Kurt Sandkuhl · Janis Stirna *Editors*

Capability Management in Digital Enterprises

Springer

Capability Management in Digital Enterprises

Kurt Sandkuhl • Janis Stirna
Editors

Capability Management in Digital Enterprises

Springer

Editors
Kurt Sandkuhl
Institut für Informatik
Universität Rostock
Rostock, Germany

Janis Stirna
Stockholm University
Kista, Sweden

ISBN 978-3-319-90423-8 ISBN 978-3-319-90424-5 (eBook)
https://doi.org/10.1007/978-3-319-90424-5

Library of Congress Control Number: 2018942640

Printed on acid-free paper

This Springer imprint is published by the registered company Springer International Publishing AG part of Springer Nature.
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Since many years, agility and the alignment of business and IT have been important topics in information systems development and IT management. Modern information systems are developed and run efficiently, they deliver the intended business value, and in many cases they are enablers of business. This is particularly true for the new breed of businesses that are done solely online, i.e., by digital enterprises. Such enterprises would not exist without their information systems. They operate in business environments that are cooperative, global, and Internet based; hence, business delivery needs to be based on the application context. Therefore, modern business planners design enterprise capabilities by setting business goals, classifying functional abilities, identifying relevant contexts, analyzing large volumes of data, as well as aligning and configuring technology solutions. This task is far from simple due to the need to consider the dominance and volatility of modern Internet-based business environments, which shifts the problem solving focus from up-front predictable designs to emerging solutions capitalizing on instantaneous business opportunities.

Operating in the modern digital business world increases the importance of business agility, e.g., in terms of customization, availability, and scalability. These aspects are of utmost significance at system runtime but hard to assess and design for during the design time of the system. The requirement for modern information systems is to have the capability of delivering business value in accordance with contextual variations caused by, e.g., business models of suppliers, user preferences and past activities, location, resource pricing and demand forecast, as well as local legislations and specifics. What makes this challenge particularly hard is that such changes are unpredictable and often sudden but at the same time requiring quick response. Hence, the established way of IT management consisting of design and redeployment cycles is in many cases highly unresponsive.

Capability thinking and capability management are promising approaches addressing this challenge and the core topic of this book. Capability management needs a solid theoretical foundation and—even more important for digital enterprises—approaches and ways to put it into practice. The fundament of this book is a

development methodology that integrates business and information systems development and runtime adjustment based on the concept of capability, namely, Capability-Driven Development (CDD), that has been proposed by the EC FP7 project CaaS (Capability as a Service) for Digital Enterprises. This book presents the main results of the CaaS project—the CDD methodology, the architecture and components of the CDD environment, examples of real-life application cases of CDD, and aspects of CDD use for creating business value and new opportunities. Capability-related topics are addressed in the 21 chapters of the book, Chap. 1 serving as an introduction to the principles of capability thinking and management as well as presenting the content of the chapters.

The authors of the book chapters are renowned researchers in the field of information systems development, enterprise modeling, and capability management, as well as practitioners and industrial experts from the same field. Majority of the authors of the chapters included in this book represent the CaaS project consortium that consisted of the following partners: use case companies—CLMS (UK), Everis (Spain), and SIV (Germany); methodology developers—Stockholm University (Sweden), Riga Technical University (Latvia), University of Rostock (Germany), and Universitat Politècnica de València (Spain); and technology developers—Altice Labs (Portugal), Croz (Croatia), and Meo-Servicos de Comunicações e Multimedia (Portugal). The content of this book goes beyond the CaaS project results and includes contributions from authors outside the CaaS project.

This book is written for those who want to explore the opportunities for developing and managing context-dependent business capabilities and the supporting business services. The book does not require an in-depth knowledge about specific development methods and tools, but some background knowledge and experience in information systems development is advisable. This book is written with three main target groups in mind:

- Instructors and researchers in the field of information systems analysis and design addressing the challenge of making business and IT more aligned and resilient
- Students in the areas of information systems, computer science, and business administration seeking new knowledge about innovative approaches and techniques
- Practitioners looking to extend their competence and to get practical advice for developing solutions based on the principles of capability management and CDD (examples of typical roles in organizations that deal with capability management are business process owners, business service managers, business analysts, and project managers)

The work presented in this book is a result of the CaaS project funded by the European Commission. It was written after the project's completion owing to the dedication and hard work of the chapter authors. We would like to thank all project partners, colleagues, and friends who actively contributed to the development of CDD and to this book. During this period, we received support of many people in our private and professional environments. Furthermore, a special thanks goes to Johanna Scheppers (European Commission), Servane Crave (Orange Labs, France),

and Prof. Rimantas Gatautis (Kaunas University of Technology, Lithuania) for their valuable support and feedback during the course of the CaaS project.

Rostock, Germany — Kurt Sandkuhl
Stockholm, Sweden — Janis Stirna
January 2018

Contents

Abbreviations

4EM	For enterprise modeling
ADS	All-do-some
API	Application programming interface
BITA	Business-IT alignment
BPMN	Business process model and notation
BPO	Business process outsourcing
BSP	Business service provider
BVIT	Business value of IT
CaaS	Capability as a service
CCP	Capability context platform
CDA	Capability delivery application
CDD	Capability-driven development
CDT	Capability design tool
CMM	Capability meta-model
CMMC	Context modeling method component
CNA	Capability navigation application
CPR	Capability pattern repository
DE	Digital enterprise
DevOps	Development and IT operations
EA	Enterprise architecture
EAM	Enterprise architecture management
EM	Enterprise modeling
ERP	Enterprise resource planning
GW	Gateway
IS	Information system
IT	Information technology
KPI	Key performance indicator
MDD	Model-driven development
OMG	Object Management Group

PV	Process variant
RACI	Responsible-accountable-consulted-informed
REST	Representational state transfer
SDA	Some-do-all
SOA	Service-oriented architecture
VP	Variation point

Chapter 1
Capability Thinking

Kurt Sandkuhl and Janis Stirna

Abstract Capability thinking characterizes an organizational mindset. It puts capabilities in focus of the business model and information systems development. Capability thinking is expected to help organizations and in particular digital enterprises increase flexibility and agility in adapting to changes in their economic and regulatory environments. Capability management denotes the principles and organizational means of how capability thinking should be implemented in an organization. This book is devoted to capability management in digital enterprises, and the capability-driven development (CDD) methodology in particular. This chapter introduces the basic principles of capability thinking, such as the business needs for context-dependent and adaptable business solutions, key aspects of capability thinking, capability management life cycle, and the principle of method component used to structure the CDD methodology. The chapter is rounded up with a presentation of the rest of chapters in this book.

