

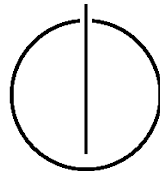
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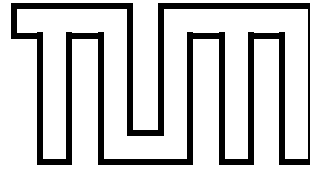
Bachelor's Thesis in Information Systems

**Guideline for combining and  
differentiating between CMMN,  
DMN and BPMN: An indicator-based  
use case study**

Dominik Gerbershagen







# FAKULTÄT FÜR INFORMATIK

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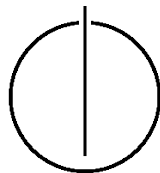
Richtlinie zur Kombination und Differenzierung  
zwischen CMMN, DMN und BPMN: Eine  
indikatorbasierte Falluntersuchung

Author: Dominik Gerbershagen

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Date: November 15, 2016





Ich versichere, dass ich diese Bachelor-Thesis selbständig verfasst und nur die angegebenen Quellen und Hilfsmittel verwendet habe.

I confirm that this bachelor's thesis is my own work and I have documented all sources and material used.

Munich, November 15, 2016

Dominik Gerbershagen



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## **Abstract**





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## Acknowledgements



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## Acronyms

**CMMN** Case Management and Notation Model

**DMN** Decision Model and Notation

**OMG** Object Management Group

**BPMN** Business Process Model and Notation

**BPM** Business Process Management

**ARIS** Architecture of Integrated Information Systems

**BPR** Business Process Redesign

**IBM** International Business Machines Corporation

**BPMI** Business Process Management Initiative

**BPEL** Business Process Execution Language

**UML** Unified Modeling Language

**DRD** Decision Requirement Diagram

**fig** Figure



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**Part I.**

**Introduction**



# 1. Introduction

## 1.1. Motivation

## 1.2. Problem Statement

The Business Model and Notation (BPMN) modeling language and technique has become a quasi-standard for modeling business processes, logical steps in software-systems or align companies along the process chains. BPMN was standardized in 2005 by the Objective Management Group (OMG), but had a long list of predecessors including the *Event-driven Process Chain* (EPC), the *Swimlane Visualization*, *Business Process Re-engineering* to mention only a few. Despite the inheritance of these languages, BPMN has some major downsides which will be discussed. BPMN suits best when it comes to processes that incorporate the *Value Chain Model* by Michael E. Porter [1]. Every company needs these strict processes to optimize the value chain, for the value creation and to separate the hierarchies between employees and departments.

By 2016 these processes have been largely automated. For this automation, the BPMN syntax suited very well due to the strict processes that could be automated more or less easily. The next challenge is to support processes that cannot be simply automated: decisions and case management. At this point, *Case Management Model and Notation* (CMMN) and *Decision Model and Notation* (DMN) come into play. Both are highly anticipated by people working in modeling departments. This thesis will investigate the benefits of separating the decision logic and case management into these new standards as well as combining them into a macro model. Additionally, every language has its own indicators and way of modeling. The weaknesses and strengths of BPMN, CMMN and DMN will be presented in detail in order to form indicators for when to use which language best. Both modeling languages are relatively new to the market as they were standardized in 2014 (CMMN) and 2015 (DMN). The goal of this thesis is to provide a guideline helping modelers to differentiate between the languages, to help combining each language and to provide information about the historical background

of these new standards. Another key aspect in this thesis is the use case study to prove the indicators by real process models taken from the eKulturPortal GmbH. An evaluation will show how the indicators applied on a model work and how they can work for the reader's own models.

Summing up the preceding paragraph leads to three research questions:

- Investigation of the new Decision Model and Notation specification published by the Object Management Group, extracting the downsides and advantages especially concerning the vast modeling of gateways in BPMN. Is DMN the solution to simplify decision-modeling?
- Investigation of the Case Management Model and Notation specification by the Object Management Group, particularly how case modeling can be applied in a model-driven software development project.
- How do CMMN, DMN and BPMN work together in a model-driven software project? Is there a valid possibility to combine all three specifications in one model? Is it possible to improve the process and information flow, readability and eventually implementation of the model by the developer?

