C-acts are the request and the promise.
- The execution phase (E-phase), during which the P-fact is brought about by the executor.
- Result phase (R-phase), during which the initiator and the executor negotiate for achieving consensus about the P-fact that is actually produced. The main C-acts are the state and the corresponding accept.

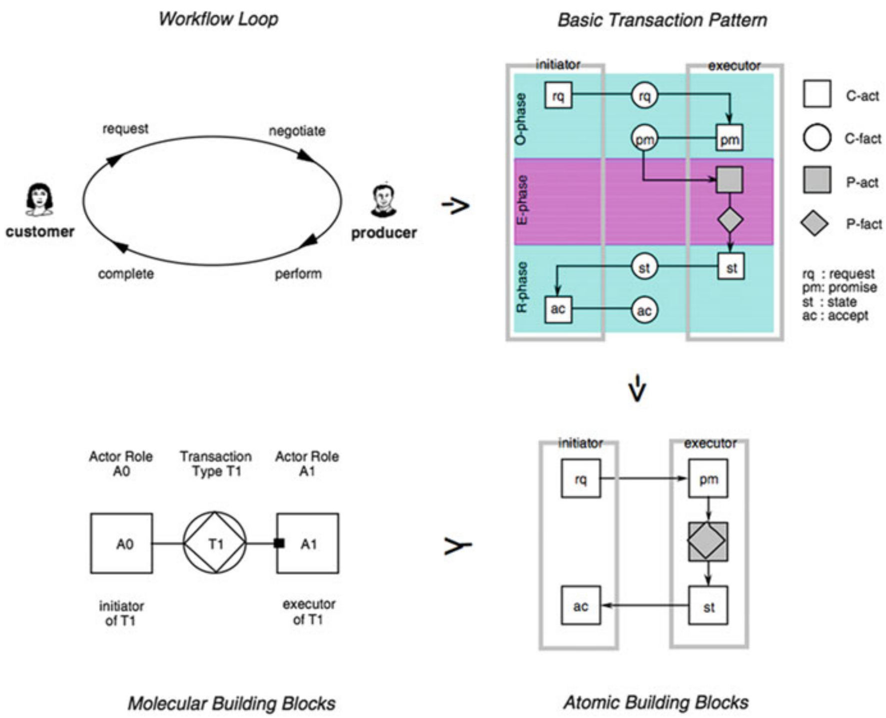


Fig. 14.22 Building blocks of an enterprise ontology (Ettema and Dietz 2009)

The transaction described above may be more complex as discussed in (Dietz 2006). The notation for representing the basic transaction pattern is shown on the lower right side of Fig. 14.22. A C-act and its resulting C-fact, and likewise, a P-act and P-fact, are represented by one symbol each. The lower left side of the figure represents the complete transaction pattern by one symbol—the transaction symbol. It consists of a diamond (representing production) embedded in a disk (representing coordination). Transaction types and actor roles are the molecular building blocks of business processes and organizations, the transaction steps being the atomic building blocks.

DEMO is based on the principle that humans have three abilities—the forma, the informa, and the performa ability. They are used both in C-acts and in P-acts (Table 14.4).

This distinction of human abilities motivates the layered view on organizations. As discussed in Dietz (2006) organizations have three aspects:

- D-organization dealing with datalogical problems such as the syntactic aspects of information (data) and the operations on data and documents, e.g., storing, copying and transporting.

Table 14.4 Three human abilities in terms of coordination and production, adapted from (Dietz 2006)

Coordination	Human ability	Production
Exposing commitment (as performer) Evoking commitment (as addressee)	*performa* (Latin for "through the form")	Ontological action (deciding, judging)
Expressing thought (formulating) Educing thought (interpreting	*informa* (Latin for "in the form")	Infological action (reproducing, deducing, reasoning, computing, etc.)
Uttering information (speaking, writing) Perceiving information (listening reading)	*forma* (Latin for "form")	Datalogical action (storing, transmitting, copying, destroying, etc.)

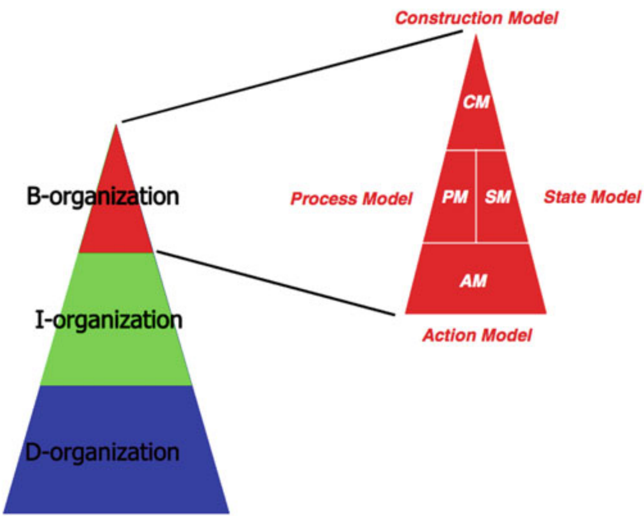


Fig. 14.23 The three aspects of an organization and the ontological model

- I-organization dealing with infological problems: the semantic aspects of information and computational operations.
- B-organization dealing with new and original facts, i.e., facts that change the business world, such as decisions and judgments.

According to DEMO the ontological model of an organization should focus on the B-organization (see Fig. 14.23). Such a model should consists of four aspect models:

- The Construction Model representing the actor roles and transaction kinds
- The Process Model representing the business processes and business events
- The State Model representing the business objects and business facts, and
- The Action Model representing the business rules.

Notations for the Construction Model and Process model will be shown in the next part of this section. DEMO uses ORM—Object Role Modeling (Halpin 2001). The Action model consists of action rule specified in a pseudo-algorithmic language described in (Dietz 2006).

14.4.4 Model Example

A large collection of cases are available on the Enterprise Engineering Institute Web site (http://www.demo.nl/practical-case-studies).

This section shows a few examples from a case used in (Ettema and Dietz 2009). The case is about the process of registering an imported car in The Netherlands at the Dutch Tax Department. This process is associated with paying a special kind of tax called BPM. After analyzing the background description of the case and applying the transaction pattern, three transaction types are identified: T01—the import of a car, T02—payment of the VAT on the car, T03—the admission of a car to the Dutch road network, and T04—the payment of the BPM tax. In this context car import and admitting it to the road network should be seen as two different issues, and in principle one could do the first but not the second. Considering this Actor Transaction Diagram Shown in Fig. 14.24 can be developed. This together with the transaction result table (Table 14.5) constitute the Construction Model. Since both parts of the process are disconnected only the part associated to T03 and T04 is elaborated in the Process Model (see Fig. 14.24). CA03 and CA04 are fulfilled by a private person. RDW (The Netherlands Road Transport Department) fulfills actor role A02 (road network admitter). Tax Office (Belastingdienst) is performing T04/ac. The dashed arrow from T04/ac to T03/ex means that the RDW has to wait until the BPM tax has been paid before deciding to admit a car to the road network (Fig. 14.25).

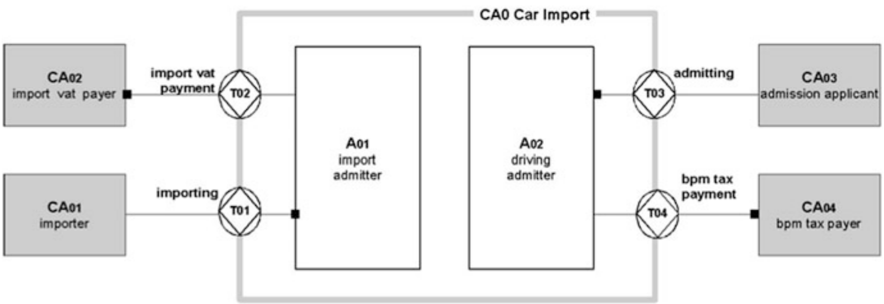


Fig. 14.24 Actor transaction diagram for the car import case (Ettema and Dietz 2009)

Table 14.5 Transaction result table of the car import case

Transaction type	Transaction result
T01 importing	R01 Import 1 has been performed
T02 import VAT PAYMENT	R01 Import VAT for import 1 has been paid
T03 admitting	R03 Admission A has been started
T04 BPM tax payment	R04 BPM tax for admission A has been paid

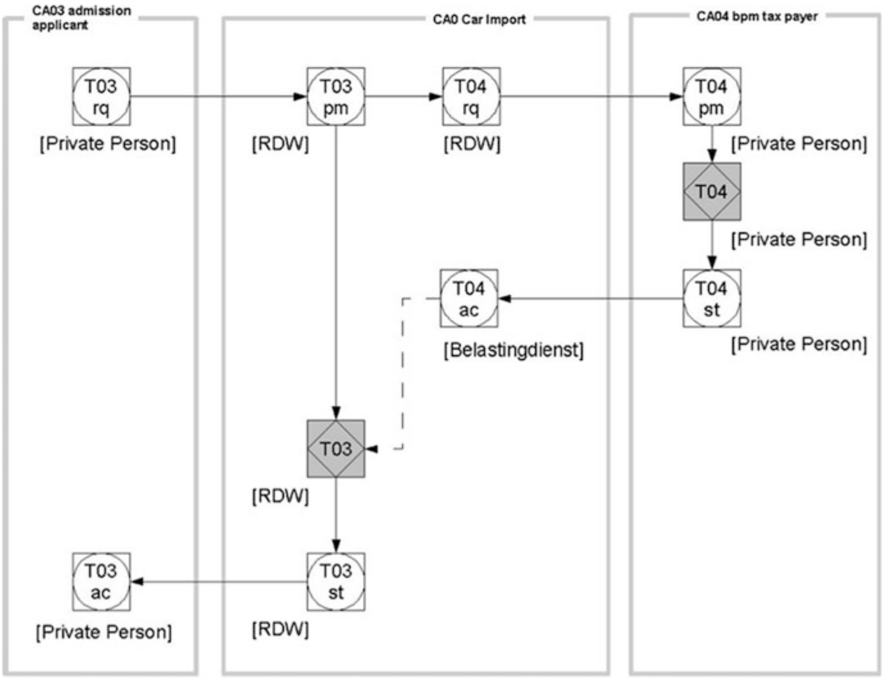


Fig. 14.25 Process model for the car import case (Ettema and Dietz 2009)

14.4.5 Perspectives

As discussed previously DEMO supports the following aspects—the Construction Model representing the actor roles and transaction kinds, the Process Model representing the business processes and business events, the State Model representing the business objects and business facts, as well as the Action Model representing the business rules. The foundations of the methodology make these perspectives closely interlinked, which is one of the advantages of DEMO in comparison with other approaches where different models and modeling perspectives may be more or less only "talked" together (Dietz 2006).

Table 14.6 Comparison of 4EM perspectives and DEMO

4EM perspective	DEMO perspectives
Goals and problems	Not explicitly defined
Business processes	Process model and construction model
Actors and resources	Construction model, actor transaction diagram
Concepts	State model using ORM
Business rules	Action model
Technical components	Not explicitly defined

Table 14.6 shows, which perspectives in 4EM and in DEMO have similar or comparable purposes.

14.4.6 Further Reading

The most thorough source about DEMO is the book by Jan Dietz (2006). There also are a large number of scientific publications available. To begin exploring the world of DEMO, we would like to suggest the following. Ettema and Dietz (2009) provide a comparative evaluation of ArchiMate and DEMO. Albani and Dietz (2011) demonstrate the suitability of DEMO for information system development. Caetano et al. (2012) present an approach to analyze the consistency and completeness of process models according to the principles of the ψ-theory and the underlying concept of business transaction. In addition the website of the Enterprise Engineering Institute has a large collection of publications such as case studies, DEMO specifications, as well as research publications.

14.5 Multi-perspective Enterprise Modeling

14.5.1 Origin/History

Development of the Multi-perspective Enterprise Modeling (MEMO) method started in the 1990s in Germany in an academic context. The initiator and still main developer and driving force behind MEMO is Ulrich Frank, now professor at the University of Duisburg—Essen in Germany. From its very origin, MEMO incorporated several perspectives and emphasized the importance of them. A perspective in MEMO is used to satisfy the intended model user's perspective, i.e., to provide the specific goals and capabilities required by the user, and to represent this user perspective in an appropriate way in the enterprise model.

