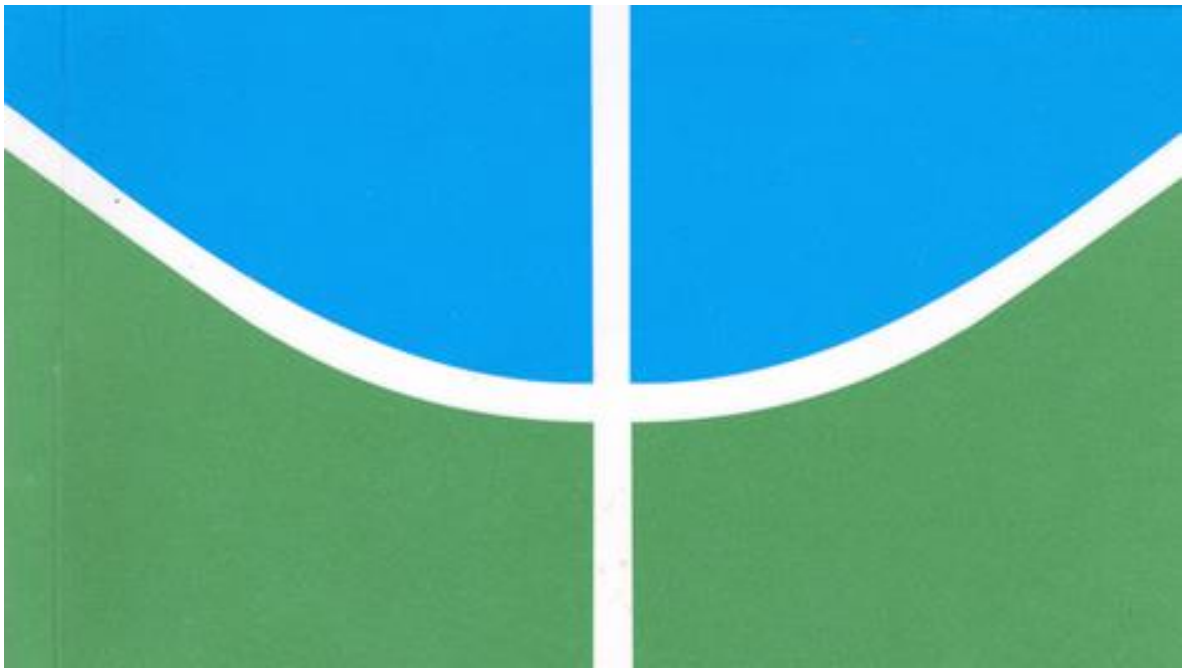

ADAPTIVE CASE MANAGEMENT IN PRACTICE
(CASOS DE USO ADAPTATIVOS NA PRÁTICA)

JÜRGEN KRESS

UNIVERSIDADE DE BRASÍLIA
FACULDADE DE TECNOLOGIA
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ORIENTADOR: RICARDO STACIARINI PUTTINI

DISSERTAÇÃO DE MESTRADO EM ENGENHARIA ELÉTRICA

PUBLICAÇÃO: PPGENE.DM632/2016
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UNIVERSIDADE DE BRASÍLIA
FACULDADE DE TECNOLOGIA
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CASOS DE USO ADAPTATIVOS NA PRÁTICA

JUERGEN MARCUS KRESS

DISSERTAÇÃO DE MESTRADO SUBMETIDA AO DEPARTAMENTO DE ENGENHARIA ELÉTRICA DA FACULDADE DE TECNOLOGIA DA UNIVERSIDADE DE BRASÍLIA, COMO PARTE DOS REQUISITOS NECESSÁRIOS PARA A OBTENÇÃO DO GRAU DE MESTRE.

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Abstract

This dissertation aims at developing and validating a new software engineering methodology for Adaptive Case Management (ACM). ACM is a relatively new design pattern used to support work that is well suited for work scenarios where a precise workflow cannot be strictly defined. In such scenarios, work is highly dependent on knowledge-based decisions about activities and outcomes, leading to multiple work paths and business rules that can become quite complex or even unfeasible to model and completely automate.

Concepts and research on Adaptive Case Management, also reviewed in this work, are still evolving and maturing. Current ACM state-of-art lacks of formally described and proven methodology for development of ACM solutions. The goal of this work is to contribute with fulfilling this gap.

The proposed ACM Methodology is based on the five phases, which covers typical software engineering disciplines: Business Modeling, Visualization, Analysis, Design and Implementation. New software artifact models for ACM user interfaces (ACM Workspace) and ACM solution analysis and design (ACM Canvas) are also among the contributions of this work. ACM design leverages the recently established Case Management Modeling Notation (CMMN v1.1). Templates of software artifacts, developed for each methodology phase, are also presented. These support a guided outcome and ensure projects progress and success.

The methodology was developed over the past two years from work and analysis of actual ACM projects in different industries. In this dissertation, a Case Study is completely described and implemented, as a proof-of-concept for the proposed methodology.

Resumo

Esta dissertação tem como objetivo desenvolver e validar uma nova metodologia de engenharia de software para Gerenciamento de Casos Adaptativos (ACM). ACM é um padrão de projeto (*design pattern*), relativamente novo, utilizado para apoiar, de forma mais adequada, cenários de trabalho em que um fluxo de trabalho preciso não pode ser definido de maneira rigorosa. Em tais cenários, o trabalho é altamente dependente de decisões baseadas no conhecimento sobre as atividades e resultados, levando a várias regras de negócio e possibilidades de fluxo de atividades que podem tornar a modelagem e a automatização bastante complexas ou, até mesmo, inviável.

Conceitos e pesquisas sobre Gerenciamento de Casos Adaptativos, também apresentados neste trabalho, ainda estão evoluindo e amadurecendo. O estado-da-arte atual em ACM carece de metodologia descrita formalmente e comprovada para o desenvolvimento de soluções ACM. O objetivo deste trabalho é contribuir para o preenchimento dessa lacuna.

A proposta de metodologia ACM é baseada em cinco fases, que abrange as seguintes disciplinas típicas de engenharia de software: Modelagem de Negócio, Visualização, Análise, Projeto e Implementação. Novos modelos de artefatos de software para interfaces de usuário ACM (ACM *Workspace*) e análise e projeto de solução ACM (ACM *Canvas*) também estão entre as contribuições deste trabalho. O projeto em ACM utiliza a recentemente criada Notação para Modelagem de Gerenciamento de Casos Adaptativos (*Case Management Modeling Notation* - CMMN). Modelos para artefatos de software, desenvolvidos para cada fase metodologia, também são apresentados. Tudo isso suporta um resultado orientado e garante o progresso e sucesso de projetos.

Essa metodologia foi desenvolvida ao longo dos últimos dois anos de trabalho e análise de projetos ACM reais em diferentes indústrias. Nesta dissertação, um estudo de caso completo é descrito e implementado, como uma prova de conceito para a metodologia proposta.

SUMMARY

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ACRONYMS

ACM	Adaptive Case Management
BMM	Business Motivation Model
BPM	Business Process Management
BPMN	Business Process Modeling Notation
CDM	Collaborative Decision Making
CMMN	Case Management Model and Notation
CORA	Common Reference Architecture
DMN	Decision Model and Notation
IDE	Integrated Development Environment
IT	Information Technology
KPI	Key Performance Indicator
OACM	Ontology based Adaptive Case Management
OMG	Object Management Group
SOA	Service Oriented Architecture
SWOT	Strength Weakness Opportunities Threats
UI	User Interface
UML	Unified Modeling Language
WSDL	Web Service Definition Language

1. INTRODUCTION

Business Process Management (BPM) based solutions have brought major advances to work organizations and automation. However, given BPM's strong basis on formal workflow definition, oftentimes BPM solutions are not well suited for work scenarios where a precise workflow cannot be strictly defined. In such scenarios, work is highly dependent on knowledge-based decisions about activities and outcomes, leading to multiple work paths and business rules that can become quite complex or even unfeasible to model and completely automate. In these cases, a different technology support approach is required. The focus is not to isolate and automate decisions and rules, but rather to deliver opportunistic information support to the knowledge worker to accomplish them. Adaptive Case Management (ACM) rises as a successful design pattern for this.

The BPM design-pattern is well-understood and supporting technologies are maturing. Such approaches have been under consideration and development for decades. While established and proven methodologies for developing BPM-based automations exist, ACM design pattern and technologies are still evolving. Industry practices for ACM are not yet consistently established and mature. The main goal of this dissertation is to fill in these gaps and to provide a practice-proven and systematic approach for developing ACM-based solutions.

A software development methodology refers to the framework and disciplines that are used to structure, plan, and control the process of developing an information system (CMS, 2005). The ACM methodology described here covers typical software engineering disciplines: business modeling, analysis, design and implementation. This approach provides well-understood separation of interest criteria, which aims at making it easier for business analysts and software architects to understand and incorporate ACM design practices into their current professional skills. Additionally, specialized business models and software artifacts required for the successful realization of ACM design pattern are presented and developed in details.