### 1.3. Approach

To start the analysis of each modeling language, a brief background information about the demand for standardization by people working in modeling departments or researchers will be provided. On this account a thorough literature research suits best, presenting the results in the Background chapter.

In chapter 2 we will examine the specifications provided by the OMG and have a look at each modeling language. What are the strengths and weaknesses, what has been standardized and when do the standards suit best. These questions will be answered for each CMMN and DMN. BPMN will not be analyzed in detail, but is a key element to do the comparison between the standards. The goal is to carve out the scope, requirements which were met and indicators of each language. In the following chapter, the ability to combine each standard with BPMN will be presented. At first, the modularity of each standard will be determined. Is each language able to stand for its own or does it need to be implemented in a larger model to work properly? Afterwards, the results are taken in order to compare the combination aspect of BPMN, DMN and CMMN. The questions are directed on how to combine each language, whether a model with all three languages is

possible or if there are any downsides that prohibit combining the languages. Additionally, the connectors of each model will be carved out.

With these findings obtained we will do the use case study in order to demonstrate the robustness of the indicators. Process models from the eKulturPortal GmbH will be analyzed with regard to the indicators and remodeled to show the working concept of each standard. A demonstration of the connectors, the scope of each language and the requirements which were met will be presented in this chapter.

Closing up this thesis a chapter of evaluation and discussion is succeeding and the conclusion with a summary of the findings and proposals for future work.

## **1.4. Contributions**

## **1.5. Organization**





# **Part II.**

## **Related Work**



## 2. Related Work

### 2.1. BPMN

– todo

Geplant: Am Ende der Ausarbeitung

### 2.2. CMMN

Case Management and knowledge work are not brand new inventions that have been created in the past few years. "Peter F. Drucker made the first reference to knowledge work in (...) 1959 (...)" [2]. A current "overview and research challenges" provide [2] who explain the difference between business process management and adaptive case management. They briefly sum up the state of the art in case management technology and the next generation solutions. Mentioning technology and tools for Case Management, CMMN and Adaptive Case Management, there are many articles dealing with these topics. [3] describe how adaptive case management can be implemented in businesses and integrated in Enterprise Resource Planning systems (ERP). Additionally they approach a new architecture which decouples decision logic, knowledge work and process flows. All this leads to a better handling of information and an optimization of business modeling. Another practical example provide [4] explaining the company's approach towards an implementation of the CMMN paradigm. This includes the ability to change requirements or orders during run-time, which is one of the major aspects in their system. To achieve this goal, they first set up a meta model of their order-based system and enhanced it afterwards. These practical examples are important in order to evaluate the compatibility with the CMMN specification and other modeling languages, specifically BPMN. They also provide a good overview of how to combine modeling techniques and how they are realized as a system in companies. A more theoretical approach to case management and CMMN particularly provide [5] and [6]. They both do research on transforming CMMN into different

languages. [5] do model-to-model transformation from CMMN to DDML (DEVS-driven Modeling Language) which is used to formalize CMMN and analyze it afterwards. [6] have a similar approach, but a different goal. Due to weaknesses of CMMN, the language cannot be used to create a platform for both agile and route processes. They describe agile processes as the ones "(...) of which the exact flow cannot be determined completely a priori" [6], which is a fundamental characteristic of knowledge work and the reason why case management is so important for many industries. Coping with CMMN's downsides they build their platform on a "rule-based cross-perspective and model intermediate language on textual basis, (...) called *Declarative Process Intermediate Language (DPIL)*" [6].

A useful source for evaluating CMMN as a standardization for adaptive case management is [7]. The subtitle *Examining the applicability of a new OMG standard for adaptive case management* is a good foundation to see how OMG met the expectations from the industry and researchers. This paper sets up requirements deriving from different sources described in detail in section two [7]. At the end of their paper, they evaluate how good the requirements were fulfilled by the CMMN standardization and provide feedback for future improvements.