In addition to work on conceptualizing perspectives from a modeling point of view and on identifying what perspectives typically are required, a meta-model, modeling languages, and tool support were developed. MEMO has been used in a variety of research and development projects, most of them driven by or with participation of Ulrich Frank and his team. MEMO specifications are publicly available. The method is not a commercial product.

14.5.2 Purpose

The intention of MEMO is to support the modeler in designing and analyzing enterprise models. The method's purpose on the one hand side is to promote communication and collaboration between the different participants in the model design and analysis process, which includes providing a common reference. On the other hand the model has to promote control and change, which refers to reliable development processes and adaptability to change in the modeling subject.

MEMO was developed in the context of information systems development and promotes the codesign of information systems or software systems as complex IT artifacts with the organizational system which has to be supported.

The codesign requires views and abstractions for the business professionals involved in the organizational system and the technology professionals engineering the software systems. These views and abstractions are accounted for in different perspectives of an enterprise model, which basically are represented in specific conceptual models. Thus, an enterprise model "comprises conceptual models of software systems (. . .) that are integrated with conceptual models of the surrounding action systems" (Frank 2013).

14.5.3 Elements of the Approach

MEMO consists of a high-level conceptual framework, domain-specific modeling languages, and methods and tools accompanying these languages. The high-level framework primarily consists of

- Perspectives offering a specific abstraction of the enterprise for a certain stakeholder group starting from the generic perspectives "strategy," "organization," and "information system," more specific perspectives for stakeholder groups can be developed
- Aspects, which are used to further detail the perspectives. Typical aspects are goal, process, structure, or resource.

Each perspective is associated with a set of domain-specific modeling languages (DSML) capable of expressing the aspects. The MEMO modeling language(s) are all specified with a common meta-modeling language, the MEMO MML, which leads to a language architecture: the meta-meta-model is used to define the meta-models for the domain-specific modeling languages for the different perspectives.

These DSML in turn is used to capture the actual conceptual models of the perspectives. Due to the existence of a meta-meta-model, other DSML can be defined which allows for adaptation to the modeling purpose at hand. The DSML defined by MEMO are the strategy modeling language SML, the organization modeling language OrgML, the goal modeling language GoalML, the IT infrastructure modeling language ITML, and the object-oriented modeling language OML. In addition to those, various language extensions exist, e.g., for modeling decision scenarios or IT security.

Method support in MEMO initially focused on information system development as a codesign activity with developing organizational structures and processes. During the last years, methods for specific purposes were added, like a method for IT management or IT audit risk management. The methods are described in separate publications.

The tool environment for MEMO is called MEMO center. It implements the MEMO language architectures and comprises a meta-model editor and an extensible set of model editors for DSML.

The meta-model editor does not only allow for specifying meta-models and corresponding notations. It also enables generating respective editors.

14.5.4 Model Example

This section will show two examples to illustrate the MEMO approach. As indicated above, MEMO includes the general possibility to define domain-specific modeling languages and four DSML are already defined as part of MEMO: the strategy modeling language SML, the organization modeling language OrgML, the IT infrastructure modeling language ITML, and the object-oriented modeling language OML The first example model addresses process modeling with MEMO. Within MEMO, process modeling is part of the organization modeling language (OrgML). Figure 14.27 shows a small process model in OrgML and Fig. 14.26 presents the modeling elements and symbols used in this small example. Regarding the modeling elements,

OrgML includes elements for modeling processes, events, exceptions, and control flows. The language distinguishes five different process types, three of which are shown in Fig. 14.26: the manual process (performed by a human actor without IT-support), the computer-supported process (performed by a human actor with IT-Support), and the automated process (performed by a computer). Additionally, OrgML also supports the process type "any process" (if the exact process type is not known) and any external process (performed by an external human actor or computer). With respect to events, the language allows for modeling events related to time aspects (point in time, time interval), change of information objects (create, modify, delete information object; unspecified change), and notification events related to human actors (asynchronous via traditional communication means or via electronic means, synchronous, not specified) or software (publish, poll, not specified).

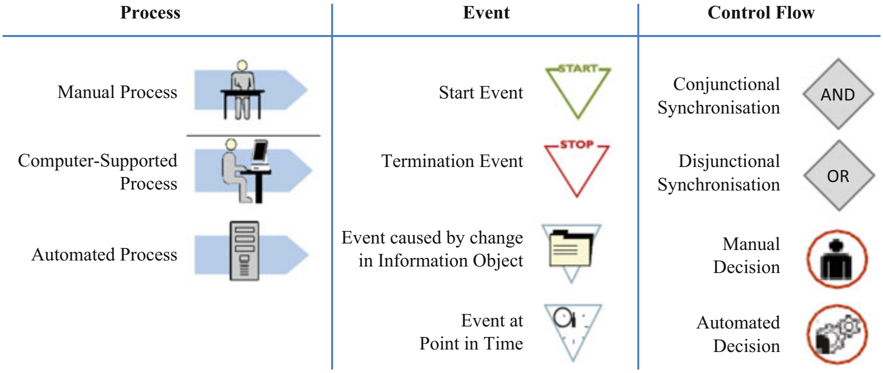


Fig. 14.26 Selected OrgML elements for business process modeling

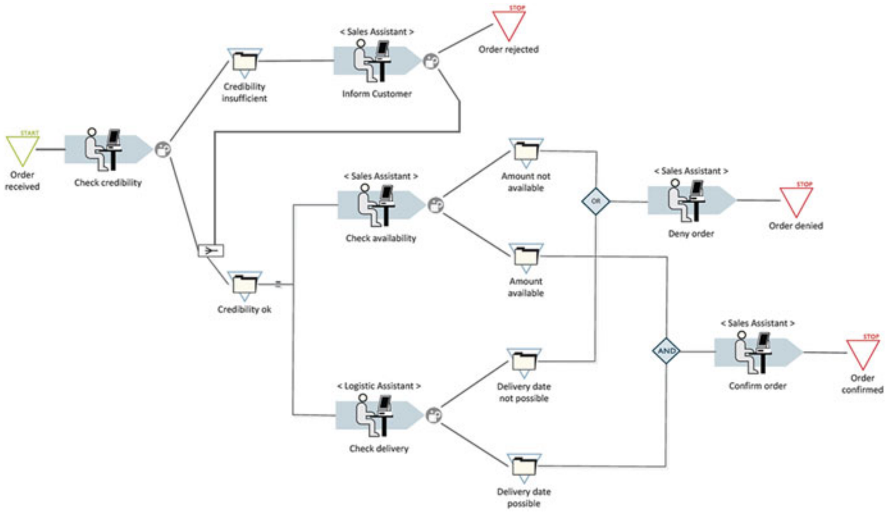


Fig. 14.27 MEMO example model “order process management”

The different aspects are represented in basic symbols which can be combined when modeling events. Due to the many different possibilities to combine time, change, and notification aspects, the language has 96 different event symbols. Four of these symbols are shown in Fig. 14.26: the start event (begin of a process), the stop event (end of a process), an event caused by a change in an information object, and an event caused at a point in time.

In order to model the control flow, the language allows for sequential flow of processes, branching in alternative flows, and concurrent flow of processes. Branching is modeled by using one of four different modeling elements indicating that an exclusive choice between the branches following the element has to be made. Figure 14.27 shows two of these elements: branching by “manual decision” (made by a human actor) and "automated decision" (made by an IT system). If parallel process flows were modeled or if branches of processes can run in parallel, synchronization of these concurrent paths is necessary. This is possible by using "AND" and "OR" modeling elements for conjunctive synchronization (all parallel paths have to terminate before the following process is started) or disjunctive synchronization (the following process is started after the first parallel process finished). Figure 14.26 does not show any symbols for exceptions, since there is no exception included in the example in Fig. 14.27. OrgML has three basic classes of exception (cause, effect, detection) with in total 11 basic exception types.

The business process shown in Fig. 14.26 describes an order process management which begins with the start event "order received." The following computer-supported process "check credibility" is followed by a manual branching decision where a human actor decides whether the credibility is sufficient or not. If the credibility is not sufficient, the upper path is taken: the "information change" event "credibility insufficient" (i.e., the decision is entered into a computer system which causes a change in the information object representing the customer's credibility) is followed by the process "inform customer" performed by the "sales assistant." This again results in a manual decision, which either leads to "order rejection" and the termination of the process or to the "information change" event "credibility ok." In the latter case, the process flow is merged with the alternative branch following the "check credibility" process at the beginning of the business process. In the remaining part of the example, the use of conjunctive and disjunctive synchronization also is illustrated.

The second example addresses modeling of organizational structures. Again, this is part of OrgML and illustrated in two figures: Fig. 14.28 shows selected elements of the graphical notation and Fig. 14.29 shows an example. The graphical notation includes elements for organization units, positions, and roles. Furthermore, relationships and interactions between organization units, positions, and roles can be expressed, and constraints can be defined.

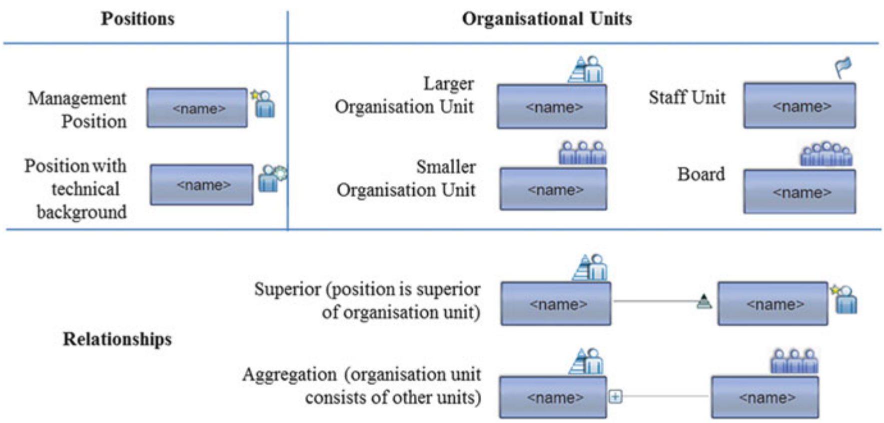


Fig. 14.28 Selected OrgML elements for organization structure modeling

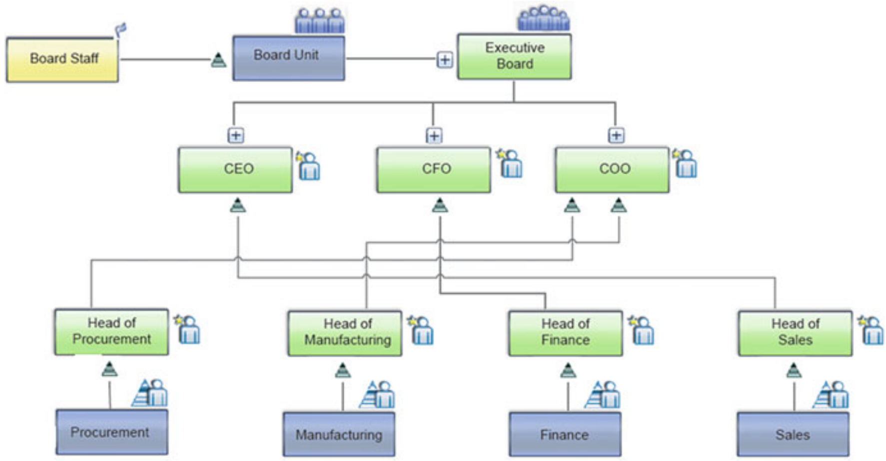


Fig. 14.29 MEMO example model "functional organization"

OrgML offers a rich set of elements for modeling organizational entities, which includes different symbols for positions, like positions with technical background, management positions, sales or procurement positions, etc., and for organization units, e.g., larger organization unit, smaller organization unit, staff unit, committee, and board (e.g., board of directors). These organizational entities can be connected with different types of relationships. Figure 14.28 shows the aggregation relationship and the "superior" relationship as examples. Furthermore, the symbols can be enhanced with information regarding the performance of the organizational entity or textboxes showing indicators.