1 Introduction

Capability thinking helps increase productivity and flexibility of digital enterprises. Capability management denotes the principles and organizational means of how capability thinking should be implemented in an organization. In a nutshell, these statements describe the content of this chapter (with a focus on capability thinking) and to some extent even of the ethos of this book (with a focus on capability management).

The term "capability" is not entirely new in industrial and organizational practice. For the context of this book, it is important to notice that "capability" often is an

K. Sandkuhl (✉)
Chair of Business Information Systems, Institute of Computer Science, University of Rostock, Rostock, Germany
e-mail: kurt.sandkuhl@uni-rostock.de

J. Stirna
Department of Computer and Systems Sciences, Stockholm University, Stockholm, Sweden

K. Sandkuhl, J. Stirna (eds.), *Capability Management in Digital Enterprises*,
https://doi.org/10.1007/978-3-319-90424-5_1

overlooked concept of business- and IT-related stakeholder groups throughout an organization, and—as a consequence—the potential of applying capabilities as the guiding concept in organizational change is not sufficiently exploited. From our perspective, capability management offers an excellent opportunity to business development that integrates different stakeholder perspectives and supports flexibility and agility in organizations. Capabilities and capability management can be applied for governing the coordinated development of business models, business services related to the business, and IT support for implementing the business services.

Capability as a concept is used in a variety of contexts with differences in its meaning and interpretation. Chapters 2 and 3 of this book analyze these differences in detail. However, most views on capability agree that possessing a capability means to have competence and ability, and to also have the right resources in adequate amount, to do something. In this book, we will therefore use the term "capability" as *the ability and capacity that enables an enterprise to achieve a business goal in a certain context* [1]. Ability refers to the level of available competence, where competence is understood as talent intelligence and disposition, of a subject or enterprise to accomplish a goal; capacity means availability of resources, for example, money, time, personnel, and tools. Note here that capacity, being the amount of available resources, is an integral part of a capability and that capabilities are always provided in a certain context.

An example for advantages of capabilities in comparison to more widely used concepts of business design, such as business service or business process, is that of context-dependent variability. The fact that an organization is able to achieve a business goal or carry out a business service in one setting does not necessarily guarantee that it is also able to do the same in another setting.

Example
Considering the banking sector, a Swedish bank has developed its capability for issuing mortgage loans for private customers. Business activity is governed by a number of business goals of the bank as is achieved by a specific business process. It is supported by the ability in terms of competence requirements of its credit officers and by capacity in terms of having a sufficient number of credit officers in the bank offices as well as supporting information systems for loan calculation and risk assessment. Much of this capability has been developed over the years; it is fine-tuned to the Swedish real estate market situation, and it functions successfully. There are, however, two typical kinds of change that can be encountered. First, *internal context* change, for example, from 2018, new laws are in effect, changing the rules for mortgage repayment. This requires changes in the business process, as well as altering the calculations for loan issue and risk assessment. Second, *external context* change, for example, if this bank establishes a branch office in Latvia, it needs to change the

(continued)

business process according to the legislation in Latvia, develop the competence of credit officers, hire them, and develop supporting information systems for mortgage issuing that are able, for example, to interface with the Land Registry Office. This would in essence require developing a new capability, one which the bank did not have previously. If, however, this bank opens a branch office in neighboring Lithuania, much of this capability design can be reused because of the similarities in terms of legislation and business environment.

In many organizations, different stakeholders have their own "local" view on the capabilities of an organization, and the local view might not fit to other stakeholders' perspectives within the same organization [2]. Furthermore, there often is a gap between what business and IT stakeholders consider as capabilities, which results in challenges of business and IT alignment [3], that is, there is no joint thinking about capabilities as a central instrument for the implementation of the business strategy. In this regard, capabilities offer a view on what the organization should be doing without the consideration of details of how it should be achieved. The "how" dimension or the operational side of business is often expressed in the form of business process models, and, hence, capabilities offer a view that brings together the business strategy view with the business operations view.

This chapter aims at introducing what capability thinking is and why it should be implemented in organizations. Furthermore, we will link capability thinking to capability management as a means to plan, develop, implement, and control capabilities. For this purpose, the following sections of this chapter address different aspects of capability thinking and capability management:

- Section 2 briefly analyzes the situation that today's enterprises face in a globalized and dynamic market environments with a specific focus on digital enterprises. The need for agility and flexibility motivates the shift to capability thinking.
- Section 3 is dedicated to investigating selected operational challenges for enterprises in more detail. Capability management aims to address these operational challenges.
- Section 4 presents the basic idea of capability thinking. Capability thinking primarily describes the overall attitude manifested by a shared viewpoint within an enterprise that capabilities are a central concept for anchoring agility in business strategy. Section 4 also shows the main elements of capability management, that is, what is required in an enterprise from structural and process perspective to implement capability thinking.
- Section 5 discusses how the remaining chapters of this book elaborate on different aspects of capability management.