### 2.3. DMN

The Decision Model and Notation standardization was meant to improve the *separation of concerns* [8] which is the decoupling of decision logic and the control-flow. Biard et al. investigate how the new standard DMN can be used for decoupling BPMN and the decisions modeled as gateways. Decision-modeling is not typically included in control-flow oriented modeling languages. BPMN has not the power to model vast decision-trees due to the gateway restrictions. [9] even calls it a "(...) [misuse] for modeling decision logic". They found an autonomous way of separating the concerns. After averaging more than 900 models from different industries they introduced a "(...) semi-automatic approach to identify decision logic in business processes (...) " [9]. This semi-automatic approach incorporates the 900+ models they used to identify patterns in decision modeling. Formalization is not one of the key issues in this thesis, but the translation of BPMN to DMN or the link between them definitely is. Evaluating the compatibility of DMN with different modeling languages has been the objective of [10]. They approached a combined solution for knowledge-intensive work modeling and extracting the decision logic, what lead them to a new language called *Declare-R-DMN*. Although the Declare language is not part of this thesis, the combination of it with DMN is

useful to evaluate the compatibility with BPMN and CMMN.



# **Part III.**

## **Background**





## 3. Background

### 3.1. BPMN and its shortcomings

#### 3.1.1. Origins of BPMN

The evolution of business processes and process thinking dates back to the 1980s when Michael Porter developed the *Value Chain* making a first proposal on how to align companies along the business processes [1]. This major step initiated consecutive research and improvements in the field of business process engineering and re-engineering. The latter has been a very popular technique for companies to strip down their legacy processes, optimize them and implement the new ones. A very prominent example is Ford who copied the Mazda's concept of a central database replacing an old fashioned paper stream [11].

Inspired by Ford and Mazda, the *Business Process Redesign* (BPR) was emerging in until the late 1990s. At that time, companies tried to redesign in a radical manner the way processes, people and data keeping works. Dumas et al. define four reasons for the fall of BPR, whereof over-radicalism might be the most influential one [11].

Despite the fall of BPR, the management of business processes became a prominent part of business optimization. Consequential different methodologies like the *BPM lifecycle* or the *Architecture of Integrated Information Systems* (ARIS) were born along with new modeling languages. "ARIS [also] provides a modeling language known as event-driven process chains (EPCs)" [12]. By today, ARIS still is a very popular, thus a well known, methodology for enterprise modeling and EPCs a widely used modeling language for event-driven processes, as the name states.

ARIS was published 1994 by August Wilhelm Scheer, a researcher for Business Information Systems at the Saarland University. Around ten years later, Stephen A. White and the *Business Process Management Initiative*, consisting of roughly 35 individuals and companies total, published the first version of the new *Business Process Modeling and Notation* (BPMN) concept [13]. In 2006, the OMG adopted BPMN as

well as the BPMI and published an overhauled version, BPMN v. 2.0 in 2011. This version was highly anticipated and had to meet high expectations. The goal was to create a language with the ability to interchange modeling tools. New parts were added such as the *Choreography diagram* for modeling data exchange between partners and the *Conversation diagram* showing the relationship between several partners [13].

#### 3.1.2. Shortcomings

"As the name already indicates, BPMN is restricted to process modeling [...]" [12]. The goal in terms of BPMN was to create a powerful tool for modeling traditional processes. BPMN is an interchangeable language predestined as a middleware between the database and software layers. It has the ability to be executed *Business Process Execution Language* (BPEL) and a well-known set of symbols and artifacts for modeling the diagrams. Additionally, it inherited its simplicity from EPCs and the *Unified Modeling Language* (UML), which is also part of the OMG family. This simplicity, however, has limitations when it comes to agile and decision intensive models. Decisions, for instance, are illustrated by gateways. These gateways work as connectors separating the process flow into different branches. Each branch has a token wandering in flow direction through the graph. But what if a business wants to change decisions in real time without losing the tokens flowing through the chart? At the current state of development, which is BPMN v 2.0.2, there is no possibility to do so. This is only one of the problems which [14] and [15] investigated more closely. They both came to the conclusion that BPMN is lacking the ability implement business rules which leads the user to display them in spreadsheets. Another downside is the impossibility of modeling agile processes. People working in departments which do not have strict processes but more agile ones cannot use the supportive power of BPMN or process optimization. Despite their knowledge intensive work, they still can benefit from optimizing workflows, or even help new employees getting known to their new job in the department. In this thesis, we will not focus on Business Process Model and Notation (BPMN)'s syntax deficits but more on the possibility CMMN and DMN offer.