Examples of initial approaches for ACM methodologies include the "The 7 Key Components for an Effective Case Management Methodology" (Wanless, 2010), Dana Khoyi's chapter, "Building the Solution with ACM" within the book Mastering the Unpredictable (Swenson, et al., 2010), and the "Case Management Solution Framework" part of Oracle Case Management Solutions by Leon Smiers (Smiers, Koster, Deb, & Palvankar, 2015). Available

methodologies for ACM systems represent a good start considering the maturity of the adaptive case management concept. These would evolve and mature over time, based on research and project experience.

Object Management Group (OMG) recently introduces the Case Management Model and Notation 1.1 (CMMN) (Babich, et al., Case Management Model and Notation (CMMN), 2013). CMMN has a similar impact to ACM like the Business Process Modeling Notation (BPMN) for BPM. This dissertation takes current ACM Methodologies a step further, by showing how to use CMMN as part of a practice-based ACM methodology and throughout the whole lifecycle of an ACM solution.

The ACM methodology presented at this work was developed and refined over the past two years during execution of actual ACM projects in different customers and industry scenarios. Therefore, it brings together practical experience and real use of existing ACM software platforms.

1.1 MOTIVATION

In the last 10 years Information Technology progress quickly from Service Oriented Architectures and Business Process Management towards new architectures like Adaptive Case Management. With the publications by Thomas Erl including SOA Design Patterns (Erl T. , SOA Design Patterns, 2009), SOA Governance (Erl , et al., 2011), Next Generation SOA (Erl, et al., 2014), a SOA Methodology and international standards like BPEL and WLSDL, Service Oriented Architectures became mature. The same is valid for Business Process Management. BPMN2.0 was defined as a standard and books and methodologies like Enterprise BPM Method and Style (Silver, Bpmn Method and Style with Bpmn Implementer's Guide, 2011) or Enterprise BPM (Slama & Nelius, Enterprise BPM, 2011) have been published. For both architectures countless customer projects have been realized. Compared to Service Oriented Architecture and Business Process Management, Adaptive Case Management is a young architecture paradigm. With the publication of CMMN 1.1 the standard is evolving, first projects are realized, knowledge is published in various books like Mastering the Unpredictable (Swenson, et al., 2010), How Knowledge Workers Get Things Done (Swenson K. D., Palmer , Pucher, Webster, & Manuel, 2012). For further maturity an ACM Methodology, making use of the CMMN notation, is the next milestone. With this dissertation this milestone is achieved. With the Adaptive Case Management Methodology

chapter in the book, Best Practice to Support Knowledge Workers, this knowledge is contributed to the community.

1.2 OBJECTIVES

The main objective of this dissertation is the development and validation of an Adaptive Case Management Methodology. This objective is further detailed in four specific goals:
Development of an ACM Methodology encompassing characteristic software engineering disciplines of Business Modeling, Analysis, Design and Implementation.
Development of software development artifacts specially designed to cover the specificities of ACM, including the usage of the recently established Case Management Modeling Notation (CMMN).
Visualization development of appropriate user interface (workspace).
Validation of the ACM Methodology with a proof-of-concept implementation based on a customer project.

The work presented in this dissertation resulted in five publications over the past two years:
Created a CMMN Poster published at www.acmcommunity.com (Kress, et al., 2014)
Contributed a CMMN Model to the CMMN Notation published in CMMN 1.1 by OMG (Babich, et al., Case Management Model and Notation (CMMN), 2014).
Developed an ACM-Proof of-Concept which validates the ACM Methodology.
Author of the ACM book "Thriving on Adaptability: Best Practices for Knowledge Workers" (Swenson, et al., 2015)published by Keith Swenson leading industry ACM expert.
Published an ACM Methodology in the book "Best Practices for Knowledge Workers" (Swenson K. D., et al., 2016) by the adoption and extension of the characteristic phases.

Expected benefits

- Guided approach to successfully capture and meet requirements from knowledge workers and bridge them to technical requirements of the ACM development team.
- Build work packages to scale and distribute the tasks within the ACM development team.
- Ensure successful ACM implementation with a clear five phase based model for Business Modeling, Visualization, Analysis, Design and Implementation.
- Support the knowledge worker with a specially designed user interface, called ACM Workspace.

1.3 METHODOLOGY

This dissertation describes an applied research, with a qualitative and descriptive approach to the problem (Shields & Rangarajan, 2013). This is an exploratory research, whose main purpose is to develop, clarify and modify concepts and ideas, with a view to formulating an Adaptive Case Methodology. This exploratory research involves bibliographical review, application of software engineering practices and techniques, and a Case Study.

This type of research is carried out especially when the chosen subject is underexplored and a new approach is identified. The result of this research is a systematic approach for Adaptive Case Management projects.

The body of knowledge that gives basis for the design of the proposed solution model in this study was developed in five steps, summarized in Table 1-1.

Table 1-1 Phases in Research Realization

1st Step Literature review of existing ACM Methodologies and related work.	2nd Step Definition of Methodology Framework based on classical software engineering disciplines: Business Modeling, Analysis, Design and Implementation.
	3rd Step Study of actual Adaptive Case Management projects and Implementation Phases.
	4th Step Systemization of Adaptive Case Management Methodology.
	5th Step Realization of Proof-of-Concept and validation base on Case Study.

1.4 LIMITATIONS AND RESTRICTIONS

For the development of the methodology, a qualitative research approach was used. This option was necessary because the study aimed at developing a new approach for Adaptive Case Management projects. This method has its limitation though adequate:

- Excellence of the individual ACM Methodology phases might be increased, as the focus is on the adoption and combination of existing techniques.
- The methodology was developed in a waterfall approach, due to the relatively young age of the Adaptive Case Management concept. The characteristics of an ACM project might favor a more agile approach, which is appropriate for future research. In a first step the Business Modeling, Visualization and Analysis phases can be leveraged in an agile fashion. Followed by an agile approach for the Design and Implementation phases, executed by each identified activities.
- The methodology was proven in two successful customer ACM projects, by industry experts and a proof-of-concept. Validation and experimental data is limited to a reduced number of work. This is due to the complexity of developing end-to-end execution of the proposed methodology. As an academic research this study validation was limited to two customer examples developed over the last two years. The publication of the methodology and further customer projects from various industries will continue to improve and reinforce the methodology.

1.5 ORGANIZATION OF WORK

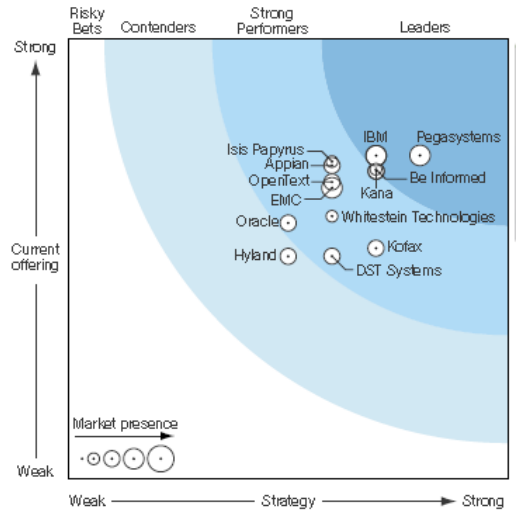
This dissertation is organized in five chapters. After this introduction as followed:
Chapter 2 explains the concepts and their theoretical foundation of Adaptive Case Management. Followed by the research status of the existing ACM Methodologies.
Chapter 3 explains the concepts and elements of the Case Management Modeling Notation.
Chapter 4 explains the Adaptive Case Management Methodology detailed by five phases: Business Modeling, Visualization, Analysis, Design and Implementation.
Chapter 5 explains the validation of the Adaptive Case Management Methodology by a detailed Case Study to describe the methodology in a practical example. This Case Study was fully implemented, based on the described Adaptive Case Methodology, by a Proof-of-Concept.
Chapter 6 highlight the strengths of weakness of the Adaptive Case Management Methodology.
Chapter 7 concludes the dissertation.

2. ADAPTIVE CASE MANAGEMENT CONCEPTS & RESEARCH STATUS

Industrial revolution has changed the economies in the last 100 years massively. From hand made products via mass production to a service oriented industry. Industry production is outsourced to cheap wage countries like China or automated. Value creation of today's successful societies more and more relies on knowledge. "The most valuable assets of the 20th-century company were its production equipment. The most valuable asset of a 21st-century institution, whether business or non-business, will be its knowledge worker and their productivity" (Drucker, 2001). The amount of data and information is exploding. At the same time, globalization and Internet made knowledge available everywhere and anytime (Telecommunication Development Bureau, 2015).

Adaptive Case Management (ACM) is the solution that supports knowledge workers in their decision for unstructured processes. With ACM-based solutions, knowledge workers can make better decisions on core company values, which result in more successful business and work organization, in a competitive global environment.