The example in Fig. 14.29 shows a functional organization including the structure on management level. In this model, colors were used in order to visualize the different organizational levels. The smaller organization unit "board unit" is superior to the "board staff" and is part of the "executive board." The executive board, which is a "board" organization entity, also includes the three management positions CEO, CFO, and COO. CEO, CFO, and COO all are superior to other positions. The CEO is superior to the management position "Head of sales," to take one example. The "Head of. . ." positions are responsible for larger organization units each, e.g., the "Head of Sales" is responsible for the "Sales" organization unit. The more detailed inner structures of these larger organization units are not included in the example.

14.5.5 Perspectives

As already discussed above, perspectives are part of the overall MEMO framework and a key concept reflected in DSML in MEMO. However, when comparing with

Table 14.7 Comparison of 4EM perspectives and MEMO

4EM perspective	MEMO aspect or perspective
Goals and problems	Goal aspect (in strategy and organization perspective), GoalML as specific modeling language
Business processes	Process aspect (in strategy and organization perspective)
Actors and resources	Resource aspect and structure aspect (in strategy and organization perspective)
Concepts	Not explicitly defined. Can be included in DSML
Business rules	Not explicitly defined as aspect. Expressed in IS perspective
Technical components	Resource aspect and structure aspect (in IS perspective)

4EM, differences exist in the interpretation of the term perspective and the way it is used. In 4EM, a perspective is referring to a perspective on the enterprise, while in MEMO it is more the perspective of a specific model user group. These two interpretations are difficult to compare since the perspective on the enterprise potentially could also be the perspective or abstraction required for specific user group. However, the "aspects" of MEMO and the perspectives of 4EM seem to be quite close. Both modeling approaches consider goals, processes, and structures. MEMO's resource aspect is similar to resources in 4EM's actor and resource model. The following table compares the 4EM perspective with MEMO's aspects of comparable or similar meaning (Table 14.7).

It should be noted that MEMO's DSML provides more model component types than 4EM which gives MEMO more expressivity but makes the modeling languages more complex and more difficult to master.

14.5.6 Further Readings

Ulrich Frank summarizes MEMO and the underlying assumptions and thoughts in the following journal article:

- Frank U (2013) Multi-perspective enterprise modeling: foundational concepts, prospects and future research challenges, software and systems modeling. Online first (http://link.springer.com/article/10.1007/s10270-012-0273-9)

Reports describing the MEMO meta modeling language and the different DSML are available from the following URL: http://www.wi-inf.uni-duisburg-essen.de/FGFrank/

14.6 Open Model Initiative

14.6.1 Origin/History

The Open Model Initiative (OMI, http://www.openmodels.at) started in 2008 with a feasibility study for creating a community and platform willing to share models similar to open source in software engineering. The initiator and driving force of the Open Models Community was at that time Dimitris Karagiannis from the University of Vienna. Due to Karagiannis close relation to BOC Group, a company specialized in IT-based management solutions, BOC and its meta-modeling platform ADOxx have been supportive and linked to the initiative via the OMI Laboratory (OMiLAB, http://www.omilab.org) from the beginning.

The primary goal of the initiative is the "establishment of a community that deals with the creation, maintenance, modification, distribution, and analysis of models" (Karagiannis et al. 2008, p. 8).

14.6.2 Purpose

The open models initiative considers models a key means for knowledge intensive business. Sharing models and model content at the same time contributes to sharing knowledge captured in the models and helps to increase the level of productivity in knowledge intensive business since existing models can be reused or adapted which saves time and efforts.

The purpose of the initiative is not only to involve modeling experts but also users of models. With respect to the types of models, there is in principal no selection made. However, much effort of the initiative were spent on conceptual models, process, or enterprise models, which make the development relevant for this book. Since providing access to models free of charge often will not be sufficient for facilitating their reuse, knowledge about creation and use of knowledge and expertise regarding knowledge content and modeling languages are in the scope of the initiative.

14.6.3 Elements of the Approach

The core constituents of the Open Models Initiative are according to (Karagiannis et al. 2008, p. 25) the Open Model Community, Open Model Projects, and Open Model Foundations. These three topics are still reflected in the content of the Open Models Web site, which forms the open model community platform.

The community in autumn 2013 primarily consists of members from an academic context. The community has an inner organization structure and defined processes for its governance. It has a nonprofit organization structure.

Open Model Projects are targeting the development of models or reference models in a certain domain, and the development of modeling "infrastructure," which includes tools, templates, model transformers, etc. The open model foundations include modeling languages, procedures for model development and creation, and recommendations for environments or algorithms for model analysis and transformation. The results of open model projects can be accessed on the community Web site and often incorporate parts of the foundations developed.

With respect to modeling languages, the community supports existing modeling languages, like UML, ER, or EPC. A list of existing languages, the purpose of these languages, tool support, and further information is provided. Furthermore, creation, use, and distribution of domain-specific languages are supported. When it comes to modeling environments, the initiative promotes development and use of environments supporting collaboration between different modeling experts and users. The community platform provides among other functionality to navigate, browse, and retrieve models also a model repository.

14.6.4 Model Example

For the Open Model Initiative, we will not include example models, since the objective is not to promote a specific modeling language or notation, but to share models and model content from various modeling approaches. The current status is available at (OMI 2014), presenting 25 modeling methods, which have been conceptualized, developed, and deployed by different research groups, located in 18 universities on four different continents.

14.6.5 Perspectives

Since the Open Model Initiative includes different models and modeling procedures, it is not possible to compare open models in general with 4EM. For this book, we downloaded and examined several modeling method implementations of the community Web site. It showed that the methods usually did not follow the method understanding introduced in Chap. 3; rather, tool support for modeling specific aspects of an enterprise and instructions how to use this tool support is available. A selected example, a language for modeling IT security, is implemented on ADOxx (Fill and Karagiannis 2013), and is available for download on the community Web site (Table 14.8).

14.6.6 Further Readings

The Open Model Community Web site (http://www.openmodels.at/) provides access to existing literature about the initiative. The "Feasibility Study" report is

Table 14.8 Comparison of 4EM perspectives and OMI

4EM perspective	Open modeling language examples supporting the 4EM perspectives
Goals and problems	
Business processes	EPC
Actors and resources	To some extent supported in EPC
Concepts	UML and ERM
Business rules	UML (e.g., using OCL)
Technical components	To some extent supported in EPC

a good source for learning more about the motivation and background of the Open Model Initiative:

- Karagiannis D, Grossmann W, Höfferer P (2008) Open model initiative—A feasibility study. University of Vienna, September 2008. Available at: http://cms.dke.univie.ac.at/uploads/media/Open_Models_Feasibility_Study_SEPT_2008.pdf
- Open Model Initiative (2014) Open model laboratory booklet. University of Vienna. Available at: http://www.omilab.org/web/user/booklet/
- Fill H-G, Karagiannis D (2013) On the conceptualization of modelling methods using the ADOxx meta modelling platform. Enterprise Model Inform Syst Architect 8(1); 4–25

Chapter 15
Frameworks and Reference Architectures

Within the field of Enterprise Modeling, substantial work has been spent on defining frameworks and architectures. In comparison to EM methods (see Chap. 14), frameworks and architectures do not focus on procedures for the actual modeling process, notations, or modeling languages, but they address the modeling domain or the results of the modeling process.

Most frameworks were developed within a specific application domain or for an enterprise function and structure this domain and function. Typical organizational structures and process areas, important concepts, or building blocks of enterprises or solution are identified and described, documented, and made available as templates or generic models. The intention is to make those elements of previous modeling projects available and reusable, which are not specific for a single enterprise, but general for a whole industry domain or for an enterprise function.

Architectures typically focus on building blocks and their relationships, while frameworks can have different ambitions, like combining architectures with design or modeling procedures or reusable models or model fragments with the way of developing them into a specific solution. Both approaches have in common that they have to be adapted for the modeling project or the enterprise under consideration, i.e., they are rather a rough blueprint than a ready-made solution.

Frameworks and architectures are part of this book, since they might be useful in different phases of an EM project. Depending on the intention and the purpose of the project, frameworks and architectures could be used:

- In the scoping phase to help structuring the overall application domain and identify, together with the stakeholders in the enterprise, which areas to focus on
- When designing the "to be" situation to identify potential best practices in the domain or to get inspiration for how to structure the overall field
- In the analysis phase to reuse proven definitions of general concepts in the domain, as long as they fit to the understanding in the enterprise under consideration.

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_15

It should be noted that identifying and understanding the problem to be solved by an EM project usually is not supported by frameworks and architectures, i.e., understanding problems and issues to be considered is prime and should come first. Selecting and using frameworks or architectures from the domain can be recommendable, but should be the second step.

From the many existing frameworks and architectures, only a few will be discussed in this section:

- *The Zachman framework*—a framework providing support to analyze enterprises which during many years was very popular in industry,
- *GERAM*—an approach which combines different industrial reference architectures to a generalized framework,
- *TOGAF*—the open group architecture framework.

We will give TOGAF more room in this chapter than Zachman's framework and GERAM, since the interest in TOGAF in industry, the public sector, and academia seems to be significantly higher than for the other two approaches. Many more exist and are covered in the literature, like, e.g., DoDAF (Department of Defense 2007) or MODAF (Ministry of Defense 2008).

15.1 The Zachman Framework

The Zachman Framework for enterprise architecture was proposed by John A. Zachman, a former IBM employee, who developed the framework as tool to help analyze enterprises or parts of enterprises. The core idea of the analysis tool is that the complexity of an enterprise can be more easily analyzed and captured if you use the different perspectives of the stakeholders interested in the analysis result and if you classify the enterprise information according to the content of the analysis subject. This idea resulted in a two-dimensional matrix consisting of perspectives and subject classifications, called "abstractions", which can be used to guide the analysis work. Furthermore, the matrix also provides a classification scheme for what Zachman calls "descriptive representations of an enterprise" (Zachman 1987).

The perspectives distinguished in Zachman's framework are depicted in Fig. 15.1:

- *The owner's perspective*. The owner in this context either is the owner of the enterprise under consideration or the recipient of the end product produced. The latter is relevant if an organization form is considered where many partners jointly produce a complex product, like a consortium of partners producing a ship.
- *The designer's perspective*. The "descriptive representations" in this perspective are meant to form the basis for implementing what is desired by the owner, i.e., the intermediary between owner's and builder's perspective. In an enterprise,

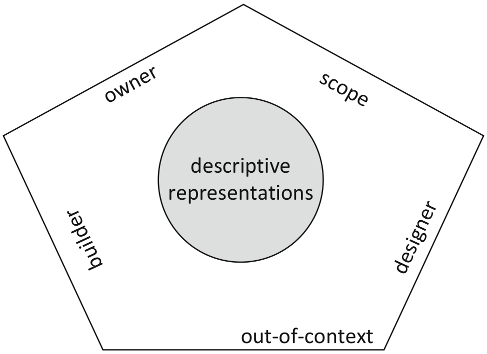


Fig. 15.1 Descriptive representations of Zachman's framework according to (Zachman 2003)

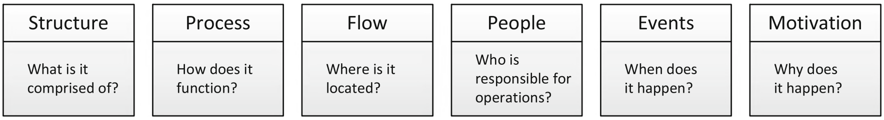


Fig. 15.2 Abstractions of Zachman's framework according to (Zachman 2003)

this usually is the systematic and conceptual design of the administrative, manufacturing, and management processes and structures.

- *The builder's perspective*. This perspective captures how the design perspective actually is to be implemented, which takes into account existing technical or organizational constraints.
- *The scope perspective* establishes the inner and outer limits of what has to be considered in the other perspectives, i.e., what has to be subject of the descriptive representations and what is beyond the limit.
- *The out-of-context perspective* captures aspects out of the context of the enterprise or product modeled but still in the scope of the modeling project. In an enterprise, this could be the actual physical products manufactured, in contrast to the design and manufacturing processes and blueprints of these products which would be subject of the designer's and builder's perspective.