## 3.2. Origins of CMMN

Case Management and Notation Model (CMMN) was standardized by the Object Management Group (OMG) in 2014 which represented a peak in terms of notation

for the case management research. However, research began more than ten years ago when Wil Van der Aalst first published his paper about case handling offering a new approach for flexible processes [16]. He summarized different opinions from several authors into the statement that contemporary workflow-systems were not able to handle flexible processes. To be precise, he identified four problems:

- work needs to be divided into atomic steps, so called
- the routing of activities was used to distribute the tasks and authorize workers the workers to do them
- *context tunneling*: workers only focused on the process flow but not on the context surrounding the activities
- the individual's focus was more on what *should* be done instead of what *can* be done

He portrayed a *blind surgeon* as a metaphor who incorporates the four problems in his daily work, for instance refusing a blood sample when it was necessary but not part of the problem in case of what could be done and what should be done [16]. Consequently he solved the problems inventing an adapted model for cases, which consists of objects that can be found in the OMG'S specification from 2014 as well. In 3.1 a comparison of the key objects of Case Handling and CMMN is provided. The Case Handling's key objects are:

- activities or tasks which are the atomic unit of work
- Actors with roles who execute, skip or redo the tasks
- Case representing the product the actor is producing
- data objects for information and values
- forms that present data objects from different point of views

Van der Aalst proved his concept practically in a joint venture with dutch Construction company. They applied the Case Handling model and built a prototype with FLOWer resulting in a rudimentary workflow management system. They requested workers to use the system during their work and evaluated the prototype in the end. Van der Aalst calculated a Return on Investment (ROI) of 0.7 to 1.4 years in the year 2002 [16]. With today's workflow management systems, the ROI would presumably be much higher.

Table 3.1.: Comparison CMMN and Case Handling Model

	van der Aalst	CMMN Specification
Product	Case	Case
Atomic Unit of work	Activity / Task	Task
Information Handler	Data Object	Case File Items
Information Representation	Forms	
Executing Person	Actors and Roles	Human tasks with assignees
Connectors	not specified	specified
Triggers	not specified	Event Listeners

### 3.3. Origins of DMN

The Decision Model and Notation language describes processes in a different way as BPMN does. They differ in their way of how to achieve the actual goal of the process. BPMN, for instance, describes an imperative way. Goedertiert et al. define imperative as "[...] [focusing] on providing a precise definition of the control-flow of the business process in a graph-based process modeling language" [17]. In order to model decisions, BPMN has a rich amount of gateways to direct the control-flow into the desired tasks depending on the decisions being made. Additionally BPMN provides a Business Rule Task sending data to and receiving it from a business rule engine [18]. However, this business rule task "[...] cannot be decomposed any further - and involves no user interaction" [19]. Thus the modeler is not able to define roles for decision, define any requirements for these and is not able to decompose them into fine-grained steps. This might be unnecessary for simple decisions, but in larger and more sophisticated diagrams, complex decisions cause huge branches in the control-flow making the diagram confusing the reader. [20] formulated *Seven Process Modeling Guidelines* according to an empirical study. They built an EPC model with various branches connected by *AND*, *OR* and *XOR* connections. Additionally they violated naming conventions and used multiple end points. One of the resulting guidelines (G1) states "Use as few elements in the model as possible" [20], which is contradicting the imperative way of modeling decisions in BPMN. In this situation, declarative modeling approaches are more appropriate. According to Alan Fish, declarative languages "[...] focus on