Papyrus (ISIS Papyrus , 2016) OpenText (OpenText Case360, 2016), IBM (IBM, 2016), Pega (Pega, 2016), be informed (be informed, 2016), EMC (EMC, 2016) and Oracle (Oracle, 2016) offer the first commercial ACM solutions. Figure 2-1 shows the Forrester Wave for Dynamic case Management solutions from multiple vendors (Clair & Miers, 2014).



Source: Clair & Miers, 2014 p.7

Figure 2-1 The Forrester Wave™: Dynamic Case Management Q1 2014

2.1 ADAPTIVE CASE MANAGEMENT CONCEPTS

Adaptive Case Management bases on the key concepts of a *knowledge worker* who handles a *case*.

2.1.1 Knowledge Worker

Knowledge work can differentiated from other forms of work by its emphasis on "non-routine" problem solving that requires a combination of convergent, divergent, and creative thinking (Pyöriä, 1997). Winslow Taylor fostered scientific management in a structured way to automate predictable and repeatable processes, which can be approached with workflow automation. Knowledge work is not predictable in that way and requires a different approach. The raise of knowledge work has actually been foreseen for years. (Davenport, 2006). A knowledge worker works towards a goal by continuous planning, re-evaluating and executing, as his work is non-predictable and the information is unfolding over the time, i.e. not completely available from the start of the activity. Table 2-1 compares and illustrates these types of workers and related work characteristics.

Table 2-1 Types of Workers and Work Characteristics

Types of Workers & IT Technology	**Technology**	**Example**
Routine work	BPM	Airline check-in
Knowledge work	ACM	Claim management

Knowledge Work versus Routine Work	**Routine Work**	**Knowledge Work**
Information	Available at start of activity	Unfolding over time
Path to outcome	Predicable / prescribed	Unpredictable
IT support	Automation	Decision support
Focus / aim for	Productivity / efficiency	Milestone & goal / effectiveness

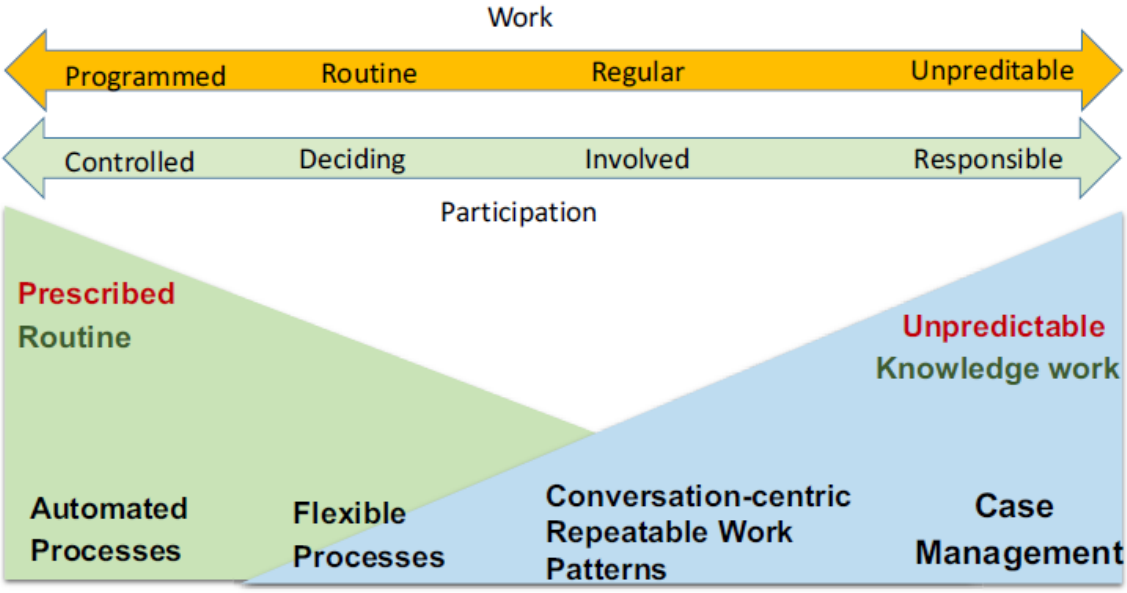
Two examples clarify the different characteristics of work. An example for routine work is the check-in procedure at an airport. An example for knowledge work is the claim regulation

by an insurance company. In the airline example, some persons might remember when it was required to board a plane with a printed ticket and a boarding pass. A travel agency issued the ticket for the flight. The airline check-in validated the documents, handled the luggage and printed the boarding pass. At the gate, a clerk verifies the boarding pass. The required information for the flight is available at the start of the activity. The process from issuing the ticket in the travel agency, check-in and boarding the plane is predictable. Today the whole process is automated, from electronic tickets and boarding passes, self-service check-in, to self-service boarding gates. The automated process allows airlines to achieve higher productivity.

An example for knowledge work is claim regulation within an insurance company. With the creation of a new claim, first information e.g. damage of a car is available. The responsible knowledge worker of the insurance company has the goal to regulate and process the claim. He can receive and request additional information and documents. Two days after the claim was created, he receives a notification that also a person was injured. Personal damage might raise the claim value significantly, therefore the systems suggests him to request a police report. Based on the additional information and an exchange with an experience colleague, who handled similar cases in the past, he decided to request a report from an expert who investigates the accident, and a report from the doctor who examined the patient. The accident report, which also includes pictures, unveils that both drivers were speeding. In the meantime, the police launched an official investigation that resulted in legal proceedings. Based on the judgment, the knowledge worker will evaluate the claim regulation. The example shows that additional information becomes available during the case. Based on this information the knowledge worker decides on the activities. IT can support the knowledge worker with a central repository of all case data e.g. report, pictures and communications and a claim history. Search functionality helps the knowledge worker to access the information. The IT system can also present similar previous cases to support the knowledge worker in the decisions. The claim history & audit trail makes the case comprehensible. Based on the unfolding information, the path of the outcome is unpredictable as each case is unique. The knowledge worker can make the decision of which activity to execute to achieve his milestones and goals.

Motahari Nezhard & Keith D. Swenson (Motahari-Nezhad & Swenson, 2013) summarize the different spectrums of work in Figure 2-2. In the check-in example, the process was

routine work, and later an automated process. On the other end of the chart, the claim regulation example is highly unpredictable managed by a knowledge worker.



Source: Motahari-Nezhad & Swenson, 2013 p.3

Figure 2-2 Spectrum of Work

Nathaniel Palmer 2011, 2013 published a conducted study on work modes of knowledge workers shown in Figure 2-3. For two third of the work time, knowledge workers are focused on unstructured and unpredictable work patterns. Only one third of their work time is dedicated on structured, predictable, automated or automatable work (Swenson, Palmer, & Carlsen, Empowering Knowledge Workers, 2014).

Source: Swenson, Palmer, & Carlsen, 2014 p. 297

Figure 2-3 Percentage of the day spent in different modes

2.1.2 Case

A case is the coordination of multiple tasks, planned or unplanned, for a specific purpose (Swenson K. D., Palmer, Silver, Fischer, & Koulopoulos, 2011). From a practical perspective, the case can usually be presented as a clip or folder for data & behavior from a domain. This folder can be access by the knowledge worker via a user interface. Examples can be student admission, claim management, patient record, criminal investigation, research, and service procurement or incident.

Within a case, three layers can be defined: user interface, data and behavior. Through the user interface, data can be accessed and behavior can be executed. Data is divided in case and information data. Case data contains for example the case identifier, status or history. Case information data represents unstructured data like communications and pictures. Behavior describes the actions the knowledge worker can execute and stages to where the case can progress. Behavior entities include activities, events, milestones, and goals.

2.1.3 Adaptive Case Management

Forrester (Le Clai & Moore, 2009) defines case management as "a highly structured but also collaborate dynamic and information intensive process that is driven by outside event and requires incremental and progressive responses from the business domain handling the case". Examples of case folders include a patient record, data, collaboration artifacts, policies, rules, analytics, and other information needed to press and manage the case.

In 2014, a group of architects, Jürgen Kress, Berthold Maier, Hajo Normann, Danilo Schmiedel, Guido Schmutz, Bernd Trops, Clemens Utschig-Utschig and Torsten Winterberg outlined "What is ACM" and "Why ACM?" is required. The team has a broad background of software architectures and implementations. The experience from first SOA implementations towards a mature architecture and methodology was published in multiple books and article series including SOA Design Patterns (Erl T. , SOA Design Patterns, 2009) Industrial SOA (Kress, et al., 2013), Next Generation SOA (Erl, et al., 2014). With the raise of BPM both architectures where combined and research focused on the new ACM architecture. As a result the poster Adaptive Case Management (ACM) in Practice (Kress, et al., 2014) was published.

What is ACM?