2 Business Environment of Digital Enterprises

2.1 Need for Agility and Flexibility in Enterprises

Among the many reasons why capability management as a topic and capability thinking as a principle receive more and more attention is the need for enterprises to be able to quickly adapt to changes in their economic and regulatory environments. In many industrial and service sectors, agility, flexibility, and dealing with complexity are seen as major factors in enterprises for achieving competitiveness and maintaining a strong position in the market [4]. Several developments can be identified which cause the increasing need for agility and flexibility, namely:

- *New technological developments*, for example, in the field of Internet of Things, cyber-physical systems, big data, or social media, offer the opportunity to extend and enhance products and services, and to also achieve more efficient operations in an enterprise. However, these new technologies have not reached their final level of maturity and will change and improve continuously. Exploiting opportunities connected to new technologies basically requires the capability of adapting structures and processes.
- *Emergence of new business models.* The abovementioned new technologies also motivate and initiate new kinds of business models, many of them disrupting established market structures and customer relationships. Shorter innovation cycles and the costumer expectation of continuously improved products create a demand for frequent updates of business services.
- *Legislation changes or new regulations* lead to compliance requirements that have to be implemented in fixed time frames. Although some industries are more heavily affected, for example, financial industries, energy sector, and pharmaceutical industries, basically all business areas are challenged by similar developments due to the growing number of general regulations, for example, in information security by the General Data Protection Regulation (GDPR).
- *Digitization of traditional industries* with physical products or with physical locations where business is done does not only lead to services complementing the products or collecting operational data at runtime but also to an increasing virtualization of places and services. Digitized products and services open opportunities in new markets, which also require their integration in business models, operational processes, and IT infrastructures.
- *Service integration and packaging.* In many industries, customers expect an integration of different service offerings into packages and bundles. Changing constellations and partners for realizing such bundles have an immediate impact on IT infrastructures, operational processes, and business strategies.
- *Performance monitoring and adjustment.* Modern enterprises have introduced several means of monitoring performance of services, business functions, employees, customers, and suppliers. As a result, a lot of data about the business is usually available. Hence, many organizations face the challenge of making a good use of it, that is, aligning the monitoring and benchmarking efforts with the business strategy and making the right kinds of business adjustment decisions. In

this regard, capability thinking and capability management have substantial advantages and measurable effects to offer.

All of the above trends and developments do not only lead to adaptation processes which can be planned and implemented by means of traditional change management and project portfolio implementation. These trends also lead to changes required at short notice without significant investments, and hence this kind of responsiveness on the business and IT level makes long-term planning difficult. Of course, the solutions based on the concept of capability are not the "magic" solutions to all challenges in agility and productivity of enterprises; they merely offer a methodological support for the design and delivery of business solutions, especially in cases requiring business agility.

2.2 Digital Enterprises

Our specific focus is on digital enterprises and the role of capability management in such enterprises. Digital enterprises show some specifics compared to traditional enterprises [5, 6], which will be discussed in this section.

An enterprise commonly has been established for a certain purpose reflected in the business area and long-term strategies. In day-to-day business, this materializes in business goals, products or services offered to clients, and organizational structures and behavior associated to it. Important stakeholder groups in enterprises are owners, customers, suppliers, employees, regulators, and public bodies defining the legal constraints. An enterprise has an organization structure defining tasks and responsibilities of organizational roles; processes or functions for value creation and supporting activities; products and/or services with their structures and dependencies; resources of different kinds for value creation or support activities (e.g., manufacturing machines, IT infrastructure or components); and suppliers or partners for production, distribution, sales, or other enterprise functions.

A digital enterprise offers a substantial part of its products/services in a digital way and/or performs a substantial part of its value creation and supporting processes digitally. "Digital" in this context refers to the use of IT and information processing. With their digital products/services and processes, digital enterprises aim at leveraging digital technology as a competitive advantage. This leads to an increased awareness as compared to traditional enterprises that are unaware of digital potentials, for example, in terms of the importance of digital technologies and IT as a basis, driving force, and facilitator for business. Thus, in digital enterprises, business and IT alignment needs approaches for a stronger integration of business model, services offered to customers, and IT in order to support the business strategy implementation.

In such a context, capability thinking as a mindset and capability management as an integrative approach can be expected to reach its maximum potential and to be acknowledged by the stakeholders as a concept for development and management.

3 Challenges in Digital Enterprises

The promise of increased flexibility and adaptability remains quite abstract if it is not linked to application contexts or usage scenarios. This section introduces the challenges in digital enterprises which are observed in many real-world cases and which motivate the use of capability management. Part III of this book will also contribute to this aspect, as it is dedicated to real-world examples in the field.

3.1 Stakeholder Groups with Different Priorities

In digital enterprises, like in all enterprises, different stakeholder groups exist with different concerns related to their background. In order to fulfill their tasks and responsibilities, the individuals of each stakeholder group have specific views on the enterprise and often different positions and priorities. Examples of stakeholder groups are business-related stakeholders, such as product manager and head of controlling; development-related stakeholders, such as systems architect and software engineer; as well as operations-related stakeholders, such as system managers and operators.

All roles and stakeholders develop a view on what is important in the enterprise to fulfill their task, which can be seen as the "local view" for their stakeholder group or technical discipline. These local views are, of course, necessary to focus on the actual task, and all local views existing in the enterprise probably will agree on the same overall goal in order to reach the defined business objectives of an enterprise. At the same time, they often have problems in seeing the dependencies and effects of their actions on other stakeholder groups. The concept of capability can help focus the attention of different stakeholder groups on a joint objective (e.g., achieving or maintaining defined capabilities) more detailed than a business goal but still concrete enough to fit into their local view of what the responsibility is. This makes capability an integrative concept.