With the above perspectives as one dimension, the "abstractions" are the second dimension of the framework (see Fig. 15.2) and structure the different characteristics and aspects required to describe the subject under consideration:

- What the subject or object under consideration is comprised of
- How it works, i.e., the specification of a process or of the functionality
- Where the subject or its components are located, i.e., the spatial dimension
- Who is responsible for what and who performs which work
- When activities or events happen in relation to each other
- Why things happen or are performed in the enterprise. This motivational dimension usually relates to the strategy

Zachman describes the perspectives and abstractions as primitive and comprehensive in the sense that each abstraction and each perspective is different from each of the other ones and that no other perspectives and abstractions are needed to provide a complete knowledge base about the enterprise. For the single cells of the matrix generic models are available which have to be specialized for the enterprise under consideration. If different levels of detail are required, they have to be modeled within the different cells of the matrix, i.e., the columns are not intended to and do not provide a possibility to model different levels of detail.

In Enterprise Modeling, the Zachman framework can be used as a general guideline what to consider in order to not forget certain aspects. However, it implies an ambition to reach a certain level of completeness, which is not required for all EM purposes.

The framework has been very popular and widely used in the first decade of the 2000s. Judging from the decreasing number of publications and experience reports, it nowadays is no longer so widely used. One reason for this might be that Zachman's framework formed the basis for the *Technical Architecture Framework for Information Management (TAFIM)* developed by the US department of defense in 1994. TAFIM later formed one of the starting points for TOGAF (see Sect. 15.3) which now is widely used in industry and which somehow replaced Zachman's framework.

Further readings regarding the Zachman Framework is available on the Web site http://www.zachmaninternational.com.

15.2 GERAM

The IFAC/IFIP task force on architectures for enterprise integration produced in 1998 the Generalized Enterprise Reference Architecture and Methodology (GERAM) (Williams 1995). GERAM was based on a number of previous developments which complemented each other:

- CIMOSA (Computer Integrated Manufacturing Open System Architecture) has been developed in a European project and aims to support the enterprise integration. This architechture is based on the system life cycle concept, and offers a modeling language, methodology, and supporting technology.
- GRAI is a methodology which was developed at the University of Bordeaux in the 1990s. The methodology includes a graphical modeling technique and considers an organization as a complex system consisting of three subsystems: the decision subsystem, the information subsystem and the physical subsystem.
- PERA is a methodology originating from Purdue University (USA) and includes a generic list of tasks in a manufacturing plant and a hierarchical functional framework for relating them to each other.

The intention of GERAM was to combine the above described industrial reference architectures to a generalized framework with all components needed for

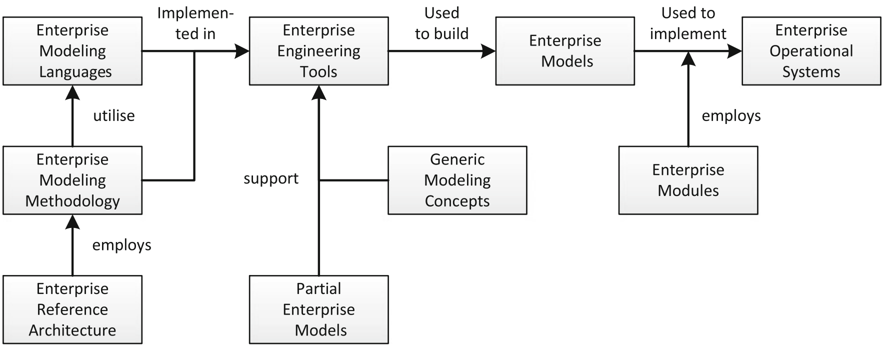


Fig. 15.3 Overview to GERAM components (Lillehagen and Krogstie 2008)

enterprise engineering and enterprise integration. "Enterprise engineering" as a term indicates that GERAM is part of an industrially driven initiative which considers enterprises as complex systems that can be "engineered" in a similar manner as complex products, i.e., for well-known problems or tasks in an enterprise, the processes and structures for solutions to these problems and tasks can be predefined and captured as models. These models and their implementation in real-world systems form "components" representing the knowledge about an enterprise in a certain domain that can be reused if changes in the enterprise or integration with other enterprises need to be implemented.

The GERAM framework consists of eight elements depicted in Fig. 15.3. These elements are:

- *The GERA analysis and modeling framework*: this framework defines three dimensions for identifying scope, subject, and content of Enterprise Modeling: lifecycle, instantiation (level of abstraction), and view. The lifecycle dimension in GERA consists of the phases identification, concept, requirements, (preliminary and detailed) design, implementation, operation, and decommission. The instantiation dimension basically defines different levels of abstraction, which are generic, partial, and particular. The view dimension includes views regarding the purpose of the activity (e.g., customer service, management, and control), the model content (resource, information, organization, function), the physical manifestation (e.g., software, hardware), and the means of implementation (human, machine). When using these dimensions, enterprise modelers and enterprise model users are supported in defining the scope of a modeling project by selecting which aspects of the different dimensions are required, in systematically modeling the defined scope, and in structuring the modeled knowledge about the enterprise.
- *Enterprise Engineering Methodology*: the methodologies provided by GERAM are meant to describe the process to be performed for every aspect of the lifecycle dimension in a generalized way. The methodologies are supposed to be applicable regardless of the industry domain concerned and support their

users in the process of enterprise engineering and integration, both for management-related and engineering-related aspects.

- *Enterprise Modeling Languages:* modeling languages define the constructs and the notation to be used for expressing enterprise models (see also Sect. 3.1)
- *Generic Enterprise Modeling Concepts*: concepts frequently used in Enterprise Modeling, engineering, and integration should be consistent throughout the different activities. In case these concepts are generic, i.e., not specific for a certain enterprise only, they should be defined once in order to allow for reuse. Potential ways to define generic EM concepts are glossaries, meta-models, and ontologies. GERAM recommends to use meta-models for generic concept definition.
- *Partial Enterprise Models* capture concepts of certain aspects of GERA that are common to many enterprises. These partial models can be considered as reusable parts or even reference architecture which can speed up the modeling process by reusing these proven models if suitable for the enterprise under consideration.
- *Enterprise Engineering Tools* support the process of the different activities in enterprise engineering and integration, i.e., analysis, design, reuse, and use of enterprise models.
- *Enterprise Modules are building blocks or systems* implemented in an enterprise, which can be accessed and utilized in an enterprise or offered as resources on the market. Often, these enterprise modules are implementations of partial enterprise models.
- *Enterprise Models* capture selected aspects of an enterprise in a model (see also Sect. 3.1) in a defined EM language.
- *Enterprise Operational Systems* usually consist of the hardware and software required for operations in a particular enterprise, i.e., they are platform supporting operations in an enterprise.

15.3 TOGAF

The purpose of this section is to give a brief view on TOGAF 9.1, an architecture framework, which originally established in the 1990s and since then evolved as a leading standard for developing an Enterprise Architecture (EA). More than 100,000 downloads, 16,000 certified practitioners, 220 corporate members are in touch already with the TOGAF Framework since 2011 (Weismann 2011).

The section is structured as follows: Section 15.3.1 presents briefly the relationship between Enterprise Modelling and EA and describes what TOGAF is, where it has its origins, and how it evolved over time. Section 15.3.2 focuses on EA and on how TOGAF interprets and defines this term. The main components of TOGAF are presented in Sect. 15.3.3 with focus on the Architecture Development Method (ADM) and the Enterprise Continuum. Finally, a summary of the main characteristics of TOGAF is included.

15.3.1 Enterprise Modeling and TOGAF

Business and IT stakeholders in a company have different views of the enterprise and, therefore, different viewpoints on its architecture (Glissmann and Sanz 2011). Consequently, special techniques for describing enterprise architectures (EA) in a coherent way and communicating them with all relevant stakeholders are necessary in order to create an integrated perspective of the enterprise. EA models support bridging the communication gap between enterprise or IT architects and stakeholders from business [5]. In general specific EA models are used to map architecture descriptions that represent different and/or partial views of the whole EA. For instance, 4EM can be used just for specifying important goal components to get an overview about the enterprise strategy as well as 4EM can be used to model problem issues like described in the case study (see Chap. 6).

TOGAF stands for The Open Group Architecture Framework and presents a "comprehensive architecture framework and methodology, which enables the design, evaluation, and implementation of the right architecture for an enterprise" (The Open Group 2011). It provides methods, tools, and best practices to support the "acceptance, production, use, and maintenance of an enterprise architecture" (The Open Group 2011), which can be customized to and implemented in different companies for their needs.

The original version of TOGAF, Version 1, was introduced in 1995 by the US Department of Defense Technical Architecture Framework for Information Management (TAFIM). After that the Department of Defense gave The Open Group the permission to take over the further development of the framework. Since then, more than 300 member organizations of The OpenGroup's Architecture Forum are constantly working on TOGAF, adding new features and concepts.

TOGAF did not always focus on EA. Initially, it included only technical architectures (Version 1–7). With the release of Version 8, called Enterprise Edition, it also began to cover the business architecture domain. The latest version, TOGAF 9.1, was launched in December 2011. All related documentation about TOGAF can be obtained from The Open Group Web site, so that the usage is encouraged (Harrison and Varveris 2004).

TOGAF has two main components. The first core component is the Architecture Development Method, or the ADM for short, which defines iterative processes for developing and maintaining an organization's enterprise architecture. The Enterprise Continuum is the second core component to TOGAF. It describes a collection of reusable assets, called building blocks, which supply architects with reference architectures, models, and processes, which can be adopted to create new architectures (Temnenco 2007).

15.3.2 Enterprise Architecture Management in TOGAF

Before characterizing the four types of architectures, which TOGAF deals with, it is essential to define how to understand the architecture concept. “An architecture is a fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principle guiding the organization’s design and evolution” (Lankhorst et al. 2009). Lankhorst describes architecture in an analogy:

> *“Suppose you contract an architect to design your house. You discuss how rooms, staircases, windows, bathrooms, balconies, doors, a roof etc. will be put together. You agree on a master plan, on the basis of which the architect will produce detailed specifications, to be used by the engineers and builders. How is it that you can communicate so efficiently about that master plan? We think it is because you share a common frame of reference: you both know what a “room” is, a “balcony”, a “staircase” etc. You know their function and their relation. A “room” for example serves as a shelter and is connected to another “room” via a “door”. You both use mentally an architectural model of a house”* (Lankhorst et al. 2009).

No common definition of the term EA has emerged yet. It depends on the different point of views. Thus it is mainly related to IT Architecture focusing on creating and using IT systems as well as Business Architecture, which concentrates on achieving the business strategy by specific, suitable actions (Aier et al. 2008). EA is the idea of modeling the elements, roles, responsibilities, and systems, as part of the enterprise infrastructure, and their relations. In this sense the capture of all behavior that goes on in an organization including processed data, shared tasks such as who does what, why everything is done, and where everything is (Harrison and Varveris 2004). It is a coherent whole of principles, methods, and models that are used in the design and the realization of the enterprise organizational structure (Lankhorst et al. 2009).

There are four architecture domains that are accepted as subsets of an EA (Fig. 15.4) and TOGAF is designed to support all of them.

The Business Architecture defines the business strategy, governance, organization, and key business processes. This architecture addresses the concerns of the users, planners, and business managers (Glissmann and Sanz 2011). The Data Architecture describes the structure of an organization’s logical and physical data assets and data management resources . Its objective is to define the major types of data, necessary to support the business. This architecture addresses the concerns of database designers and administrators (Glissmann and Sanz 2011). In some organizations, Data Architecture is also called Information Architecture. The Application Architecture provides a blueprint for the individual application systems to be deployed, for their interactions and their relationships to the core business processes

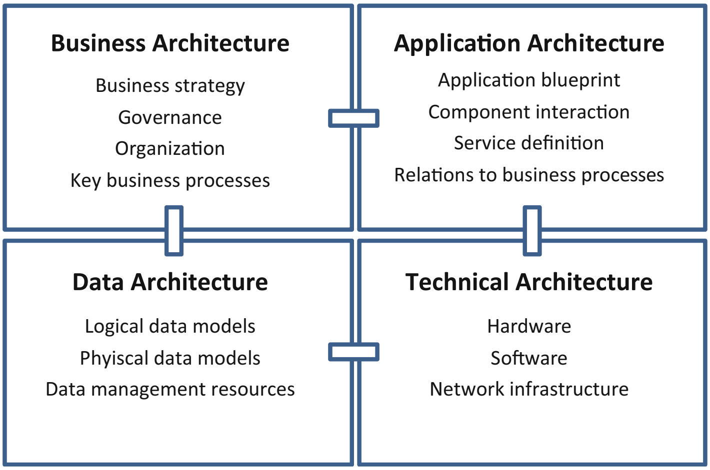


Fig. 15.4 TOGAF architecture domains

Table 15.1 Summarized architecture types supported by TOGAF (The Open Group 2011)

Architecture type	Description
Business architecture	The business strategy, governance, organization, and key business processes
Data architecture	The structure of an organization's logical and physical data assets and data management resources
Application architecture	A blueprint for the individual applications to be deployed, their interactions, and their relationships to the core business processes of the organization
Technology architecture	The logical software and hardware capabilities that are required to support the deployment of business, data, and application services. This includes IT infrastructure, middleware, networks, communications, processing, and standards

of an organization. The Technology Architecture describes the physical realization of an architectural solution. The logical software and hardware capabilities, which are required to support the deployment of business, data, and application services, are also defined in this dimension. The four architechture types are summarized in Table 15.1.