- “ACM aids in the decision making process through suggestions, yet putting the human back into the driver seat.
- ACM is centered around living information and relationships, while traditional business processes are centered around a-priori defined activity sequences.
- ACM can lead to optimized, normative processes.
- ACM is based on dynamic runtime assembly of known and new activities.
- ACM and rigid (normative) process modeling are disciplines within the realm of BPM and are complementary.
- ACM can be the island within the BPMN process or the other way round.
- ACM platforms must integrate seamlessly into an Enterprise's Platform Architecture.” (Kress, et al., 2014)

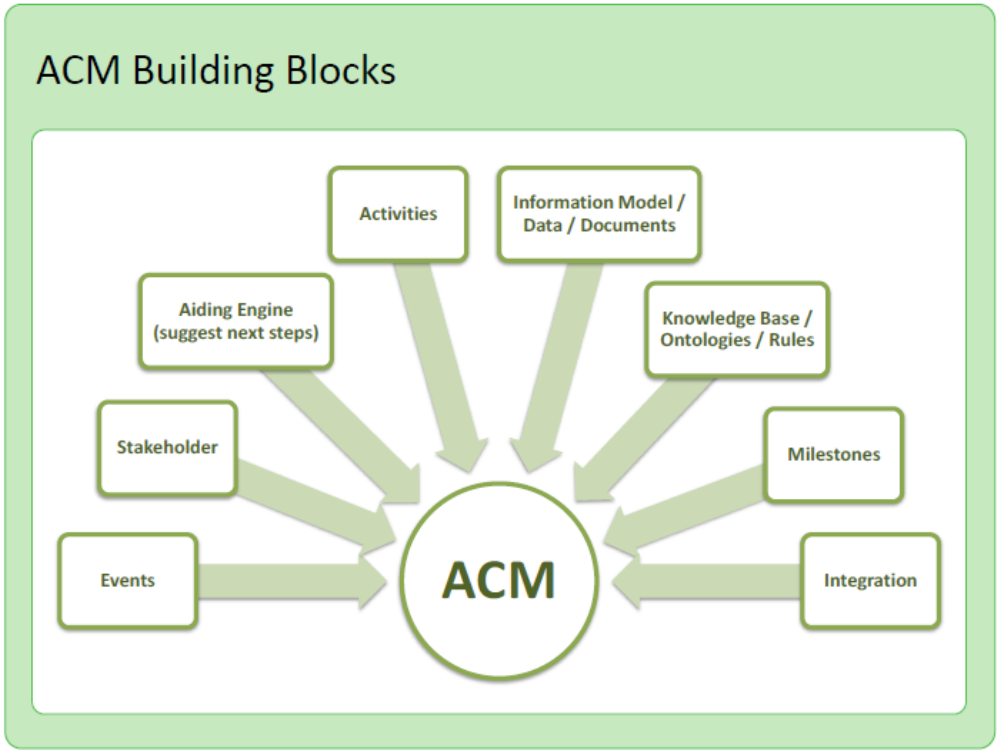
To clarify ACM, and why a knowledge worker requires ACM support, the claim regulation example is used. The claimant, an insurance company customer, files a claim related to a car accident. Within the insurance company, a claim is created and an employee, the claim manager, is assigned. The claim manager is responsible to make the decision about the next step how to handle the claim. He receives new information like a police report, or collaborates with experienced colleagues. His work is data centric. Based on new data, the knowledge worker decides on the next and new activities, like to request a medical report. This report might be send via collaboration tools, e.g. e-mail, or received via and integration platform from enterprise applications. Once he achieves his goal to regulate this claim, the next step, e.g. payment of the claim, might be a normative BPMN process.

Why ACM?

- “Empower Knowledge Worker
- Living Knowledge base to embrace the learning organization
- Suggesting instead of Mandating
- No more rigid process boundaries
- Adaptive approach to the unpredictable process variances
- Discovery of process paths
- Complements BPMN
- Collaborative Decision Making” (Kress, et al., 2014)

In the claim management example ACM empowers the knowledge worker to make better decision, which might result in reduced regulation spending, e.g. by detecting fraud, and an increase in customer satisfaction by faster claim regulation. As the audit trail and data of each decision becomes available, the knowledge base of the ACM system constantly increases, the knowledge worker easily can access via search functionality previous cases. He is not forced in process steps that are not required. Instead, he can take unpredictable process variances. In the claim management example, personal damage might result in incapacity to work, and high regulation payments. Therefore, the knowledge worker can get support from an experienced colleague to collaborative make the decision. The additional assigned experienced knowledge worker gets, via the ACM system, an instant overview of achieved milestones and data, e.g. the police investigation, or the accident pictures. Equipped with this information, he can make faster and better decisions. This might also apply in case one knowledge worker is on sick leave and a colleague needs to take over the case.

Based on the requirements of a knowledge worker, and how case management can support them, ACM Building Blocks can be defined. Figure 2-4 shows typical ACM Building Blocks (Kress, et al., 2014), which are described with the aid of the claim regulation example.



Source: Kress, et al., 2014 p. 1

Figure 2-4 ACM Building Blocks

Stakeholder: The claim manager is a stakeholder.

Milestones: With the identification of the stakeholder a milestone is achieved.

Integration: The ACM system is integrated with corporate applications, which provide case data, e.g. insurance contract data, claimant address.

Events: Receiving a new document, e.g. the police report, is an event.

Activities: The stakeholder can request a missing document.

Aiding Engine: The ACM system can suggest, as a next step, the activity to request a doctor report, following similar progress on previous cases.

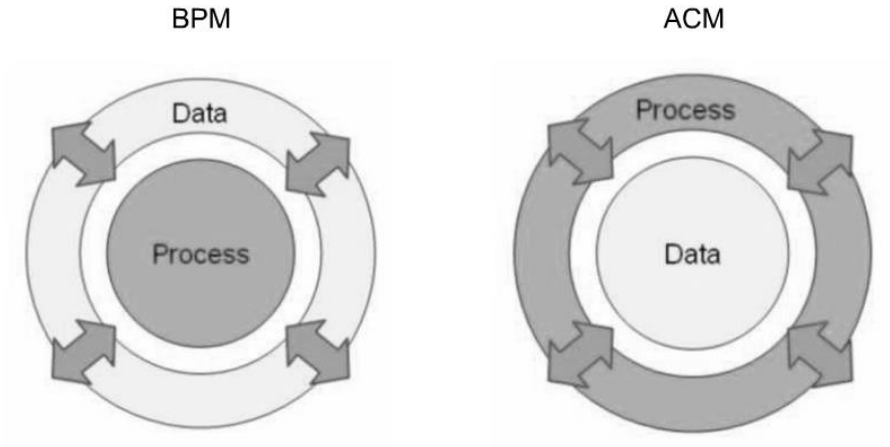
I**nformation Model / Data / Documents**: All case data and documents are organized and searchable at a central repository, e.g. claim file, accident report, car pictures, doctor report, and communications with the police.

Knowledge Base / Ontologies / Rules: Based on a rule, a next activity might be suggested or enforced. For example, if the claim value exceeds 1 Million Euro, a second claim manager needs to be consulted. Case history from previous similar cases can be easily identified and accessed.

2.2 BUSINESS PROCESS MANAGEMENT AND ADAPTIVE CASE MANAGEMENT

The check-in and claim regulation examples clarify BPM and ACM. Within BPM, the process is the central theme with the goal to rationalize it. Today an airline check-in process can be automated. The BPM system keeps the process persistent. A token represents the status within the rigid process, the process is the driver. Within ACM, process data is the central theme. Today, a claim handling process can be supported with ACM. The ACM system supports the knowledge worker to achieve his milestones and goals. The ACM systems keeps the data persistent, data is the driver.

From the technical perspective, a BPM engine steps need to be performed in a persistent order. Once a process instance has started, new steps cannot be added. (Silver, Case Management: Adressing unique BPM requirements, 2012). An ACM engine step can be added or changed at runtime by the knowledge worker. Figure 2-5 (Swenson, et al., 2010) shows the organization of a BPM Systems and an ACM System.



Source: Swenson, et al., 2010 p. 813

Figure 2-5 Organization of a BPM System and an ACM System

Strengths of Business Process Management is the rationalize structures process rigid to achieve the goal efficient. Compared to it, the strengths of Adaptive Case Management is the combination of the knowledge worker experience with additional IT based information, to enable the knowledge worker to make better decisions (Pucher, 2012). Table 2-2 highlights the key characteristics of Business Process Management versus Adaptive Case Management.

Table 2-2 Business Process Management versus Adaptive Case Management

Business Process Management	**Adaptive Case Management**
Process centric	Data centric
Routine worker	Knowledge worker
Structured rigid process	Unstructured process
Predictable process flow	Unpredictable process flow
Structured data	Unstructured data
Objective to automate process	Objective to achieve milestones and goal
Process initiates tasks	Knowledge worker selects activities: to-do list, checklist, reach goal, suggest next step
Designed by domain expert	Knowledge worker control
Audit trail shows the process flow	Audit trail shows decision data
Top down approach	Button up approach / combined approach

2.3 INDUSTRY EXAMPLES ADAPTIVE CASE MANAGEMENT

Table 2-3 shows various ACM samples across industries.