Example
Let us assume the digital enterprise (DE) offers services to support municipalities in touristic regions for collecting the local tourist tax. This tax has to be paid by the hotels in the municipality, and it is based on the number of nights a tourist stays. The hotels are offered to send a file with the required data about the guests to the service provided by DE. DE transforms the data into the exchange format defined by the municipality in question, transfers the data, stores the electronic receipt issued by the municipality, and manages exceptions caused by errors occurring during processing.

(continued)

The team running the service at DE in our simplified example consists of the service owner responsible for all economic aspects and for customer relationships, the solution architect in charge for design and development, and the operator responsible for exception handling, maintenance, and operations. All members of the team share the same objective: to provide high-quality service with a growing number of customers and revenues. All members also have their local view on what is necessary to achieve this goal, which, for example, is to minimize the number of exceptions from the solution architect's perspective, to increase the number of municipalities and hotels using the service (service owner), and to minimize downtime of the IT (operator).

In small enterprises, this team probably will develop a joint understanding for the view and challenges of all individual team members, but in an enterprise with many services and various IT environments in operation, such an understanding will suffer. For example, if the service owner at DE decides to offer the same kind of service for collecting the local dog license fee, she/he needs to understand under what circumstances the same solution design can be used and what possible performance constraints exist in the operational environment—to name just two examples of possible interdependencies between business, information system (IS) design, and operations. To think of tourist tax and dog license fee collection as two services of the capability to collect local taxes instead of two separate business services will create the required integrative view. At the same time, capability will offer a level of abstraction for identifying the required variants in the solution, for example, in terms of business processes. The principles of how and under what preconditions an organization needs to move from business services to capabilities are discussed in Chap. 7.

3.2 Integration of Business and IT Development

The development and provision of products or services in digital enterprises usually includes various activities, is embedded in a defined process, and involves many stakeholders. Important aspects of new or modified products and services commonly encompass business model development, organizational changes, information systems (IS) design, production, operations, and maintenance.

The business-related stakeholders (product management, marketing, sales) take the lead on business model development, designers and engineers are in charge of IS design and development, and the stakeholders from the technical team focus on operations. However, the established mechanisms or organization structures to connect business- and IT-related aspects often are perceived as too static, involving the more traditional approaches of project-based cycles of design, development, deployment, and maintenance, and hence they do not sufficiently support agility.

Business models have been an essential element of economic behavior since decades, but received significantly growing attention in research with the advent of the Internet and expanding industries dependent on postindustrial technologies. In general, the business model of an enterprise describes the essential elements that create and deliver a value proposition for the customers, including the economic model and underlying business goals. Business models also specify how the business goals are reached in terms of key resources, organizational structure, and business processes and what kinds of IT components are needed.

Traditionally, business models have been developed on the basis of the organization's vision that its shareholders and employees put forward. This follows a number of assumptions, namely, (1) that the business vision and the enterprise architecture (EA) that is designed to realize the vision are relatively stable, (2) that changes are triggered periodically, (3) and that they can be predicted at least in general terms. A common principle is that changes in the design of the organization are planned, designed, and implemented as change management and development projects. The same can be said about IT development—contemporary information system (IS) development approaches mostly focus on design, development, and deployment. Once operational, the IS is often monitored, its performance analyzed, and functionality customized according to evolving user needs or changes in the environment.

These activities are distinguishably separate even if the current agile development frameworks such as development and IT operations (DevOps) [7] aim at continuous development and cloud deployment. Even if IS configuration is a practicable and commonly used approach (e.g., in the business area of enterprise resource planning (ERP) systems), it only supports changes limited in functionality. More substantial changes often need to be accomplished by performing the more conventional cycle of redesign, implementation, and redeployment. This way of working, however, has become increasingly difficult because changes with the current rapid volume and the pace cannot efficiently be addressed with the more contemporary methods and tools that require "crafting" solutions for each case separately.

What is needed are methodologies and supporting tools that shorten the time frame needed from a change in the business model to the operational solution deployed in the market. Capability thinking lays the foundation for designing IT solutions for quick adaptivity by making the context of applications with its potential variations explicit. In combination with pattern-based reuse of solution components, this approach reduces the need for redesign, implementation, and redeployment cycles.

3.3 Context Dependency and Variation of Services

Business services by digital enterprises usually are developed with certain customer groups, operational processes, and delivery environments in mind, which can be summarized as the context the business services are designed for. However, in

established IS development methods, it is not sufficiently taken into account what changes in the context will require what changes in the solution. Furthermore, most digital services do not only exist in one variant but are deployed in several variations.

Context and variation are closely related concepts. The aspects which define the context of use for a business service will at the same time also cause variations as soon as their values change at runtime. Hence, the already known variations of a business service will probably have to be related to the aspects of the context that are likely to change.

Example
The digital enterprise (DE) introduced in Sect. 3.1 has clients for their business service "collecting the local tourist tax" in different regions of the same state with different tax rates and slight differences in administrative procedures. Thus, the conditions in the different regions can be considered as the context for the business service. The possibility of parameterizing the business service to different tax rates was built into the IT solution from the very beginning. Differences in the administrative procedures of the different regions became clear to DE when they started to offer their service in more than one state. The process variations identified in this step required a revision of the IT solution, that is, a new design-implement-deploy cycle.

The team members at DE individually are aware of more factors than the tax rate which influence the applicability of the IT solution in different contexts. For example, the operator knows that there is a performance limit regarding the maximum number of transactions that can be processed in a certain time frame, which could be an issue for future service-level agreements (SLA). The service owner is aware of the effects of differences in legislation, if they would start to offer the same service in another country. The solution architect would like to see more process variants implemented to handle exceptions more efficiently. All of them are individually aware of these factors, but the factors are not documented in a way accessible to others and not implemented in the IT solution.

Capability thinking is closely linked to understanding context and variants of a business service. Capability management includes activities for capturing context, preparing business services for variations in this context, and designing adaptation mechanisms.