Those four dimensions are intimately connected through the relationships between the individual meta-model elements. For instance, a data entity (DA) is used by a logical application component (AA), which is used by an actor in a business process to meet business objectives (BA). TA supports the application component (Glissmann and Sanz 2011).

The idea of Enterprise Architecture Management (EAM) includes the planning, transforming, monitoring, and improvement of the different architecture levels. In this context, the Enterprise Architecture (EA) serves as map with information of the current situation of its elements and dependencies. There is a variety of reasons for implementing EAM:

- It supports delivery of the business strategy
- It facilitates management and exploitation of information is key to business success and competitive advantage
- It facilitates management of stakeholder concerns that needed to be addressed by IT systems
- It enables management of complexity and changes to business/IT
- It enables the right balance between IT efficiency and business innovation
- It improves transparency and manage risks

TOGAF also helps implementing a strategy oriented control of the different architectural levels, which enables economic success.

15.3.3 Components of TOGAF 9.1

TOGAF 9.1 consists of seven parts presented in the following parts of this section.

15.3.3.1 Part 1: Introduction

The first part of the TOGAF framework involves the introduction the EA key concepts. Therefore, it contains the definitions of terms used throughout TOGAF and release notes detailing the changes between the different versions of TOGAF. Questions like “What is an enterprise? Why do I need an enterprise architecture? Why do I need TOGAF as a framework for enterprise architecture?” will be answered in this section.

15.3.3.2 Part 2: The Architecture Development Method

The architecture development method (ADM) is a step-by-step approach to develop and use an EA. The main purpose of the approach is to help to derive a specific architecture from a set of common architectures to meet the business requirements of an enterprise (Josey et al. 2009). The ADM supports the development of an architecture in the four different domains (business, application, data, and technology), described in the previous section. It consists of ten consecutive phases (see Fig. 15.5) enclosed in a loop (Temnenco 2007).

Each phase has an input, an output, which at the same time serves as an input for the next following phase, and a number of steps. In the following these phases will be described briefly:

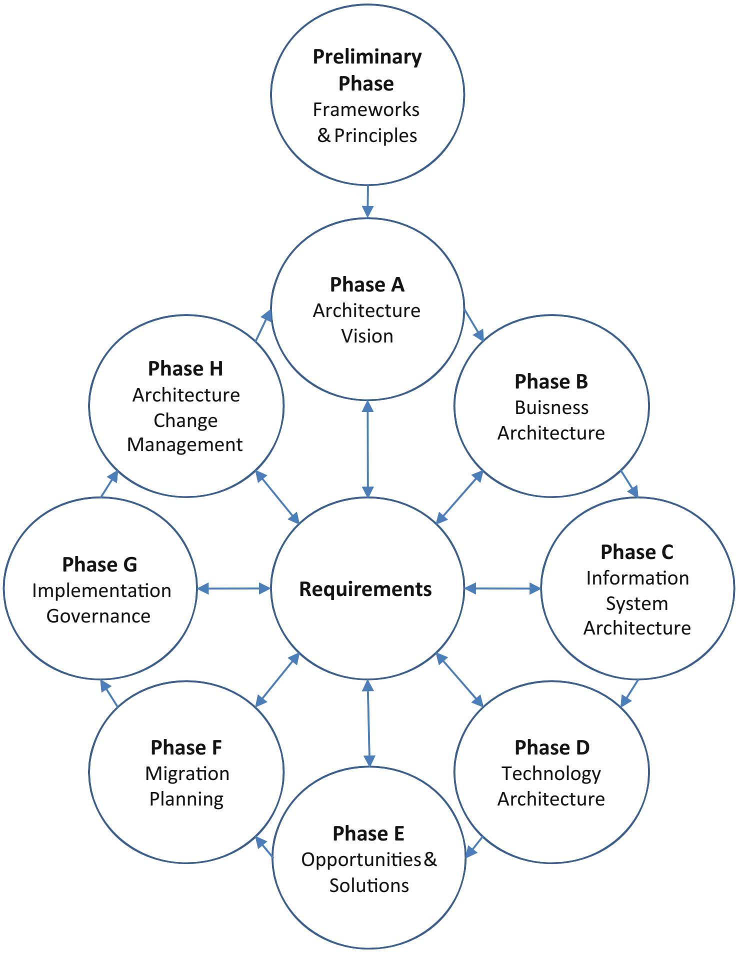


Fig. 15.5 The architecture development method cycle (The Open Group 2011)

- *Preliminary Phase:* The main goal of this phase is to prepare the organization and get the stakeholders ready for a successful TOGAF project. Typical steps of this phase are defining the scope of the enterprise, establishing the team and the organization, and determining the architecture principles.
- *Phase A:* Architecture Vision: Phase A is dedicated to articulating the EA vision and principles, and presents the initial phase of the architecture development cycle. Its most crucial objectives are to obtain a management commitment for this particular cycle of the ADM and to validate business principles, goals, and key performance indicators. During the preliminary phase and Phase A, it must be clarified, how much information will be captured, how it will be maintained, what notations or methods are used to build the enterprise models.

- *Phase B:* Business Architecture (BA): Phase B describes the current and the target business architecture and tries to determine the gap between these two. The motivation for developing a BA is to support the Architecture Vision which was agreed upon in the previous phase. Adequate tools which can be applied in this phase in order to develop the required models are, e.g., BPMN and UML (Harrison and Varveris 2004).
- *Phase C:* Information Systems Architectures: Phase C focuses on the Information Systems Architectures, which comprise the Data and Application Architectures. These architectures can be developed either sequentially or concurrently (Josey et al. 2009). In this phase, business-supporting data types and sources are to be described in such a way that the stakeholders understand them. Henceforward, the application systems, which can process the data, are to be defined.
- *Phase D:* Technology Architecture: Phase D deals with documenting the organization of the IT Systems, embodied in the enterprise hardware, software, and communication technology. The completion of Phases B and C is a prerequisite for moving on to Phase D. The development of all four architecture domains are covered after the Phases B, C, and D are finished.
- *Phase E:* Opportunities and Solutions: Phase E is the first phase, which is directly concerned with implementation (Josey et al. 2009). It has two main purposes—to clarify the opportunities presented by the target architectures, which have been identified in previous phases, and to outline the potential solutions. The important outputs of this phase are a major implementation project and an updated Application Architecture which can serve as a blueprint to be used by future implementation projects.
- *Phase F:* Migration Planning: The proposed implementation projects need to be prioritized so that a detailed planning can be performed. In this phase the enterprise knows how to move from the baseline to the target architecture by finalizing a detailed Implementation and Migration Plan. The blueprint, developed in the previous phase, is also handed over to the implementation teams.
- *Phase G:* Implementation Governance: In phase G, the projects are started as a planned program of work that is accompanied by implementation process oversights.
- *Phase H:* Architecture Change Management: Phase H provides a change management process to ensure that the designed architecture corresponds to the needs of the enterprise. If the enterprise needs change then these changes will be realized in the architecture in a controlled and procedural manner. Phase H can also result in a request for a new architecture framework and, if so, another cycle of the ADM is initiated.
- *Requirements Management:* The Requirements Management process applies to all phases of the ADM cycle because TOGAF is a requirements-centric approach (Temnenco 2007). Generally, architecture deals with change and uncertainty in requirements, since it bridges the gap between the expectations of the stakeholders and delivered solutions. That is why Requirements Management has a central meaning to TOGAF. This phase defines and stores all types of requirements, and feeds them in and out of the relevant ADM phases (Josey et al. 2009).

15.3.3.3 Part 3: ADM Guidelines and Techniques

This part provides a set of guidelines and techniques to support the application of the ADM. It deals with different scenarios, including different process styles (e.g., the use of iteration) and also specific requirements (e.g., security). The techniques support specific tasks within the ADM (e.g., defining principles, business scenarios, gap analysis, migration planning, risk management, etc.).

According to (The Open Group 2011; Keller 2012) the third part deals with the following issues:

- Using ADM as a cyclic process. This is about managing iteration and the potential strategies for applying iterative concepts to the ADM.
- Applying the ADM across the Architecture Landscape. It is about the different types of architecture engagement that may occur at different levels of the enterprise. It is also about how the ADM process can be focused to support different types of engagement or levels of granularity.
- Doing security engineering while using TOGAF. An overview of specific security issues that should be considered during different phases of the ADM is provided as well as aspects of using TOGAF for SOA support, stakeholder management, or architecture patterns.

15.3.3.4 Part 4: Architecture Content Framework

The Architecture Content Framework provides a detailed structural model for architectural content that allows the major work products including deliverables and artifacts within deliverables that an architect creates to be consistently defined, structured, and presented in Architecture Building Blocks (ABBs). The fourth part supports the following aspects:

- Increasing the consistency in the outputs of TOGAF.
- Providing a comprehensive checklist of architecture outputs.
- Promoting better integration of work products.
- Providing a detailed open standard for how architectures should be described.
- Including a detailed meta-model (see Fig. 15.6)

15.3.3.5 Part 5: Enterprise Continuum and Tools

The Enterprise Continuum (EC) is “a categorization mechanism useful for classifying” all assets relevant to an enterprise. The result of its practical implementation is an Architecture Repository which presents a collection of “reference architectures, models, and patterns that have been accepted for use within the enterprise”

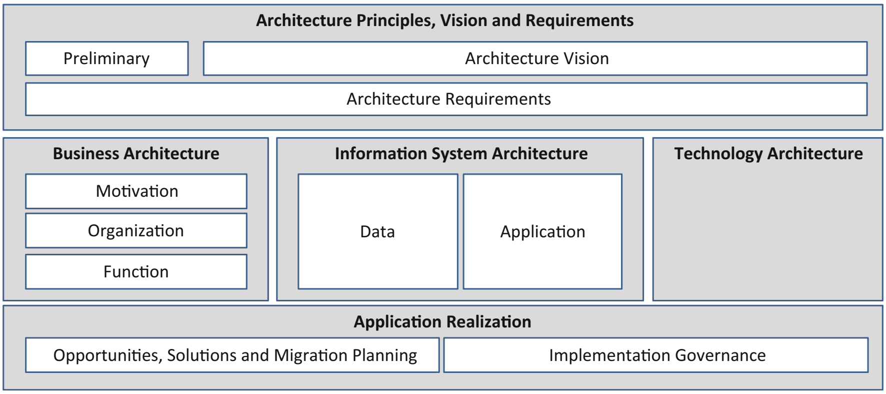


Fig. 15.6 Content meta-model (simplified) (The Open Group 2011)

(The Open Group 2011). The EC focuses strongly on the two ideas of reusability and understandability.

Reusability is achieved through the concept of the building blocks. A building block (BB) is "a (potentially reusable) component of business, IT, or architectural capability that can be combined with other building blocks to deliver architectures and solutions" (The Open Group 2011). The delivered architectures and solutions can then be used in two directions: (1) the general ones can be adapted to fulfill specific needs and (2) the specific ones can be generalized for further reuse.

The idea of understandability is achieved through two concepts. The first one is the concept of sequentially moving from generic to specific, from abstract to concrete, which helps everybody involved in the architecture development process to understand where exactly they are in the continuum and which type of architecture is currently in focus. The second concept is the separation between architectures and solutions—the EC is divided into two continua, the Architecture Continuum and the Solutions Continuum.

The Architecture Continuum (AC) is "a repository of architectural elements with increasing detail and specification" (The Open Group 2011) and has four states: foundation architectures, common systems architectures, industry architectures, and organization-specific architectures.