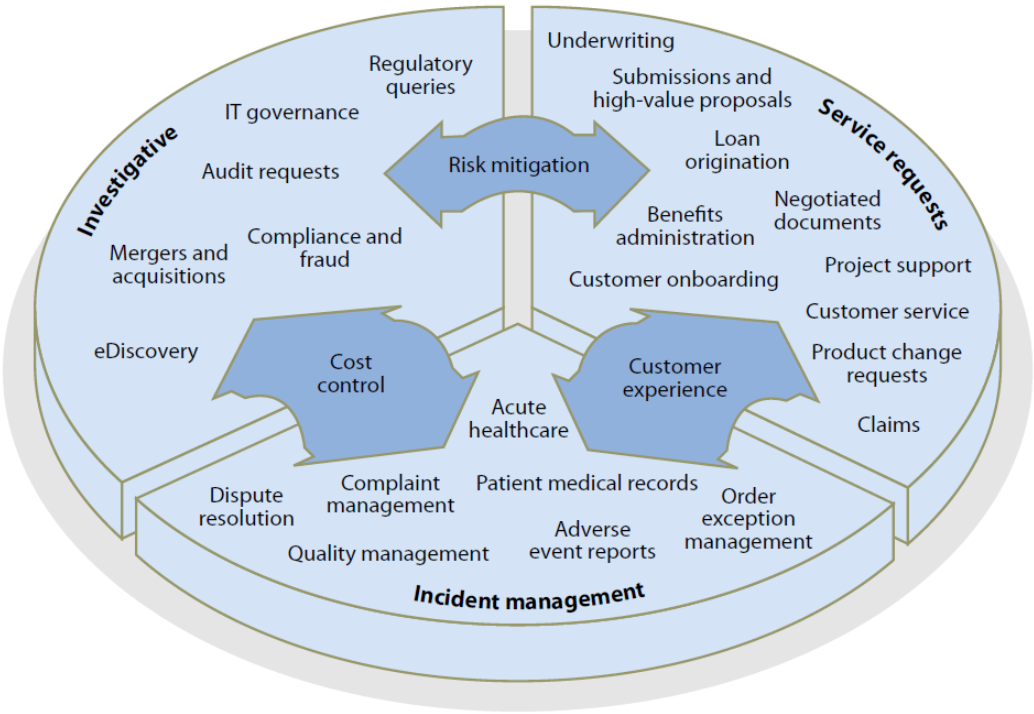
Table 2-3 Industry Examples ACM

Public Sector	Financial Services	Insurance	Healthcare	Energy & Utility	Service Business	Telecommunications	Retail
Benefits eligibility	Loan origin	Claim regulation	Payer claim processing	Process safety management	Customer service management	Network management	Warranty management
Grants management	Investor services	Underwriting	Patient record	Catastrophe management	Claim management	Customer service management	New product development
Tax processing	New account opening	New account opening	Legal contact management	Transmittals Processes	Portfolio management	Claim management	Price definition
Unemployment	Dispute resolution	Dispute resolution	Dispute resolution	Resource exploratory	Student application		
Welfare services	Wealth management	Policy management	Member enrollment		Campaign management		
Police investigation	Compliance				Contract management		
Legal case work							

Based on the ACM industry examples different ACM categories can be defined. In 2009, Forrester defined three types of case management categories:

- Investigative
- Incident management
- Service requests

The Forrester segmentation is similar to the Gartner definition. Additionally, Forrester defines three key drivers between the segments: Risk mitigation, cost control and customer experience. The claim management case is categorized as service request and involves risk mitigation and customer experience. The insurance company has the goal to manage their risks by moderating the claim payments and the goal to achieve customer experience by good and fast claim regulation. Figure 2-6 shows the Forrester case management categories (Clair & Miers, 2014).



Source: Clair & Mieres, 2014 p. 8

Figure 2-6 Three case management categories will emerge

In 2014, Gartner segmented ACM in four key areas: Service request, Investigative, Incident and Process to decision. For each area, characteristics and samples are defined (Hill, Chin, & Dunie, 2014)

Service request

Characteristic: workflow-heavy

Example: insurance and healthcare claims

Claim management for insurances and healthcare provides Gartner as typical examples for the service request category.

Investigative

Characteristic: data-heavy

Example: criminal investigation

Criminal investigation is the example for the investigative category. Within a criminal investigation, a large amount of different data is collected. The goal is to analyze relationships and patterns between this data. Based on this data, the knowledge worker, e.g. police offer, decides on ah-hoc activities.

Incident

Characteristic: collaboration-heavy

Example: Natural disasters

Incidents like natural disasters, e.g. forest fires, require from the fire department collaboration between the team and between governmental institutions, e.g. police to evacuate houses. Often, this incidents require urgency.

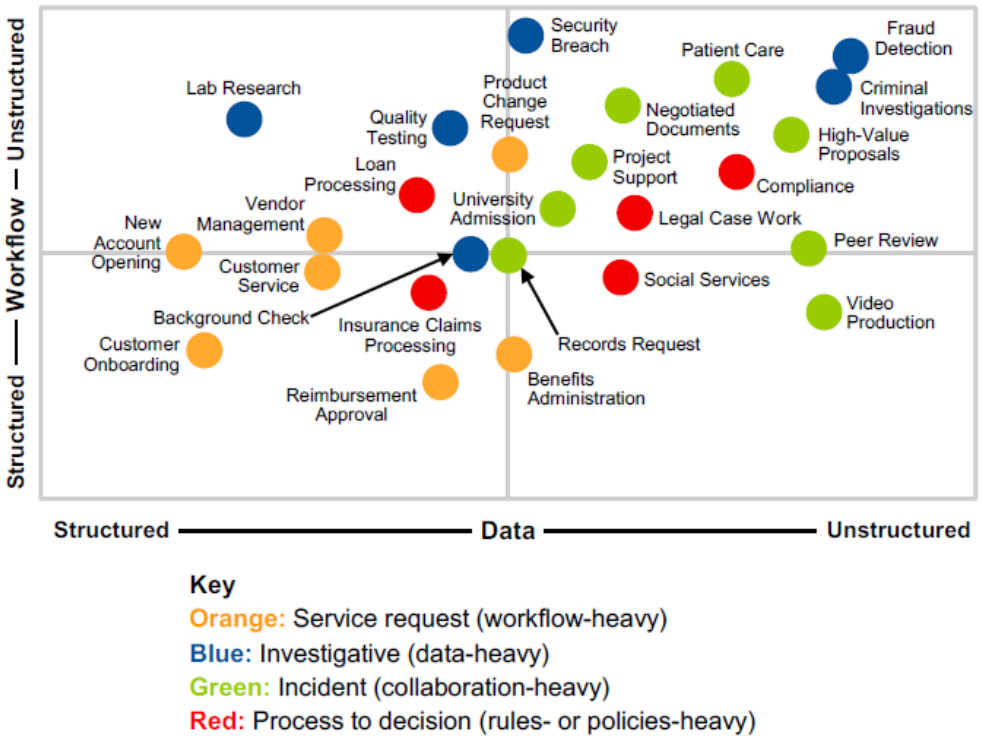
Process to decision

Characteristic: rules- or policies-heavy.

Example: compliance audits

Compliance audits driven by government regulations, e.g. banks audited by the central bank to assess their credit risks. This audits are driven by many rules and policies, e.g. credit risk exceeds a level bank needs to ensure additional securities.

Gartner clusters the category examples in a chart ordered by structured/unstructured data, and structured and unstructured workflow, shown in Figure 2-7 (Hill, Chin, & Dunie, 2014).



Source: Hill, Chin, & Dunie, 2014 p. 10

Figure 2-7 Sample Case-Based Processes

2.4 ACM ADAPTIVITY LEVELS

ACM solution sophistication can usually relates to its level of adaptivity. Swenson et al. (2015) (Swenson, et al., 2015) defines such levels in the book "Thriving on adaptability":

- Predefined
- Dynamic
- Guiding
- Adaptive (Swenson, et al., 2015)

The lowest level are represented by pre-defined workflow engines. IT departments can change pre-defined activities, which can be executed by the knowledge worker.

Dynamic adaptivity is represented by BPMN engines with ACM functionality. Events and business rules for gateway result in different process paths the knowledge worker can choose. Knowledge worker might be able to change events and rules, activities and process path is typically predefined at design time.

An ACM system which includes guiding functionality like decision dashboards or collaborative decision making are able to support the knowledge worker by suggestion next steps or similar cases. The set of activities is still defined at design time.

A truly adaptive system is based on ontologies and semantic models that results in a learning knowledge base. The knowledge worker can change the activities and data structures any time by himself without the need to interact with the IT department. Such a truly adaptive case management system is part of future studies and work. Each adaptivity level is described in the Table 2-4 (Swenson, et al., 2015) Overview of adaptivity levels, building blocks and examples.