3.4 Connection of Design and Runtime

Agility of enterprises includes quick responsiveness to changes in the market and in the enterprise's environment. This obviously is not limited to strategic aspects but

also to operative issues surfacing when business services or IT-based services are provided or delivered to clients. Many of the potential developments that operators have to react on can be built into IT solutions already at design time, for example, by determining indicators relevant for deciding on adaptations, capturing and evaluating them, and reacting on unwanted situations.

However, some aspects relevant for adaptation might not be measurable in the IT solutions available or might become relevant after the finalized implementation of the solution. An integration of such aspects is an important support for agility.

Example
Performance problems of "collecting the local tourist tax" business service could be anticipated and to a large extent avoided by taking appropriate countermeasures, if there would be a forecast of the expected number of tourists in a region. This expected number is available at the tourist information in different municipalities, but not accessible to the IT solution of DE.

4 Capability Thinking and Capability Management

This section is dedicated to presenting the basic idea of capability thinking and the main elements of capability management. Capability thinking primarily describes an attitude or shared viewpoint within an enterprise on capabilities as the central concept for anchoring agility in business strategy (Sects. 4.1 and 4.2). Capability management describes what in general is required to implement capability thinking (Sect. 4.3). An approach to capability management, the capability-driven development (CDD), is introduced in Sect. 4.4.

4.1 Capability Thinking as Organizational Mindset

Capability thinking characterizes an organizational mindset which puts capabilities in focus of the business model and information systems development. Business- and IT-related stakeholders in organizations with established capability thinking believe that capabilities are no emergent feature of an organization but should be planned, implemented, controlled, and adjusted.[1] For many enterprises, this means a shift in perspective from business service-centric to a capability-centric perspective, which includes changes in organizational culture, way of working, and tools used.

More concrete, this shift has to materialize in what is developed in enterprises (capabilities instead of business services) and how this is developed (merging

[1] See also "architectural thinking," as described in [8] and [9].

instead of separation of different aspects and stakeholder group concerns). To implement capability thinking means to establish:

- Coordination across local stakeholder concerns, for example, across such functions as strategic business development, business model implementation, IS development and operations
- Long planning horizon for capabilities with often several revision and solution life cycles as compared to the shorter planning horizons of business services for individual customers
- Integration of all relevant artifacts produced by different stakeholders, for example, of enterprise models, business models, software models, and service management models
- Control of solution variation and ways of deployment to what is defined in a capability's context design

Capability thinking also means being aware of in what context the enterprise has the capacity and ability to offer business services that contribute to achieving business goals. The context basically captures what legal, technical, process, content, or other situations the business service is prepared for and what variations in providing the business service apply for what situation. Making the context explicit helps identify where the limits for using the business service are and where unexploited opportunities exist. In some cases, the process of making the context explicit also allows identifying possible limits more visibly. The reasons for the limits also can be discovered and used for the extensions or redesigns of those aspects of the business that cause the limits. Opportunities can be actively used for developing the business by exploiting its full potential.

What is captured in context is not limited to technical or business aspects. Thus, context—and the solutions for different situations implicated by the context—also forms a support for the communication of different stakeholder groups by raising awareness for other stakeholders' concerns. Details about context modeling and context usage are provided in Chap. 9 of this book.

The enterprises still offer business services to their customers and still follow their economic objectives, but the way they are doing this is governed by a different mindset (i.e., the focus on capabilities).

4.2 Key Aspects of Capability Thinking

As discussed previously, to answer the emerging challenges, modern organizations need methods and tools that allow (1) to continuously *monitor* the application *context* of their IT infrastructure and Key Performance Indicators (KPIs) of their business and (2) to make decisions about what *adjustments* in terms of best practices (patterns or business process variants) should be made to accommodate the context changes. In this regard, the concept of capability offers an overall frame of reference for integrating aspects that are pertinent to business change. More specifically, the

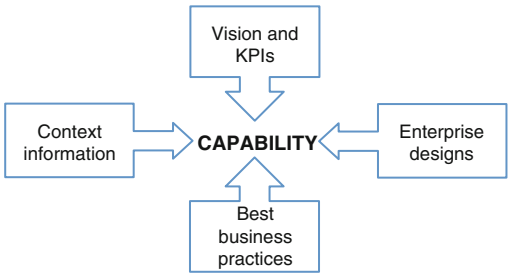

Fig. 1.1 The key aspects of capability

Table 1.1 How capability thinking addresses the challenges described in Sect. 3

Challenges in digital enterprises	Contribution from capability thinking
Stakeholder groups have different "local" views on the enterprise which are not integrated	Capability thinking helps focus the attention on a joint objective (e.g., achieving or maintaining defined capabilities) more detailed than a business goal but still concrete enough to do planning, design, and implementation
Capability as a term recognized on business strategy level but not in the IS development and implementation levels	Joining together business planning and technology, capability as support for business and IT alignment
Variability dependence on context addressed by redesign, services, and cloud as a recognized technological approach	Planning and design for context-dependent delivery, thus avoiding the need for ad hoc redesigns; capability also supports automation of the process of runtime adjustment of business solutions
Dealing with variability is done at the operational level	Variability is raised to the strategic level by designing context-dependent solution variants
Runtime adoption and risk mitigation are done at the operational level	Adaptation and risks are assessed at the strategic level, and operational mitigation measures are designed at the business planning stage
Workflow adaptation; limited proactive adaptation	Proactive capability delivery adjustment methods taking into account runtime information

following issues typically need to be elaborated—vision, context, enterprise design, and best practices (see Fig. 1.1 Table 1.1).