Foundation Architectures present architectures of building blocks and corresponding standards that support all the Common Systems Architectures and, therefore, the complete enterprise operating environment.

Common Systems Architectures are architectures of particular problem domains within an organization. Examples of such architectures are security architectures, management architectures, network architectures, etc.

Industry Architectures are architectures that integrate common systems with industry-specific components to create solutions to problems within a particular industry. Such architectures contain industry-specific logical data, industry-specific process models and applications, and industry-specific business rules.

Organization-Specific Architectures contain organization-specific business models, data, applications, and technologies. They reflect requirements and define BB specific to a particular enterprise, and provide the criteria to measure and select appropriate products, solutions, and services.

The Solution Continuum (SC) provides particular solutions to implement the corresponding architectures from the AC.

Therefore, the SC has also four states as the AC: Foundation Solutions, Common Systems Solutions, Industry Solutions, and Organization-specific Solutions.

The solutions are developed with the help of Solution Building Blocks (SBB), which, just as the ABB, increase in detail and specification in each state.

The SBB include concepts, tools, products and services such as programming languages, operating 10 systems, ERP-Systems, IT Organization-Management standards and principles such as ITIL, and others.

15.3.3.6 Part 6: TOGAF Reference Model

Part 6 of the TOGAF Framework provides two reference models:

1. The Foundation Architecture/ Technical Reference Model (TRM)
2. The Integrated Information Infrastructure Model (III-RM).

The foundation architecture provides an architectural approach of generic services and functions which should support building more specific architectures and architectural components. The foundation architecture is embodied within the universally applicable TRM that represents a model and taxonomy of generic platform services (Fig. 15.7).

The III-RM is defined as a subset of the TRM in terms of its overall scope. It supports the design of an integrated information infrastructure by defining a taxonomy concept and associated visual representation of the interrelationship of its components. According to (The Open Group 2011) the main objective of the TOGAF TRM is the allocation of a widely accepted core taxonomy and an appropriated visual representation of them.

15.3.3.7 Part 7: Architecture Capability Framework

This part discusses the organization, processes, skills, roles, and responsibilities required to establish and operate an architecture practice within an enterprise as well as provide guidance on establishing an operational practice. In order to achieve TOGAFs view on successfully operating architecture functions, it is necessary to put in place appropriate organizational structures, processes, roles, responsibilities, and skills to realize the Architecture Capability. In this section of the TOGAF Framework, a set of reference materials for how to establish such an architecture

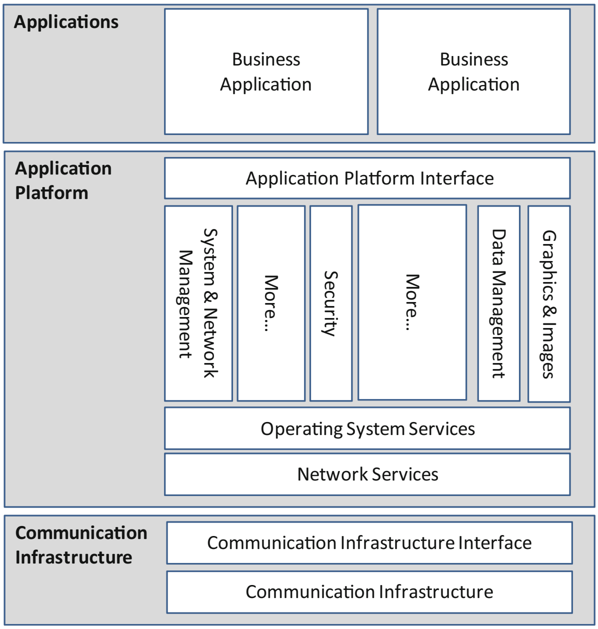


Fig. 15.7 TRM overview (simplified) (The Open Group 2011)

function is presented. The Architecture Capability Framework is not intended to be a comprehensive template for operating an enterprise Architecture Capability; it provides a number of guidelines to support key activities (The Open Group 2011).

15.4 Summary

This session introduced TOGAF—The Open Group Architecture Framework in its latest version, Version 9.1. It gave a brief insight into components of TOGAF where the ADM is the very core of TOGAF. TOGAF covers the whole lifecycle of EA and EAM—from the idea, covered in the Architecture Vision (Phase A), to the control of changes, handled in the Architecture Change Management (Phase H).

In addition to this, through the Requirements Management, new external drives, especially business strategies and requirements, can be added to the architecture during the whole lifecycle. The EC presents a virtual repository of architecture assets which evolve from generic to specific and can be adopted to develop a target architecture by starting with a common architecture and finishing with one, specific to the organization.

TOGAF provides a very interesting approach to EA and EAM which can help solve many different problems in an organization. It has the potential to help organization to deeply examine their organization, to understand how it currently operates, and to define how it must function. It encourages stakeholders and management to work together in order to achieve the desired organization. However, TOGAF is a very complex framework and its use requires thorough preparation. Only reading its documentation and visiting several workshops will not sufficiently prepare for dealing with TOGAF. This view is also shared in (Sessions 2007). There the author argues that TOGAF focuses on how to develop an EA and not on how to develop a good one. Therefore, the final architecture can either be good, bad, or indifferent. The result completely depends on the knowledge and skills of the TOGAF architects.

In addition, it is recommendable for TOGAF users to find access to communication platforms, where they can exchange knowledge, thoughts, ideas, and experience with others on different EA and TOGAF matters.

Chapter 16
Outlook

This book focuses on the fundamentals of Enterprise Modeling and has, in the preceding chapters, dealt with such topics as elicitation approaches, tools, quality aspects, and the 4EM method as a practical approach. However, the field of Enterprise Modeling is considerably broader than is possible to cover fully in an introductory book. This chapter is intended to provide an overview of a range of issues and additional content, including further technical aspects, additional ways of using models, and fields of application for Enterprise Modeling.

16.1 Further Technical Aspects

Several technical aspects of Enterprise Modeling could only be touched upon in this book, and not dealt with in full. These include meta-modeling, additional possibilities for quality assessment, and specific modeling tools.

Put simply, meta-models are descriptions of modeling languages. The technique of meta-modeling deals with developing modeling languages or adapting existing languages. Modeling language development aims to provide the necessary model components, symbols, and views for particular domains or requirements in a well-defined language. These special languages, also known as domain specific languages (DSLs), are intended to facilitate modeling and model comprehension for domain experts from the respective domain by providing only the modeling types and views that are needed. An example of this would be a specific language for public administration, which distinguishes "procedures" instead of "processes" and does not require component types for modeling product structures. The disadvantage of DSLs is that tool support for languages of this kind is often not as good as for general and more widely used languages. Meta-modeling to adapt existing languages frequently aims only at altering the symbols for individual component types or to modify the component type attributes. In this case, the properties of the original language are not fundamentally changed, and the tools can continue to be

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4_16

used. Further literature on meta-modeling can be found in scientific journals or conference proceedings, such as the International Conference on Model Driven Engineering Languages and Systems (MODELS),[1] IFIP WG8.1 Working Conference on the Practice of Enterprise Modeling (PoEM),[2] the International Conference on Business Process Management (BPM)[3] conference proceedings, as well as the journal "Business & Information Systems Engineering".[4]

With regard to assessing the quality of enterprise models, Chap. 11 of this book particularly dealt with modeling tips and practices, such as generally accepted modeling principles. However, there are also numerous other works that consider both the quality of models themselves and the quality of their use. A number of metrics for measuring the quality of models were suggested to help assess their complexity, completeness, comprehensibility, correctness, or maintainability. A summary of such metrics for process models can be found, for example, in (Mendling 2008). When using metrics of this kind, it is important to be aware that the measurements provide only indications as to quality, and do not by any means definitive statements, as ultimately the intended use and modeling object are key.

There are also a number of developments for evaluating the quality of models during their use. These consider how suitable the model is for the planned purpose from a usage perspective, how complex or efficient the model is to use, what errors or extensions are found when using the model, or how useful a model is compared to the time spent creating it. The SEQUAL framework (Krogstie 2012) is an example of a quality assessment framework in this field.

The field of tool support in Enterprise Modeling was discussed in Chap. 5 of this book with the aim of providing an overview of tool types and their functions. There are also numerous other categories of computer-based tools, which essentially cover all phases of modeling and offer special functions for particular areas of application. There are, for instance, modeling tools that generate models from the data available in information systems, or that import from data flow or process models into enterprise models. Once a model has been created, there are a number of test programs (called model checkers) and tools to facilitate the publication of models and their integration into documents. The tool categories for particular areas of application include tools for enterprise architecture management, workflow management, document management with integrated process control, or product data management, to name just a few examples. Further information on this area can be found in tool studies by consulting firms or industry associations.

[1] See http://www.modelsconference.org/

[2] See https://research.idi.ntnu.no/ifip-wg81/english/events

[3] See http://www.bpm-conference.org/

[4] See http://www.bise-journal.com/

16.2 Use of Models

Chapter 8 looked in detail at the development of different enterprise model perspectives, but did not cover all options for further model use. For some application scenarios, the models are suitable as they stand, without further changes. They include, for example, using the models as a "blueprint" for organizational changes or as a description for employees as to how processes should be carried out or how structures should look in the enterprise. However, the models must be refined further in order to introduce workflow solutions or begin developing software solutions.

The aim of workflow solutions is to support process performance by making the tasks to be carried out automatically and made available to individual roles, along with the necessary information, via a software component called the workflow engine. Once completed by a user, the next of the process defined during process modeling would then be triggered. For use in workflow management, enterprise models must be further developed with regard to the level of detail and formalization of the process model. There are modeling languages that have been specially developed for workflow applications, such as BPMN[5] and BPEL,[6] into which the relevant parts of the enterprise model must then be converted. Although closely related, workflow management is not considered as a branch of Enterprise Modeling, and features numerous specialist publications such as Weske's work on the subject (Weske 2012).

In the context of software development, enterprise models play an important role inasmuch as the context in which the software will be used is described in the model of the future target situation for an enterprise. This is part of the definition of requirements. It includes the processes that should be supported by software (corresponding to use cases in software engineering), the various roles that should use the software (i.e., user groups), or even the requirements explicitly modeled in The Technical Components and Requirements Model of 4EM. Moreover, the Concepts Model in 4EM is generally suitable for use at least as a precursor to the information model, and in fact it is often the first version of it. Depending on the development method, the use of Enterprise Modeling that results in software development requires the use or further development of models, not conversion of models. Further information on software engineering can be found, for example, in the textbook by Sommerville (2010).

Recently, organizations have been facing an increased need to adhere to changes in their business environment, which also requires adjustments of the supporting information systems. Since predicting all application contexts in advance at design time is difficult, this in essence requires tailoring enterprise designs and implementing the required application changes at run time. To this end a new approach called Capability Driven Development (CDD) has been proposed in

[5] BPMN = Business Process Model and Notation, see http://www.bpmn.org

[6] BPEL = Business Process Execution Language.

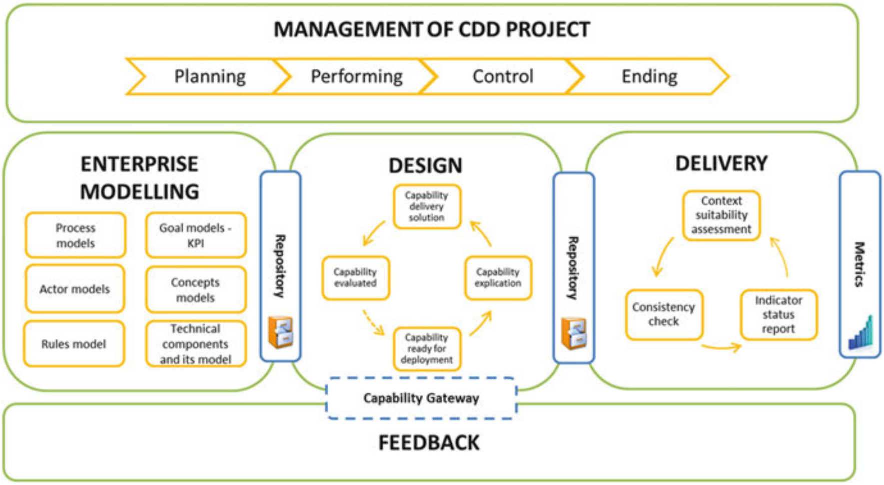


Fig. 16.1 Outlook on the capability driven development methodology

Stirna et al. (2012). From a business perspective, a capability is the ability to continuously deliver a certain business value in dynamically changing circumstances. Key aspects of capability design are that it (1) considers the application context (modeled with context models); (2) bases capability designs and delivery on best practices captured in the form of patterns, as well as (3) incorporates algorithms for capability delivery adjustments at run time.