what should be done in order to achieve business goals, without prescribing how an end state should be reached” [19]. The CMMN specification is a declarative modeling approach as well, whereas EPCs and BPMN aren’t. Fish also described a way to refine the decision requirements. He invented the Decision Requirement Diagram (DRD) to show ” [...] the structure of the required decision-making as a network of decisions and subdecisions with their supporting areas of business knowledge and data” [19]. The main use for this DRD is to make knowledge involved in decision-making explicit instead of implicit. In the Decision Model and Notation (DMN) Specification by the Object Management Group, a DRD can also be found. This DRD includes the elements as Fish invented for his DRD: Decisions, Input Data (Fish: Data area), Knowledge Source (Fish: Knowledge Area). However, the OMG’s DRD is a much more refined modeling approach since it incorporates Fish’s DRD and is under constant development. Summarizing the findings, the DMN technique is derived from Fish’s findings on how to automate decisions and the declarative modeling approaches which supplement BPMN with tools to model processes without strict control-flows.



# **Part IV.**

## **Indicators**





## 4. Differentiating between BPMN, CMMN and DMN

### 4.1. BPMN and routine processes

BPMN is, as mentioned earlier in chapter 3 one of the most common modeling languages around. A huge variety of software capable of creating BPMN diagrams exists along with many instructions and modeling guides. One of these software-solution-vendors is Camunda BPMN, who also contributes as an influencing member to the OMG's BPMN standardization<sup>1</sup>. In this thesis, the Camunda Modeler is used for creating the BPMN, DMN and CMMN models.

#### 4.1.1. Theoretical indicators of routine processes and BPMN

Creating process diagrams nowadays almost seems to be intuitive. This results from a broad background of routine process modeling incorporating the rise and fall of BPR, ARIS and its EPCs and many more routine process modeling languages. Altogether, they formed the current understanding of business process management and modeling. Since BPMN is a broadly adopted modeling language and a standard that shaped the industry, users might be misled when to use BPMN correctly. In this chapter, a definition of requirements and indicators will be provided for the correct use case scenario identification in terms of BPMN as well as a short introduction to the model.

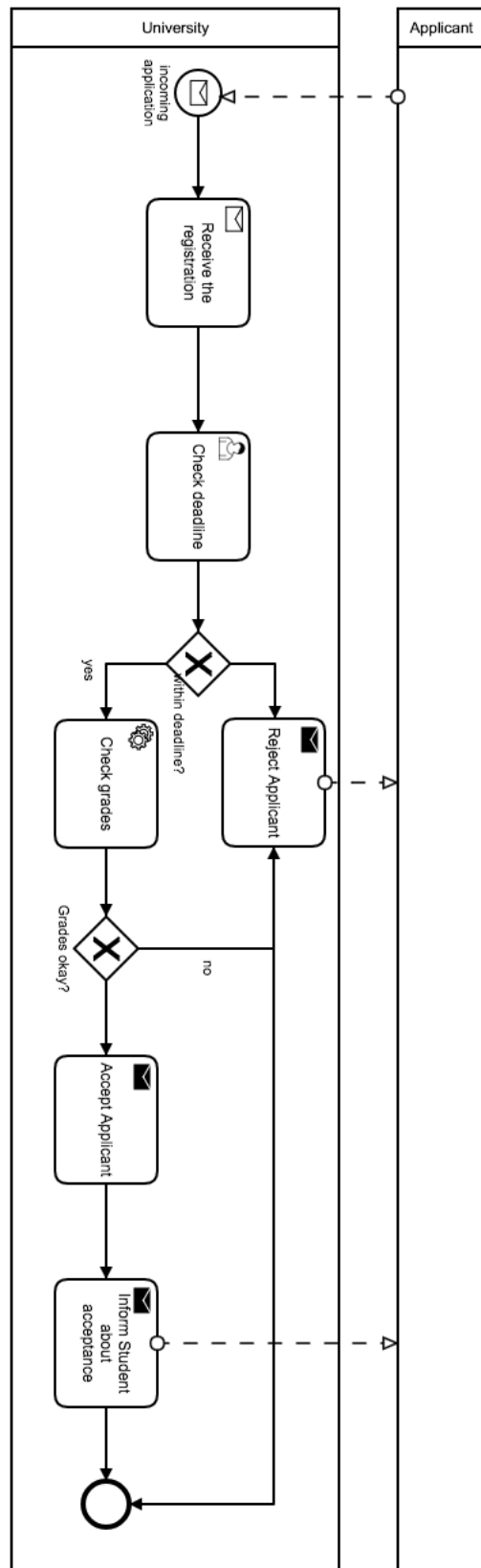
Business Process Model and Notation incorporates *Business Process*, which has been defined and redefined many times by today. For this thesis, we use the OMG's definition of business processes:

Business Processes: business plans include Courses of Action - what the enterprise has to do to achieve its Ends - transformed into Business

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<sup>1</sup>see: [http://bpm-directory.omg.org/vendor/Camunda\\_Services\\_GmbH.html](http://bpm-directory.omg.org/vendor/Camunda_Services_GmbH.html), 2016-08-08

#### 4. Differentiating between BPMN, CMMN and DMN



Processes that encompass activities, sequencing, dependencies, interactions, triggering by business events, etc. [21]

Business processes are ways to achieve goals, to align activities along them and to define interactions, decisions and events. This definition basically incorporates all the core elements of BPMN: Activities, paths, swimlanes (for responsibilities), decisions and events. To recap the notation of BPMN, a small example is shown in figure 4.1. In this model, the application process for a student program is shown, which consists of tasks such as *Receive the registration* or *Check deadline*. Tasks can be precised as *Manual tasks*, *Send / Receive Tasks* and have assignees, as shown in *Check deadline*. In current Workflowmanagementsystems, this workflow model can be fully automated and the assignee is presented its tasks when they are instantiated, e.g. when an application form was received. BPMN models have a starting and an end point which can also be events. In our example, the starting point is a *Message Event*, that indicates the process has started due to a received message. Decisions are a major concern in every control flow oriented graph and BPMN models usually consist of several decision points. They are notated as diamond-shaped *Gateways*, either empty or with a special symbol inside. Each symbol stands either for *AND*, *OR*, *XOR* or *COMPLEX*. Gateways direct the control flow depending on the decision logic prescribed. In our example, a *XOR* Gateway controls the workflow into either the direction of acceptance or the opposite one, depending on what date the applicant's form was submitted. Additionally, the communication between the workflow's two participants is notated as so called *Pools*, which can be divided into *Swimlanes*. Each pool is a communication partner and a swimlane indicates different responsibilities such as departments. If a pool is not filled with BPMN elements, the communication partner is out of scope of the modeler and the processes cannot be modeled. These pools are *Black boxes*.

As we see in the example, the process is well-structured and has no room for creative decisions or even discussions at run-time. The only way the process can differ, is human intervention or changing the process at design-time. The former is equal to not executing the process in the intended way and the latter is bad for processes in volatile environments. BPMN is suited for a limited variety of processes, foremost business processes. The OMG's specification excludes specifically the following [18]:

- Definition of organizational models and resources,
- Modeling of functional breakdowns,
- Data and information models,

#### 4. Differentiating between BPMN, CMMN and DMN

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Table 4.1.: BPMN indicators.

Indicators	BPMN
General	Predefined sequences of activities with decisions (gateways) to direct the sequence along the alternative paths or for iterations
Type of process	Predefined, fully specified, repeatable, business process, control flow oriented
Type of work	Routine work with possible automation
Type of decisions	Simple, driven by rules or events
Control flow	Strict and necessary
Intervention at run-time	no
Typical application	Value-added chain processes, workflows across companies, departments etc.
Key question before modeling	Does the work consist of routine elements which can be optimized or even automated?

- Modeling of strategy,
- Business rules models

Furthermore, the OMG's specification not only provides exclusions such as the ones mentioned above, but it helps to indicate the correct usage of BPMN. Derived from the background chapter 3 and the example above, the following indicators (table 4.1) serve as a guidance for modelers to identify when to use BPMN correctly.

Information about processes is often stored in documents, deprecated models or held by knowledge carriers according to Dumas et al. [11]

# Appendix



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