Enterprise Vision and KPIs Most modern enterprises have defined vision and objectives as well as have set means on how to monitor the path toward the vision, usually in terms of Key Performance Indicators. There are a number of approaches used for eliciting and documenting a vision such as goal modeling [10, 11], balanced scorecard [12], Business Model Canvas [13], and e3value [14]. Setting enterprise vision is also a part of enterprise architecture frameworks such as The Open Group Architecture Framework (TOGAF) [15] and NATO Architecture Framework (NAF) [16].

The Existing Enterprise Designs They specify how the organization functions, what products or services are offered, and how the IT supports. Currently, many organizations are fairly experienced with this. They have documented product structures, business processes, and IT architectures. The typical approaches to documenting and analyzing enterprise designs are enterprise modeling (EM), business process modeling, enterprise architecture, and conceptual modeling.

Context Information Traditionally, context information has been considered as part of enterprise design usually taking the form of data on the basis of which different alternatives are selected. This kind of approach presumes that the context that is relevant to the business is known at the time of design. In recent years, doing digital business has become a norm. And since the speed of change in digital business is much faster, enterprises have to assume that substantial parts of the context information will become known only after the business and its supporting IT has been designed and deployed. To respond to this challenge, a number of context modeling approaches (cf., for instance, [17–19]) have emerged on the basis of conceptual modeling. The main purpose of context modeling is to capture and analyze what the properties of the business environment that influence the enterprise's business are and require its reactions in the form of adjustments.

Best Business Practices Modern businesses are based on many known best practices that companies have accumulated throughout the years of operation. Reaction changes and adjusting business deliveries typically do not require development of new solutions. Instead, an existing best practice or solution needs to be adapted to the new situation. The commonly used approaches for this purpose are best practices [20], organizational patterns [21], business process variants [22–24], services [25], and IT components [26–28]. The current trend of the business environment is characterized by frequent and to a certain extent unpredictable changes that require rapid reaction which can be achieved with the help of patterns, but this also requires a certain degree of automation so that the adjustments are invoked without real-time involvement of analysts and designers.

Capability as a concept allows reasoning about these four aspects of the business in an integrated way because enterprises need to know how to realize the business vision and designs as well as what needs to be changed depending on real-life situations. We see the definition of capability used throughout this book as *the ability and capacity that enables an enterprise to achieve a business goal in a certain context* [1].

4.3 Capability Management

The organizational adoption of capability thinking requires careful planning with a number of different steps, which basically include a shift in organizational culture toward capabilities and a change in the methodology of how to integrate business model development, capability development, and IS development. A proposal for

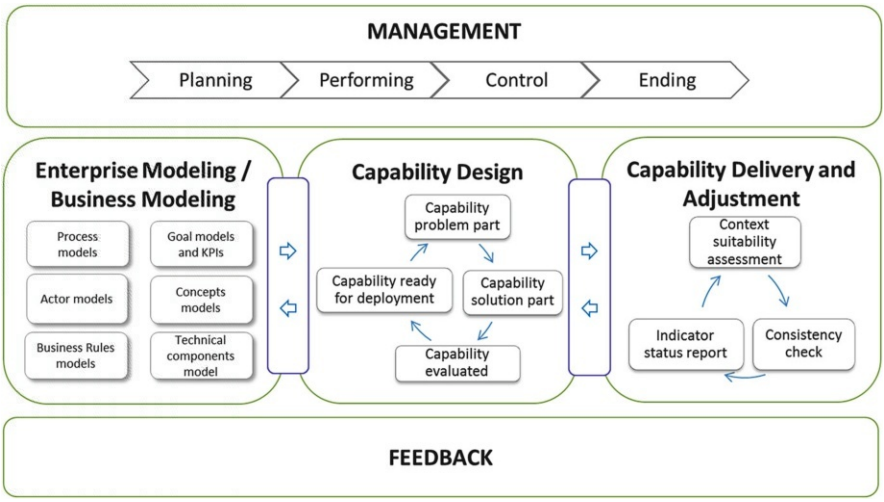

Fig. 1.2 Cycles of capability management

how this organizational adoption should be carried out is included in more detail in Chap. 12 of this book. Successful implementation of capability thinking will lead to capability management as a systematic way to plan, design, develop, deploy, operate, and adjust capabilities. Management processes are often organized in cycles, typically including a PDCA[2]-like structure. For capability management, three integrated cycles are proposed which partly reflect the different time horizons and partly the different levels of abstraction relevant in management:

- Enterprise modeling and business model development
- Capability design
- Capability delivery and adjustment

All three cycles are tightly interrelated and require mutual feedback. Furthermore, the integration of all three cycles into a consistent process also requires a management process. The different cycles are illustrated in Fig. 1.2 and described in the following.

In the business modeling and enterprise modeling cycle, the strategic business goals of an enterprise and the strategy regarding business model development are maintained, continuously updated, and translated into structures and processes required for their implementation. In established enterprises, this usually includes a transformation process from the current situation into a future state. During this cycle, an essential element of the operationalization of strategic goals is the planning of capabilities, that is, the decision about new capabilities to be created, capabilities to be modified, or capabilities to be terminated. The planning process includes the

[2]PDCA = Plan, Do, Check, Act, also known as the Deming cycle (cf. [29]).

definition or identification of KPIs to be used in capability design and delivery for deciding on goal achievement. An important input for the strategic planning comes from the capability design cycle and includes the performance of the capabilities. The planning also provides input to the capability design cycle.

The capability design process is initiated by a business request for a new capability (the request might be initiated by strategic business planning, changes in context, or discovery of new business opportunities). The design cycle starts with a formalized definition of requested capabilities and definition of the relevant context. The requested capability is matched to the enterprise architecture, and required business services and variants are identified. If IT solutions or process variants are missing, IT development for the missing elements is started. The capability designed is assessed for its business and technical feasibility. If capability delivery is deemed feasible, business structures and software enabling capability delivery are put in place. The capability delivery application is developed following the development process used by a company, and the capability-driven approach provides the necessary inputs characterizing capability delivery goals, context data, and algorithms for dealing with changes in the context.