CDD is currently elaborated to become a comprehensive development methodology with tool support under the FP7 project CaaS—Capability as Service in digital enterprises (proj.no 611351).[7]

Figure 16.1 shows an overview of the envisioned development process where Enterprise Modeling takes an important first step towards capturing and making explicit the business design. More specifically, *Enterprise Modeling*, using the 4EM method, will be used for defining the overall business design that will serve as input for the capability design. Capabilities will be designed to reach business objectives and hence, the interrelations between objectives, strategies, organizational structures, and processes are to be captured in enterprise models. The *capability design* will explicitly focus on evaluation of different business service designs in various delivery contexts and capabilities which will be customized to specific requirements.

The *Capability delivery* phase concerns the actual utilization of the capability enabled by supporting information systems (i.e., capability delivery environment) with the intention to meet the organization's business goals in continuously

[7] See http://caas-project.eu/

evolving circumstances. The approach will also consist of activities for project management and feedback collection. More about the CDD approach is available in (Zdravkovic et al. 2013; Bērziša et al. 2014).

16.3 Areas of Application

Among the application areas for Enterprise Modeling that this book has not discussed are architecture management and knowledge management. Enterprise architecture management (EAM) arose from the insight that, firstly, the number and complexity of information systems and IT solutions are constantly growing and must be coordinated and controlled in the interest of efficient IT management, and secondly, IT support is becoming increasingly important for many enterprises, and hence it is essential to understand how the enterprise's processes and structures are related to the IT solutions that support them. Enterprise models contain the information about interrelations and dependencies between processes, organizational structures, and systems that is necessary for this understanding. However, they do not provide the detailed information about each individual application or IT system that would be required in order to manage these in the long term, to plan further developments, or to analyze areas of risk, cost structures, and potential for development. In this respect, EAM has emerged as an important area of application for Enterprise Modeling. Further information can be found, for example, in (Ahlemann et al. 2012).

How particular processes can best be carried out and what is the most sensible arrangement of organizational structures could be considered as part of enterprise knowledge. Viewed from this perspective, enterprise models, since they model enterprise knowledge, should consequently be included in an organization's knowledge management activities. This area of application is attracting great interest in industry and research, which has led to the development of special methods and tools, such as the concept of "active knowledge modeling" introduced in Lillehagen and Krogstie (see also Sect. 14.1). The principle behind this is that models, once developed, are to be used by enterprise employees in their day-to-day work and thus constantly should be and updated. This avoids a situation where models over time no longer reflect the real situation in the enterprise. It also ensures that enterprise knowledge is present in models and available to domain experts within the enterprise for strategic, innovation, or improvement purposes when needed. However, this manner of using models is highly demanding in terms of the involved employees' skills. It also requires tool support functionality that allows the models to be accessed and used throughout the enterprise. To date, active knowledge modeling has only proved successful in practice for a few knowledge-intensive enterprise functions and roles.

16.4 The Art of Facilitation

Chapter 10 of this book addresses issues related to Enterprise Modeling practitioner competence. A number of the core competences were discussed in relation to different activities in an Enterprise Modeling project and in relation to different purposes of modeling. One of the core competences is the ability to facilitate modeling sessions, which means that a person is able to lead a group of domain experts in creating/refining an enterprise model and doing it in such a way that the group's knowledge and abilities work together to create a high quality model. Participatory Enterprise Modeling, as advocated by the 4EM approach, includes the activities of preparing modeling sessions, facilitating them and documenting the result.

As was mentioned in Chap. 10, facilitation is a general technique used in group processes for a wide variety of purposes, also within Enterprise Modeling (see further, e.g., Zavala and Hass 2008) and International Association of Facilitators (IAF).[8]

When talking to Enterprise Modeling practitioners about competence requirements for facilitation of modeling sessions, they often mention "social skills" as one such requirement. These "social skills" are personal characteristics, some of which can be further described as in the following sections (Astrakan 2001). Becoming a skilled facilitator requires a great deal of practice and dedication. In the context of Enterprise Modeling facilitation does not, however, only relate to the social skills of the facilitator. Apart from dealing with the group processes in a multitude of different situations, the facilitator is also responsible for the quality of the models produced both in terms of their "correctness" and in terms of their usefulness for whichever purpose they are intended.

There is not much literature on facilitation in Enterprise Modeling although some information on the topic can be found in (Nilsson et al. 1999). As of now the novice modeling practitioner is to a large extent dependent on access to more experienced colleagues for advice and feedback, which is risky since the novice can make many costly mistakes in the process of learning. This is something for an organization to take into account when adopting Enterprise Modeling (Chap. 11).

16.4.1 Listening Skills

Listening is not only about listening to what is actually being said. Listening behind the words for what is really meant is essential here. A practitioner once described the importance of taking on his "elephant ears".

[8] See http://www.iaf-world.org

16.4.2 Group Management and Pedagogical Skills

The leader role is facilitated by the ability to motivate and to keep the modeling participants interested. The ability to detect and solving potential conflicts is also part of this skill.

16.4.3 Act as an Authority

To be an authority in this context is not the same as being authoritative. To act as an authority is to create trust for your own competence and to make the modeling participants feel that you know what you are talking about.

16.4.4 Courage and Ability to Improvise

Many experienced practitioners emphasize that courage is a desired personal characteristic in a modeling facilitator. Courage in participatory Enterprise Modeling is about not being afraid of unknown situations. Not everyone accepts entering into the unknown, owing to her/his personality. Others are too inexperienced to cope with this type of situation. This characteristic relates to the issue of problem complexity, particularly the notion of "wicked problem," since such problems have many unknown variables.

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References

Ahlemann F, Stettiner E, Messerschmidt M, Legner C (eds) (2012) Strategic enterprise architecture management—challenges, best practices and future developments. Springer, Heidelberg

Aier S, Riege C, Winter R (2008) Unternehmensarchitektur—Literaturüberblick und Stand der Praxis. Wirtschaftsinformatik 50(4):292–304

Albani A, Dietz JLG (2011) Enterprise ontology based development of information systems. Int J Internet Enterprise Manag 7(1):41–63

Alexander C (1977) A pattern language. Oxford University Press, New York, NY

Allweyer T (2010) BPMN 2.0: introduction to the standard for business process modeling. BoD—Books on Demand, Norderstedt, Germany

Astrakan A (2001) Högre kurs i modelleringsledning (In Swedish). Course notes Version 1.1. Astrakan Strategisk Utbildning AB, Stockholm, Sweden

Bajec M, Krisper M (2005) A methodology and tool support for managing business rules in organisations. Inform Syst 30(6):423–443

Becker J, Rosemann M, Schütte R (1995) Grundsätze ordnungsgemäßer Modellierung. Wirtschaftsinformatik 37:435–445

Becker J, Pfeiffer D, Räckers M (2007) Domain specific process modelling in public administrations—the PICTURE-approach electronic government. Springer, Berlin, Heidelberg, pp 68–79

Bērziša S, Bravos G, Gonzalez Cardona T, Czubayko U, España S, Grabis J, Henkel M, Jokste L, Kampars J, Koc H, Kuhr J, Llorca C, Loucopoulos P, Juanes Pascual R, Sandkuhl K, Simic H, Stirna J, Zdravkovic J (2014) Deliverable 1.4: requirements specification for CDD, CaaS—capability as a service for digital enterprises, FP7 project no 611351. Riga Technical University, Latvia

Brash D, Prekas N, Persson A, Stirna J (1999) Moliere: ESI knowledge base specification, vol I and II. Department of Computer and Systems Sciences, Royal Institute of Technology, Stockholm, Sweden

Bubenko JA Jr (1988) Selecting a strategy for computer-aided software engineering, SYSLAB report NR 59. Department of Computer and Systems Science, The Royal Institute of Technology and Stockholm University, Sweden

Bubenko J (1992) On the evolution of information systems modelling—a Scandinavian perspective, SYSLAB Report No. 92-023-DSV, SYSLAB. Department of Systems and Computer Science, Royal Institute of Technology, Kista, Sweden

Bubenko JA, Persson A, Stirna J (2001) User guide of the knowledge management approach using enterprise knowledge patterns, deliverable D3, IST Programme project Hypermedia and Pattern Based Knowledge Management for Smart Organisations, project no. IST-2000-28401. Royal Institute of Technology, Sweden

K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4

Caetano A, Assis A, Borbinha JL, Tribolet J (2012) An application of the ψ-theory to the analysis of business process models. In: Poels G (ed) CONFENIS 2012, vol 139, LNBIP. Springer, Berlin, Heidelberg, pp 258–267

Castro J, Kolp M, Mylopoulos J, Tropos A (2001) A requirements-driven software development methodology. In: Proceedings of the 3rd conference on advanced information systems engineering (CAiSE 2001), LNCS 2068, Interlaken, Switzerland. Springer, Berlin, Heidelberg, pp 108–123

Coplien J, Schmidt D (eds) (1995) Pattern languages of program design. Addison Wesley, Reading, MA

Department of Defense (2007) Architecture framework version 1.5. Vol I: Definitions and guidelines, 23 April 2007. DoD Architecture Framework Working Group

Dietz JLG (1996) Introductie tot DEMO (In Dutch). http://the-art.nl/0/020_structuur/images/Demo.pdf. Accessed 03 Apr 2014

Dietz JLG (2006) Enterprise ontology—theory and methodology. Springer, Heidelberg

Dietz JLG (ed) (2011) Enterprise engineering—the manifesto. http://www.ciaonetwork.org/publications/EEManifesto.pdf. Accessed 04 Apr 2014

Dobson J, Blyth J, Strens R (1994) Organisational requirements definition for information technology. In: Proceedings of the international conference on requirements engineering, Denver, CO

Ettema RW, Dietz JLG (2009) ArchiMate and DEMO—Mates to date? In: Proceedings of CIAO!/EOMAS 2009, LNBIP 34, Springer, Berlin, Heidelberg, pp 172–186

Euromethod Project (1996) Euromethod, Version 1

F^3 Consortium (1994) F^3 reference manual. ESPRIT III Project 6612

Fill HG, Karagiannis D (2013) On the conceptualization of modelling methods using the ADOxx meta modelling platform. Enterprise Modelling and Information Systems Architectures - An International Journal, Vol. 8, No. 1, 2013.