Source: Swenson, et al, 2015 p. 43

Table 2-4 Overview of adaptivity levels, building blocks and examples

Type (level of adaptivity)	**Systems / languages / means**	**Example**
Adaptive	Ontologies, Semantic models, OACM (ontology based ACM)	Learning knowledge, inference of results rather than static queries, changes on the fly to activities, addition of new activities, changes to data structures, one (NON IT centric) vocabulary
Guiding	Analytics in ACM decision dashboard, integration of statistical means (e.g. R), Collaborative Decision Making (CDM), Social BPM	Others have done ABC in your current context, rules bases reasoning, sharing of knowledge across contexts. ACM engine suggest best next steps; user picks one, rules/statistic framework integration. Still finite set of a priori defined activities (known already at design time).
Dynamic	BPMN / workflow engine / ACM	More dynamic workflows. Typically using features like events in BPMN or like business rules for gateway logic. Often list of possible steps is dynamically read from external places, like Excel sheet. First ACM engines address this. Finite set of a priori defined activities (known already at design time),
Predefined	BPMN / workflow engine	Static workflows – a priori defined activities (all known during process design), static, changeable through IT only.

2.5 RESEARCH STATUS OF ADAPTIVE CASE MANAGEMENT METHODOLOGY

A research for the state of the scientific knowledge of Adaptive Case Management Methodologies was conducted. The three following Adaptive Case Management Methodologies were chosen as examples. The 7 Key Components for an Effective Case Management Methodology (Wanless, 2010) was chosen for being one of the first methodologies evolved in healthcare based on a document management solution. Second, the methodology Building the Solution with ACM (Swenson, et al., 2010) was chosen for being a published methodology in the ACM book, called Mastering the Unpredictable, even before the CMMN notation became available. Third, the methodology Case Management Solution Framework (Smiers, Koster, Deb, & Palvankar, 2015) was chosen for its focus on vendor tool selection for ACM solutions.

None of this three methodologies support a truly agile approach. The characteristics of an ACM project might favor a more agile approach (Agile Alliance, 2015). Expected that due to the relatively young age of the Adaptive Case Management concept a waterfall approach was preferred, which might change in the future. (Beck, et al., 2001).

The research also considered if Service Oriented Architecture or Business Process Management Methodologies could be used as an ACM Methodology. The conclusion was the advantage of SOA Methodologies, like SOA Design Patterns from Thomas Erl (Erl T., 2009), Guiding the selection of service-oriented software engineering (Gu & Lago, 2011), A methodology for service architectures (Jones & Morris, 2005), or A Service-Oriented Software Development Methodology from Ricardo Puttini (Puttini, et al., 2012), is that they are similar to ACM due to the data centric (re-usability of services) approach. On the other hand, their use for ACM is limited due to the lacking concept of knowledge workers and support for business people.

Concerning BPM Methodologies, the advantage of such kind of methodology like Business Process Management Practical Guidelines to Successful Implementations (Jeston & Nelis, 2008), Bpmn Method and Style with Bpmn Implementer's Guide (Silver, Bpmn Method and Style with Bpmn Implementer's Guide, 2011), Knowledge Automation: How to Implement Decision Management in Business Processes (Fish, 2012), Enterprise BPM: Erfolgsrezepte

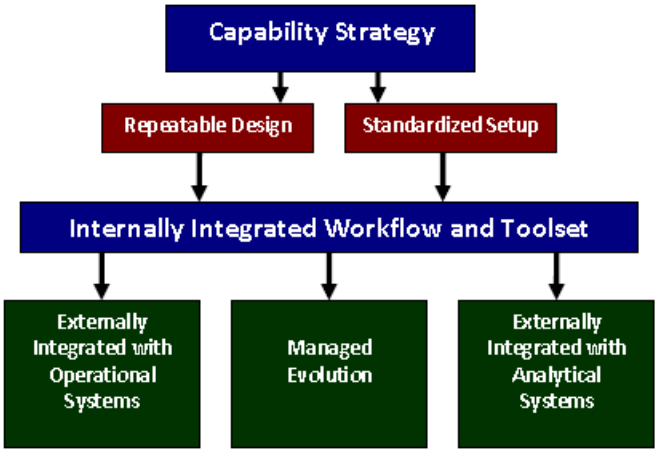
für unternehmensweites Prozessmanagement (Slama & Nelius , Enterprise BPM: Erfolgsrezepte für unternehmensweites Prozessmanagement, 2011) or How Work Gets Done: Business Process Management, Basics and Beyond (Mahal , 2010), is that they are suitable for business people. BPMN 2.0 is a widely accepted and understood notation for modeling business process. The disadvantage is that their use for ACM is limited due to the lacking support of the CMMN notation and therefore the lacking data centric approach.

The 7 Key Components for an Effective Case Management Methodology (Wanless, 2010)

The paper "The 7 Key Components for an Effective Case Management Methodology" from Scott Wanless focused on healthcare, a sweat spot for ACM. This methodology consist of seven key components

- Capability strategy
- Repeatable Design
- Standardized Setup
- Internally integrated workflow and toolset
- Externally integrated with operational systems
- Managed evolution
- Externally integrated with analytical systems (Wanless, 2010)

Based on the software tooling the methodology is focused for document driven cases in hospitals especially patient medical records. Templates and model capabilities are not components of the methodology. Figure 2-8 (Wanless, 2010) shows the seven key components of the case management methodology.



Source: Wanless, 2015 p. 8

Figure 2-8 Seven key components of a case management methodology

Building the Solution with ACM (Swenson, et al., 2010)

In the book Mastering the Unpredictable: How Adaptive Case Management Will Revolutionize the Way That Knowledge Workers Get Things Done, Dana Khoyi published a guideline how to build a ACM solution This guideline is based on the following key elements:

- Describe the Business Entities
- Describe the Relationships Between the Business Entities
- Add Detail to Each Business Entity
- Specify Associated Documents
- Specify the Tasks
- Create a Template Library
- Add Processes
- Specify User Presentation (Swenson, et al., 2010)

The example used in the guideline is a HR on-boarding solutions for new employees. In the first step the business entities are created, follow by modeling an entity-relationship model based on the ideas of Peter Chen. In the next step the capabilities and stages are defined for each business entity. Each business entity is defined as a case. In the fourth steps the case documents are outlined. Task for the knowledge worker are predefined and associated to the cases. This tasks also include the stakeholders. Predefined set of information, documents and tasks can be groups as a template. Cases might trigger structured processes. In the final step the user presentation is defined. This example indicates what steps are required to build an ACM solutions. Key concepts of modern ACM solutions like goals, milestones or CMMN modeling are not part of this process.

Case Management Solution Framework (Smiers, Koster, Deb, & Palvankar, 2015)

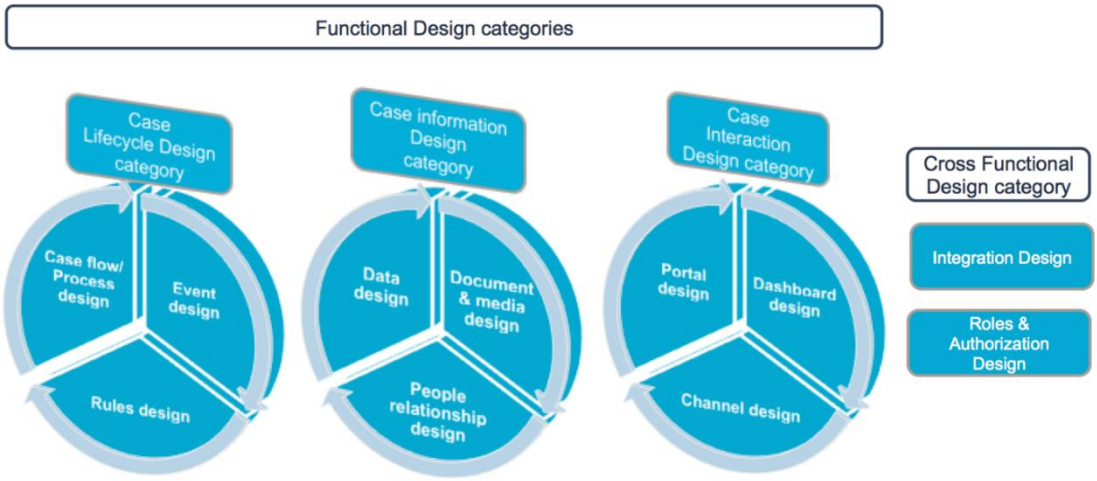
In the book Oracle Case management Solutions Leon Smiers, Manas Deb, Joop Koster and Prasen Palvankar describe an ACM solution framework. This ACM solution framework includes:

- Case management functional design
- Case management classifications
- Determine Solution mapping (Smiers, Koster, Deb, & Palvankar, 2015)

Case management functional design is divided in functional design categories and cross-functional design categories. The functional design category includes case lifecycle, case

information design and case interaction design. The cross-functional design category consists of integration design and roles & authorization design.

Based on the Forrester ACM categories (service requests, incident management and investigative handling), the functional design categories and cross functional design categories are described. In the last step, the functionality is mapped towards solution layers and technical capabilities. A Common Reference Architecture (CORA) model is provided. Figure 2-9 (Smiers, Koster, Deb, & Palvankar, 2015) shows the Case Management design categories and components.