The delivery cycle starts with the IT solutions ready and deployed in the target platform. During delivery, business goals and KPIs of the capability are monitored. Context changes are captured and alternative capability delivery evolution scenarios are evaluated. If capability is not delivered as requested, delivery adjustment is invoked to modify the capability delivery. The iterative development is used mainly due to the need to account for additional context factors because not all relevant factors can be identified during the first development iteration. Updates in the capability are initiated according to the results of capability delivery monitoring and adjustment. These results indicate the validity of context model and business service variants.

The above high-level description of capability management with three integrated management cycles can be used as a blueprint for organizing capability management in an enterprise. A concrete and validated example of how to implement capability management is capability-driven development (CDD) described in the following section.

4.4 Capability-Driven Development (CDD)

CDD was developed by a consortium consisting of academic and industrial partners of the Capability as a Service for Digital Enterprises (CaaS) project. The main role of the industrial partners was to provide industry requirements, to test the CDD methodology and CDD environment prototypes, as well as to elaborate CDD method components that address specific problems related to their business.

The requirements elicitation process consisted of several face-to-face interviews with experts from each company. The interview findings were further analyzed and consolidated in a series of participatory modeling workshops using the 4EM

approach [10]. One of the main results of these workshops was the business goal that the companies have for the improvement of their digital services. The goal model is also reported in [30, 31].

The consensus among the companies was that they need to address the increasing complexity and variety of their digital services. The goals identified during the requirements analysis are attributed to the following four groups (see Fig. 1.3):

(Group 1) *Business improvement goals*, for example, some of the supporting goals of G1, that is, G16 and G17; these address the business needs of the companies involved and motivate the need for seeking new development approaches. These goals emphasize the overall need for developing new business services or for improving the existing services for regulatory compliances.

(Group 2) *Digital service design (or development) goals* reflect the need to design capabilities. The *capability design* (G2) motivates the need for constructing capabilities and their supporting digital services. This also requires setting appropriate capability metrics (G5) and means for an efficient reuse of components and best practices (G7). A part of this is the need to have systematic means for capability evaluation (G6) as well as customization of the capability designs to meet context changes (G8).

(Group 3) *Digital service delivery (or runtime) goals* motivate CDD features for continuous monitoring, adjustment, and improvement of capability once it is

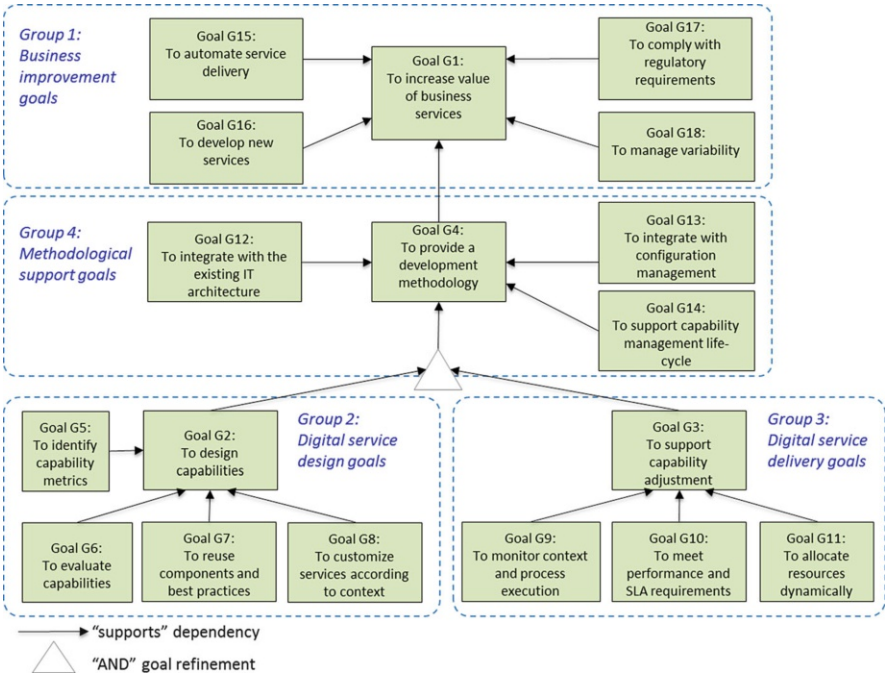

Fig. 1.3 Goal model showing the need for approaches based on capability

deployed. Capability adjustment means altering some aspects of the capability delivery in response to changing business environment and operational performance, which should be done without redesign and redeployment of the solution (G3). The companies need to monitor their operating environment and process execution (G9), as well as to meet the performance and SLA requirements (G10). The companies also recognize the need for dynamic resource allocation for capability delivery (G11). This goal implies that a capability cannot be successfully provided without having appropriate resources and that the resource provisioning is one of the envisioned capability adjustments.

The need for capability analysis, resource allocation, and delivery adjustment naturally leads to the need for a formalized representation of the capabilities which should be achieved by using appropriate modeling methods.

(Group 4) *Methodological support goals*. The capability design and delivery are tasks that require structured actions, efficiency, and repeatability, and hence they need methodological guidance (G4). Capability design and delivery is perceived as part of enterprise architecture and IT management (G12 and G13). The capabilities should be developed and managed throughout their life cycles in an integrated manner using appropriate *capability management* solutions (G14).

In summary, the requirements analysis of the CaaS project suggested that there is a strong need for a methodological approach that supports design and delivery of business in congruence with IT, which cannot be met by the existing methods and tools. A number of issues should be considered as we will discuss it in the following paragraphs.