Flores F, Ludlow JJ (1980) Doing and speaking in the office. In: Fick G, Sprague RH Jr (eds) Decision support systems: issues and challenges. Pergamon, New York, NY, pp 95–118

Fowler M (1997) Analysis patterns: reusable object model. Addison-Wesley, Reading, MA

Fox MS, Gruninger M (1998) Enterprise modeling. AI Magazine 19(3):1998

Fox MS, Chionglo JF, Fadel FG (1993) A common-sense model of the enterprise. In: Proceedings of the 2nd industrial engineering research conference, Institute for Industrial Engineers, Norcross/GA

Frank U (2011a) MEMO organisation modeling language (1): Focus on organisational structure. ICB-Research Report No. 48. University Duisburg-Essen, December 2011

Frank U (2011b) MEMO organisation modeling language (2): Focus on business process. ICB-Research Report No. 49. University Duisburg-Essen, December 2011

Frank U (2014) Multi-perspective enterprise modeling: foundational concepts, prospects and future research challenges. Softw Syst Model 13(3):941–962. doi:10.1007/s10270-012-0273-9

Frankfort-Nachmias C, Nachmias D (2007) Study guide for research methods in the social sciences. Macmillan, New York, NY

Gamma E, Helm R, Johnson R, Vlissides J (1995) Design patterns: elements of reusable object-oriented software architecture. Addison Wesley, Reading, MA

Glissmann SM, Sanz J (2011) An approach to building effective enterprise architectures. Hawaii International Conference on System Sciences, IEEE. pp 1–10

Goldkuhl G et al (1998) Method integration: the need for a learning perspective. IEE Proc Software 145(4):113–118

Halpin TA (2001) Information modeling and relational databases. Morgan Kaufmann, San Francisco, CA

Halpin T, Morgan T (2008) Information modeling and relational databases, 2nd edn. Morgan Kaufmann, San Francisco, CA

Harrison D, Varveris L (2004) TOGAF: establishing itself as the definitive method for building enterprise architectures in the commercial world

Höglund J, Persson A (2012) Up-stream and down-stream quality in enterprise modeling practice—supporting model driven continuous improvement in organizations. In: Proceedings of the 5th

IFIP WG8.1 working conference on the practice of enterprise modeling (PoEM2012), November 2012. Springer, Rostock, Germany
Johnsen S, Schümmer T, Haake J, Pawlak A, Jørgensen H, Sandkuhl K, Stirna J, Tellioglu H, Jaccuci G (2007) Model-based adaptive product and process engineering. In: Rabe M, Mihók P (eds) New technologies for the intelligent design and operation of manufacturing networks. Fraunhofer IRB, Stuttgart, Germany
Jørgensen HD (2009) Enterprise modeling—what we have learned, and what we have not. In: Proceedings of PoEM 2009, LNBIP 39. Springer, Berlin
Josey A et al (2009) TOGAFTM Version 9, A pocket guide. Van Haren, Zaltbommel, The Netherlands
Josey A et al (2013) Archimate 2.1—A pocket guide. The open group. Van Haren, Zaltbommel, The Netherlands
Kaarst-Brown ML (1999) Five symbolic roles of the external consultant—integrating change, power and symbolism. J Organ Change Manag 12(6):540–561
Karagiannis D, Grossmann W, Höfferer P (2008) Open model initiative—a feasibility study. University of Vienna, Vienna, Austria, http://cms.dke.univie.ac.at/uploads/media/Open_Models_Feasibility_Study_SEPT_2008.pdf
Keller W (2012) TOGAF 9.1 Quick start guide for IT enterprise architects, Version 0.9a, Berlin
Krogstie J (2012) Model-based development and evolution of information systems: a quality approach. Springer, London
Krogstie J, Jørgensen HD (2004) Interactive models for supporting networked organizations. Proceedings of CAiSE'2004, Riga, Latvia, LNCS. Springer, Berlin, Heidelberg
Krogstie J, Sindre G, Jørgensen H (2006) Process models representing knowledge for action: a revised quality framework. Eur J Inform Syst 15(1):91–102
Kühne T (2006) Matters of (Meta-) modeling. Softw Syst Model 5(4):369–385
Langefors B (1968) "System för företagsstyrning" (in Swedish). Studentlitteratur, Lund, Sweden
Lankhorst M et al (2009) Enterprise architecture at work: modelling, communication and analysis, 2nd edn. Springer, Berlin, London, Heidelberg
Larman C (2004) Applying UML and patterns—an introduction to object-oriented analysis and design and iterative development, 3rd edn. Prentice Hall, NJ
Larsson L, Segerberg R (2004) An approach for quality assurance in enterprise modelling. MSc thesis, Department of Computer and Systems Sciences, Stockholm University, no 04–22
Lillehagen F (2003) The foundations of AKM technology. In: Proceedings 10th international conference on concurrent engineering (CE) conference, Madeira, Portugal
Lillehagen F, Karlsen D (1999) Visual extended enterprise engineering embedding knowledge management, systems engineering and work execution. In: IEMC'99—IFIP international enterprise modelling conference, Verdal, Norway
Lillehagen F, Krogstie J (2008) Active knowledge modeling of enterprises. Springer, Berlin, Heidelberg
Lillehagen F, Krogstie J (2010) Active knowledge modeling of enterprises. Springer, Berlin, Heidelberg
Lindström C-G (1999) Lesson learned from applying business modelling: exploring opportunities and avoiding pitfalls. In: Nilsson AG, Tolis C, Nellborn C (eds) Perspectives on business modelling: understanding and changing organisations. Springer, Berlin, Heidelberg
Loucopoulos P, Kavakli V, Prekas N, Rolland C, Grosz G, Nurcan S (1997) Using the EKD approach: the modelling component. UMIST, Manchester, UK
Mendling J (2008) Metrics for process models, vol 6, LNBIP. Springer, Berlin, Heidelberg
Ministry of Defense (2008) MOD architectural framework, Version 1.2, 23 June 2008, Office of Public Sector Information, http://www.modaf.org.uk/
Moody DL, Shanks G (2003) Improving the quality of data models: empirical validation of a quality management framework. Inform Syst 28(6):619–650
Nerdinger F (2008) Foundations of behaviour in organisations (in German). Verlag W Kohlhammer, Stuttgart, Germany

Nilsson AG, Tolis C, Nellborn C (1999) Perspectives on business modelling: understanding and changing organisations. Springer, Heidelberg

O'Dell C, Grayson J Jr, Essaides N (1998) If only we knew what we know: the transfer of internal knowledge and best practice. The Free Press, New York, NY

Object Management Group (OMG) (2000) Object constraint language specification, Chapter 7 of OMG unified modeling language specification, Version 1.3, March 2000

Object Management Group (OMG) (2005) Unified modeling language (UML) 2.0

Object Management Group OMG (2008) Semantics of business vocabulary and business rules (SBVR), version 1.0

Persson A (1997) Using the F^3 enterprise model for specification of requirements—an INITIAL experience report. In: Proceedings of the CAiSE '97 international workshop on Evaluation of Modeling Methods in Systems Analysis and Design (EMMSAD), June 16–17, Barcelona, Spain

Persson A (2001) Enterprise modelling in practice: situational factors and their influence on adopting a participative approach. Ph.D. thesis, Department of Computer and Systems Sciences, Stockholm University

Persson A (2008) The practice of participatory enterprise modelling—a competency perspective. In: Johannesson P, Söderström E (eds) Information systems engineering—from data analysis to process networks. Idea Group Inc, Hershey, Pennsylvania

Persson A, Stirna J (2010) Towards defining a competence profile for the enterprise modeling practitioner. In: The 3rd IFIP WG8.1 working conference on the practice of enterprise modelling (PoEM2010), Delft, The Netherlands, November 2010, Springer, Berlin, Heidelberg

Persson A, Stirna J, Aggestam L (2008) How to disseminate professional knowledge in healthcare—the case of Skaraborg Hospital, 3, 42–64, IGI Global, Journal of Cases on Information Technology, 10, 2008

Prekas N, Loucopoulos P, Rolland C, Grosz G, Semmak F, Brash D (1999) Developing patterns as a mechanism for assisting the management of knowledge in the context of conducting organisational change. In: 10th international conference and workshop on database and expert systems applications (DEXA'99), Florence, Italy

Rittel HWJ, Webber MM (1984) Planning problems are wicked problems. In: Cross N (ed) Developments in design methodology. Wiley, Chichester, UK

Rolland C, Stirna J, Prekas N, Loucopoulos P, Grosz G, Persson A (2000) Evaluating a pattern approach as an aid for the development of organizational knowledge: an empirical study. In: Wangler B (ed) CAiSE'00, Conference on advanced information system engineering. Springer, Berlin, Heidelberg

Sandkuhl K, Lillehagen FM (2008) The early phases of enterprise knowledge modelling: practices and experiences from scaffolding and scoping. In: Proc of PoEM 2008, LNBIP 15. Springer, Berlin, Heidelberg, p 1–14

Sandkuhl K, Stirna J (2008) Evaluation of task pattern use in web-based collaborative engineering. In: Proceedings of the 34th EUROMICRO, IEEE

Scheer A-W, Nüttgens M (2000) ARIS architecture and reference models for business process management. In: van der Aalst WMP, Desel J, Oberweis A (eds) Business process management—models, techniques, and empirical studies, vol 1806, LNCS. Springer, Berlin, Heidelberg, pp 376–389

Sessions R (2007) Comparison of the top four enterprise architecture methodologies. Object Watch Inc., Houston, TX, http://www.objectwatch.com/white_papers.htm#4EA Accessed 18 June 2011

Sommerville I (2010) Software engineering, 9th edn. Addison-Wesley, Boston, MA

Stachowiak H (1973) General model theory (in German: Allgemeine Modelltheorie). Springer, Wien, New York, 1973

Stirna J (2001) The influence of intentional and situational factors on enterprise modelling tool acquisition in organisations. PhD Thesis, Department of Computer and Systems Sciences, Royal Institute of Technology, Stockholm, Sweden

Stirna J, Persson A (2008) An enterprise modeling approach to support creativity and quality in information systems and business development. In: Halpin T, Krogstie J, Proper E (eds) Innovations in information systems modeling: methods and best practices. IGI Global, Hershey, Pennsylvania

Stirna J, Persson A (2009) Anti-patterns as a means of focusing on critical quality aspects in enterprise modeling. In: Proceedings of BMMDS/EMMSAD 2009, LNBIP 29. Springer, Berlin, Heidelberg, pp 407–418

Stirna J, Persson A (2012a) Evolution of an enterprise modeling method—next generation improvements of EKD. In: Proceedings of the 5th IFIP WG8.1 working conference on the practice of enterprise modelling (PoEM2012), Rostock, Germany, November 2012. Springer, Berlin

Stirna J, Persson A (2012b) Purpose driven competency planning for enterprise modeling projects. In: Ralyté J, Franch X, Brinkkemper S, Wrycza S (eds) in proc. of CAiSE 2012, LNCS 7328. Springer, Berlin.

Stirna J, Persson A, Sandkuhl K (2007) Participative enterprise modelling: experiences and recommendations. In: Proc CAiSE'07, LNCS. Springer, Berlin

Stirna J, Grabis J, Henkel M, Zdravkovic J (2012) Capability driven development—an approach to support evolving organizations, LNBIP 134. Springer, Berlin, pp 117–131

Temnenco V (2007) TOGAF or not TOGAF: extending enterprise architecture beyond RUP

The Open Group (2011) TOGAF® Version 9.1. https://www2.opengroup.org/ogsys/catalog/g116

Vernadat F (2002) Enterprise modeling and integration: current status and perspectives. Ann Rev Control 26(15–25):2002

Weismann R (2011) An Overview of TOGAF® Version 9.1, http://www.opengroup.org/public/member/proceedings/q312/togaf_intro_weisman.pdf, accessed 24.04.14

Wesenberg H (2011) Enterprise modeling in an agile world. In: Johannesson P, Krogstie J, Opdahl AL (eds) Proc PoEM 2011, vol 92, LNBIP. Springer, Berlin, Heidelberg, pp 126–130

Weske M (2012) Business process management—concepts, languages, architectures, 2nd edn. Springer, Berlin

Willars H (1988) Handbok i ABC-metoden (in Swedish) Plandata Strategi

Willars H (1999) Business modeller's checklist: "dos" and "don'ts" in hands-on practice. In: Nilsson AG, Tolis C, Nellborn C (eds) Perspectives on business modelling: understanding and changing organisations. Springer, Berlin, Heidelberg

Williams TJ (1995) Development of GERAM, a generic enterprise reference architecture and enterprise integration methodology, Integrated Manufacturing Systems Engineering. Springer US, New York, NY, pp 279–288

Yu ESK, Mylopoulos J (1994) From E-R to "A-R"—Modelling strategic actor relationships for business process reengineering. In: Proceedings of the 13th international conference on the entity-relationship approach, Manchester, England

Zachman JA (1987) A framework for information systems architecture. IBM Syst J 26(3):276–292, IBM Publication G321-5298

Zachman JA (2003) The Zachman framework: a primer for enterprise engineering and manufacturing (electronic book). Available through http://www.zachmaninternational.com

Zavala A, Hass BH (2008) The art and power of facilitation: running powerful meetings. Management Concepts Inc., Vienna, VA

Zdravkovic J, Stirna J, Henkel M, Grabis J (2013) Modelling business capabilities and context dependent delivery by cloud service. In: Salinesi C, Norrie MC, Pastor O (eds) Proceedings of 25th international conference on advanced engineering (CAiSE 2013), vol 7908, LNCS. Springer, Heidelberg, pp 369–383

Zorgios Y (ed) (1994) Enterprise state of the art survey, Part 3, Enterprise modelling methods, DTI ISIP Project Number 8032, AIAI, The University of Edinburgh

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K. Sandkuhl et al., *Enterprise Modeling*, The Enterprise Engineering Series,
DOI 10.1007/978-3-662-43725-4