Source: Smiers, Koster, Deb, & Palvankar, 2015 p. 103

Figure 2-9 Case Management design categories and components

A detailed template for both the functional design and the cross functional design categories is described. This template, show in Table 2-5 (Smiers, Koster, Deb, & Palvankar, 2015), details the case design components including their high level functionality. This case management solution framework gives good advice for the type of ACM solution based on the Forrester categories. Therefore it is a good approach for vendor and tool selection.

Available methodologies for ACM Systems represent a good start based on the young age of the adaptive case management concept. With recent introduction of CMMN 1.0 in May 2014 ACM methodologies will evolve. This introduction of CMMN is reflected in this dissertation. Similar to service oriented architecture, ACM methodologies will mature over time based on research and project experience.

Source: Smiers, Koster, Deb, & Palvankar, 2015 p. 117

Table 2-5 Summary of case management design components

Case Design category	Case Design component	High level functionalities
Case Lifecycle design	Case Flow/Process design	The Case flow specific for a case
	Rules Design	Case lifecycle decision-making
		Entitlement determination
		Progress measurement
		Data entry validation
		Information discovery
	Event Design	Interrupting events
		Non-interrupting events
Case Information design	Data Design	Case execution data
		Case supporting data
		Tactical -related information
		Strategic data
	Document & Media design	Case input management
		Case output management
	People Relationship design	Internal stakeholders
		External stakeholders
Case User Interface design	Portal design	One central view on the case
		One overview of the customer
	Channel design	Internal communication
		External communication
	Dashboard design	KPI management
		Performance management
		Customer satisfaction determination
Cross-functional design	Integration design	Application integration
		Case integration
		Portal/Channel integration
	Roles & Authorization	Internal profiles
		External profiles
		Compliance

3. CASE MANAGEMENT MODEL AND NOTATION

Case Management Model and Notation (CMMN) is a standard defined by Object Management Group. CMMN 1.0 was published in May 2014, followed by the current version 1.1. Beta, in March 2016. Case management requires modeling and notation that can express the essential flexibility that human case workers want. (Babich, et al., Case Management Model and Notation (CMMN), 2014). CMMN can cover both design time and run time. During the design-time a business analyst is visualizing the process based on the CMMN Model. During the run time a case worker executes the model plan. During execution, this plan can evolve. (Babich, et al., Case Management Model and Notation (CMMN), 2014)

3.1 CMMN CONCEPTS

The Case Management Model Notation is based on the concepts:

- Case Plan Model & Case File Item
- Stage
- Milestone
- Activities
- Decorators
- Events
- Stakeholders

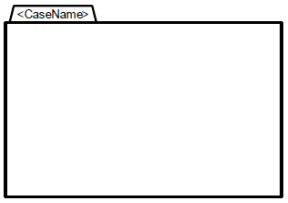
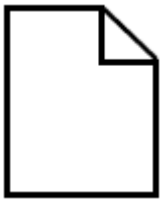
For this CMMN concepts, standardized graphical notation is defined, as shown in table 3-1. Expect the Stakeholder which are not represented in the graphical notation.

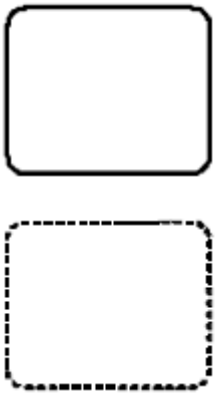
3.2 CMMN ELEMENTS

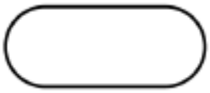
CMMN includes a visualization of the model. Similar to BPMN CMMN allows the process analyst to draw a model. The following CMMN notations are used to model a case. Table 3-1 (Kress, et al., 2014) shows the CMMN Elements and the related Notations. Figure 3-1 (Babich, et al., Case Management Model and Notation (CMMN), 2013) shows the Decorators Applicability Summary Table.

Source: Kress, et al., 2014 p. 1

Table 3-1 CMMN Elements and Notations

Element	**Notation**
Case Plan Model The complete behavior model of a Case is captured in a CasePlanModel. It comprises both: all elements that represent the initial plan of the Case, and all elements that support the further evolution of the plan through run-time planning by case workers. There are four types of PlanItems: Tasks, Plan Fragments / Stages, EventListeners and Milestones.	
Case File All information, or references to information, that is required as context for managing a Case, is defined by a CaseFile. Every Case is associated with exactly one CaseFile. It contains CaseFileItems that can be anything from a folder or document stored in CMIS (Content Management Interoperability Services), an entire folder hierarchy referring or containing other CaseFileItems or simply an XML document with a given structure.	
Stages Stages do have run-time representations in a Case (instance) plan. Instances of Stages are tracked through the CMMN-defined Stage lifecycle. They may be considered “episodes“ of a Case, though Case models allow for defining Stages that can be planned in parallel also. A Stage is depicted with a marker in the form of a “+“ (collapsed) or “-“ (expanded) sign in a small box at its bottom center.	

Tasks Case management planning is typically concerned with determination of which Tasks are applicable, or which follow-up Tasks are required. A Task is an atomic unit of work. During the design-time phase of a Case, business analysts engage in modeling, which includes defining Tasks that are always part of pre-defined segments in the Case model, and "discretionary" Tasks that are available to the Case worker, to be applied in addition, to his/her discretion. In the run-time phase, Case workers execute the plan, particularly by performing Tasks as planned and adding discretionary Tasks to the plan of the Case instance in run-time.	
Blocking Human Task A blocking HumanTask is waiting until the work associated with the Task is completed.	
Non-Blocking Human Task A non-blocking HumanTask is not waiting for the work to complete and completes immediately, upon instantiation.	
Process Task A ProcessTask can be used in the Case to call a Business Process.	
Case Task A CaseTask can be used to call another Case.	

Milestone A Milestone represents an achievable target, defined to enable evaluation of progress of the Case. No work is directly associated with a Milestone, but completion of set of Tasks or the availability of key deliverables (information in the CaseFile) typically leads to achieving a Milestone. A Milestone may have zero or more entry criteria, which define, when a Milestone is reached.	
Event Listeners In CMMN an event is something that "happens" during the course of a Case. Events may trigger, for example, the enabling, activation and termination of Stages and Tasks, or the achievement of Milestones. Instances of TimerEventListener are used to catch predefined elapses of time. A UserEventListener enables direct interaction of a user with the Case.	
Planning Tables Planning is a run-time effort. A Stage or a HumanTask can have a PlanningTable. The PlanningTable can be used to plan instances of Tasks and Stages into a Stage instance or into a Stage that contains a HumanTask with a PlanningTable.	
Sentries Sentries define the criteria according to which the PlanItems are enabled (or entered) and terminated (or exited).	

Stakeholders: CMMN defines roles for case workers. A CaseRole authorize a case worker to perform a HumanTasks.

Decorator Applicability	Planning Table	Entry Critrion	Exit Criterion	AutoComplete	Automatic Activation	Required	Repetition
CasePlanModel 	☑		☑	☑			
Stage 	☑	☑	☑	☑	☑	☑	☑
Task 	HumanTask only	☑	☑		☑	☑	☑
MileStone 		☑				☑	☑
EventListener 							
CaseFileItem 							
PlanFragment 							

Source: Babich, et al., 2014 p. 70

Figure 3-1 Decorators Applicability Summary Table

4. ADAPTIVE CASE MANAGEMENT METHODOLOGY PROPOSAL

A methodology offers the theoretical underpinning for understanding which method, set of methods, or so-called “best practices” can be applied to specific case, for example, to calculating a specific result. The New Oxford American Dictionary defined methodology as a system of methods used in a particular are of study or activity: a methodology for investigating the concept of focal points courses in research methodology and practice (Angus Stevenson, Christine A. Lindberg , 2010). A software methodology contains the phases Modeling, Visualization, Analysis, Design, Development and Implementation.

4.1 OVERVIEW ADAPTIVE CASE MANAGEMENT METHODOLOGY

In this work, existing analyses, technologies and models are adapted and combined towards a structured and formally defined Adaptive Case Management Methodology. The ACM Methodology presented at this chapter consists of five major phases:

- Business Modeling
- Visualization
- Analysis
- Design
- Implementation

Each phase is described in details together with a set of software artifacts (outcomes), which are developed by different professional roles during the process. As part of the methodology description, specialized software artifact models and templates are created to cover the interests of ACM solution development. Table 4-1 shows the ACM Methodology Phases with their artifacts and stakeholders, and Figure 4-1 shows samples of these artifacts. Each phase is also illustrated using a Case Study derived from an actual customer implementation. A sample implementation for this Case Study is available at www.acmcommunity.com.