Designing businesses and IT in congruence has become increasingly challenging. While the idea of business and IT alignment is not new, with the advent of digital business, the more traditional approach of the business defining requirements that are met by IT no longer applies in all cases because many competitive advantages are gained from innovative applications of IT. Likewise, many problems arise from IT, for example, associated with security, performance, and scalability. A key difference is that variability in business terms does not correspond to the same variability of IT solutions.

IT development methods and tools primarily focus on information system design and implementation. The design artifacts used are based on the information system architecture and the implementation technology. The primary means for dealing with complexity is increasing the level of abstraction in programming and lately using models for specifying IS design from which code is generated automatically. This is called model-driven development (MDD), and it promises significant improvements in development times and quality. However, the current methods and tools such as for MDD offer too low of a level of abstraction to be suitable for business designs.

The current approaches see IT development as design-implement-deploy stages which is sufficient for the first time an application is developed. Once it is already running, its further development needs to be not continuous. Even with agile approaches, the increments assume that the application is recompiled and

redeployed, which poses the need for design constructs that allow smoother transition from business to IT and adjustment of IT solutions at runtime.

Many companies require their IT service applications to run 24/7 because their business is continuous, and hence the IT is mission critical. To answer this challenge, the IT support cannot afford a downtime, which means that adjustments according to changes in business context not requiring significant redesigns should be done automatically.

Enterprise architecture management has become a mainstream practice of most organizations. There are many different standards used depending on the nature of the organization. Many of the frameworks are addressing organizational design mostly on a strategic level, and the operational implementations need to be achieved with other means. There are also frameworks that mostly focus on the design and documentation of the EA, and runtime monitoring is to be supported by other methods. Hence, there is a need for methodological support that offers the transition from the more strategic architecture specifications to more operational designs and runtime support. The concept of capability is used in both EA frameworks and CDD, and hence it is our intention to use it as the concept for the integration of both aspects, namely, EA and IT.

4.5 Principles of CDD Method Development

The CDD methodology has been proposed to provide a practicable approach for dealing with these challenges. Its development has followed the following principles, which were defined during the analysis of industrial requirements that were put forward by the industrial partners of the consortium that developed it—more specifically:

- CDD should not be a single methodology that is mandatory for all business cases but a ready-to-use reference methodology offering pathways from this reference methodology to proprietary methodologies. Hence, CDD integrates a number of modeling languages and method components that can be used depending on the specifics of the case. Also, if needed, one modeling language can be replaced by another if it is more suitable for the needs of the application case. The modular approach to structuring the CDD methodology also allows easy integration of CDD with other methods.
- All types of models, that is, patterns, context, process, and enterprise models, should be based on the same meta-model. The CDD meta-model defines all its components and relationships, which allows speedy elaboration of additional method components as well as assessment of what needs to be done in terms of tool integration when applying CDD in real cases.
- The (reference) methodology should not be a monolithic block but component oriented in order to allow flexible use of selected method components depending on the intentions an organization has and a particular development situation. Each

CDD method component has a clearly defined purpose which allows selecting them for a specific problem of capability design or deployment.

- Integration of existing methods or method components should be given preference before substituting them with new. To this end, CDD uses the 4EM goal modeling approach and Business Process Model and Notation (BPMN) for modeling business process. CDD is also to a large extent compatible with existing EA frameworks (see Chap. 3), and, for example, it can support operationalization of an enterprise architecture or its parts with implementation in CDD, which is particularly useful in cases where the EA framework used does not support context-dependent design or runtime monitoring.

The way methods and method components are described within CDD is an extension of the method conceptualization proposed by Goldkuhl et al. [32]. Goldkuhl et al. state that a comprehensive method description should describe the perspective, framework, cooperation principles, and all method components. Figure 1.4 illustrates how the elements of the method conceptualization are related.

The following elements are elaborated for each component of the CDD methodology:

- *Method component*—this defines in operational terms what are the concepts used, a procedure, and a notation. More specifically:

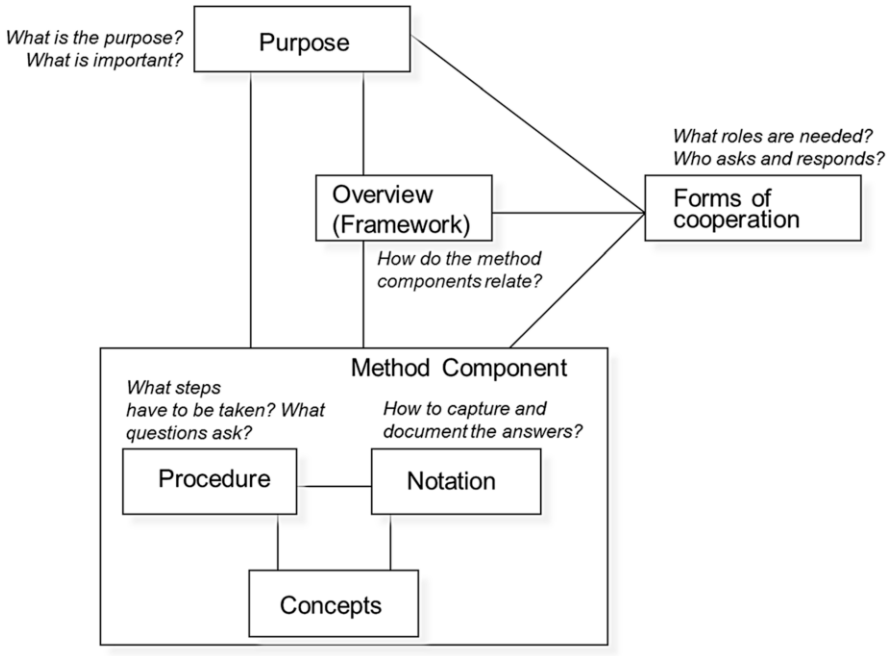

Fig. 1.4 Method components (extended from [32])