Table 4-1 ACM Methodology Phases

Phase	Artifact	Professional Role
Business Modeling	Business Motivation Model Organization Operative Model Information Model	Business Owner Business Analyst
Visualization	ACM Workspace (user interface)	Knowledge Worker Business Analyst User Experience Expert
Analysis	ACM Canvas	Knowledge Worker Business Analyst
Design	CMMN Model	Business Analyst Architect
Implementation	Implementation Spreadsheet Code (e.g. IDE project)	Developer Business Analyst

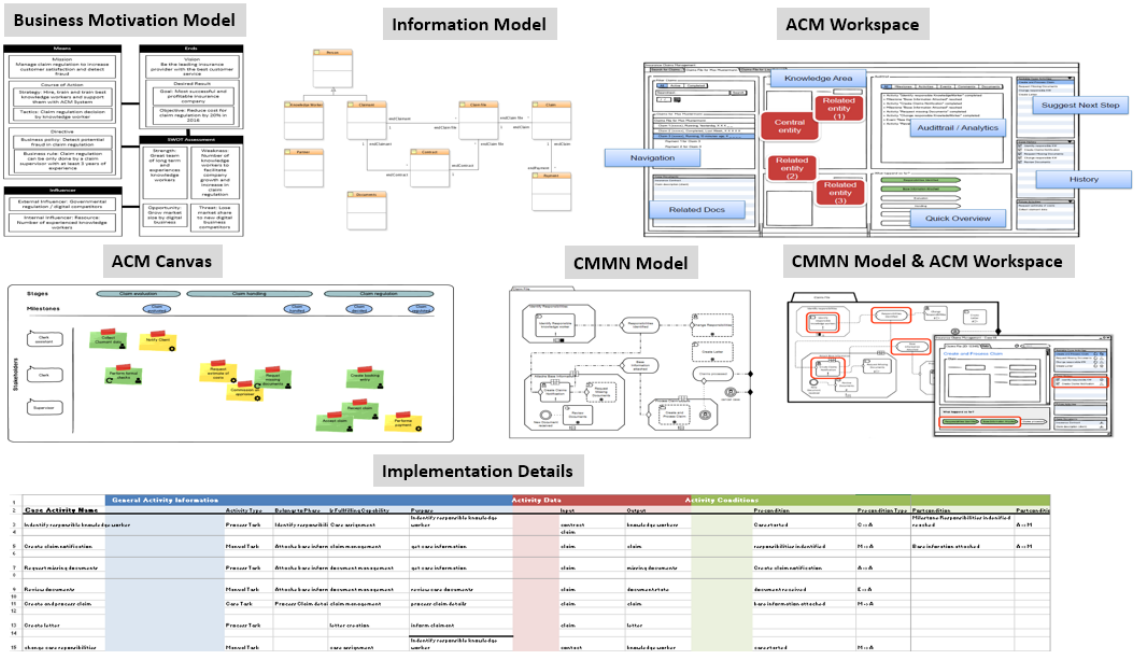


Figure 4-1 Overview of ACM Methodology Artifacts

4.2 BUSINESS MODELING

The Business Modeling phase consists of three steps, the Business Motivation Model (BMM), Organization Operative Model and Information Model. The goal is to understand why an ACM solution is needed, who are the stakeholders, and what information should it contain.

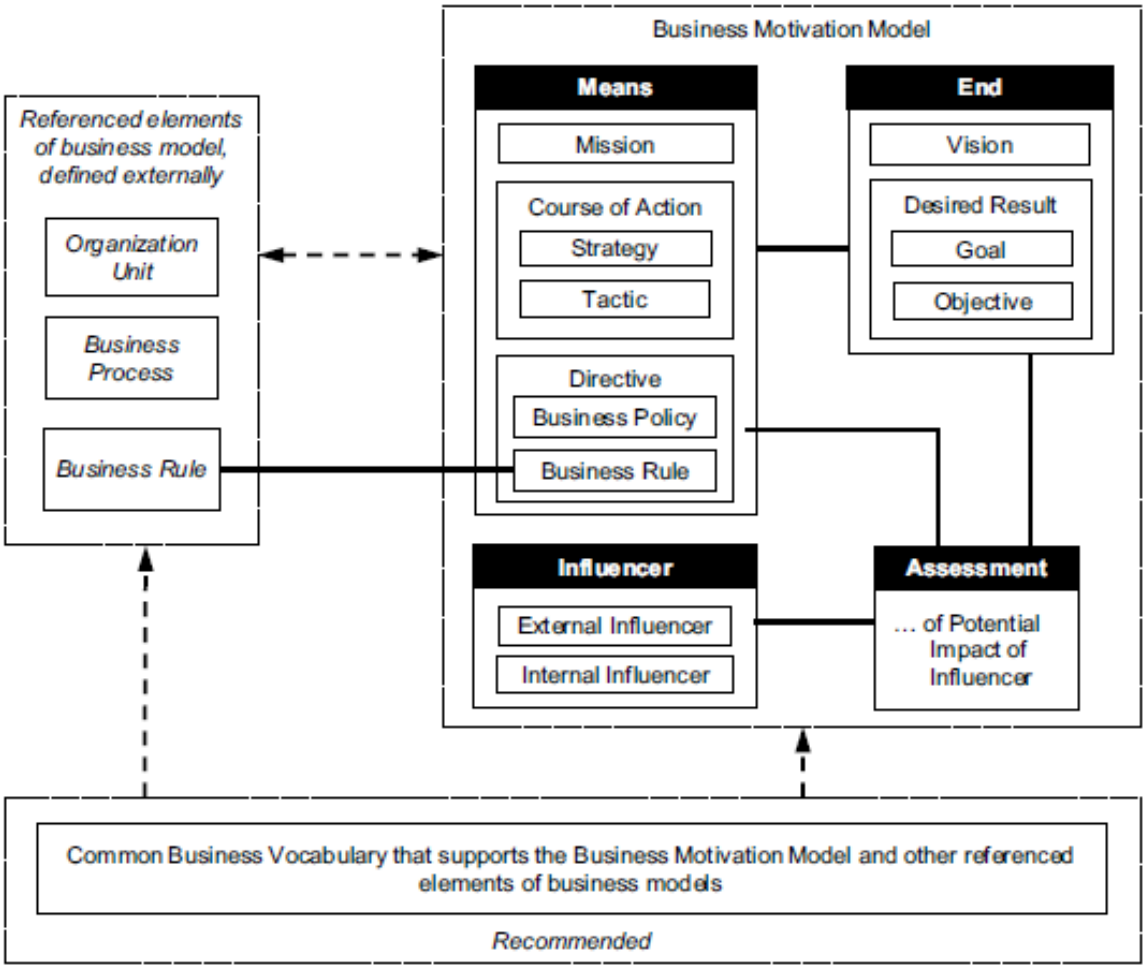
4.2.1 Business Motivation Model

To understand what and why an organization wants to achieve, a business plan is an essential tool. To support the development of a business plan, OMG developed the Business Motivation Model (BMM). The BMM does not include a methodology, but provides a structure to develop a business plan. This structured approach defines the high level motivations and elements of an enterprise business plan (Hall, Healy, & Ross, 2015). Within the ACM methodology, the BMM is used to develop a business case plan. Within the ACM methodology, the business case plan helps to understand the organization's end (its vision and desired results), and means (its mission and the course of action), to plan the business case. The ACM solutions should address a specific business goal, which is reflect the company goals driven by their strategy and tactics. The BMM is used to align the ACM Solution with existing company mission, vision and goals.

The Business Motivation Model has four key elements:

- End: What the business wants to achieve in the future.
- Means: The action plan how the business wants to achieve the end.
- Influencer: The capacity to have an effect categorized in internal and external influencers.
- Assessments: The evaluation of the influencers. Internal influences can be the strength and weakness, external influences can be threats and opportunities (SWOT).

End is expressed by the enterprise vision. *Desired Results* are described in the long-term business *Goals* and the short-term *Objectives*. An *Objective* should be attainable, time target and measurable. *Means* are expressed by the enterprise mission. *Course of Action* is described in the long-term *Strategy* and the short-term *Tactics*. *Directives* govern what can be done within the enterprise. Less formal directives are defined in *Business Policies*. Formal directives are defined in consistent *Business Rules*. *Means* reference external BMM elements including the organization unit which executes the business processes that are governed by the business rules (Hall, Healy, & Ross, 2015). Figure 4-2 shows the BMM Overview (Hall, Healy, & Ross, 2015).



Source: Hall, Healy, & Ross, 2015 p. 12

Figure 4-2 BMM Overview

4.2.2 Organization Operative Model

The Business Motivation Model is linked to the organization stakeholders and roles. The Organization Operative Model represents the stakeholders and roles at the organization involved with the case. Stakeholders can be categorized as internal and external. Internal stakeholders work within the organization, e.g. employees, while external stakeholder are outside the organization, e.g. customers. The development of the Organization Operative Model ensures that the stakeholders are identified.

Within the internal organization, several roles can be defined:

- Management: Based on the business motivation model the management defines, approves, governs, and sponsors the case means and the case end.
- Case Owner: Domain expert who is responsible for case transparency, case optimization and case performance.
- Case Controller: Business operation expert responsible for case.
- Case Manager: Knowledge worker who is the process holder that makes the process decisions.
- Case Employee: Knowledge worker who process and enriches the case with information.
- Case Administrator: Maintains case and case infrastructures.

Often one person might unify multiple roles in the organization.

4.2.3 Information Model

As ACM is about information, the starting point for an ACM solution design is an information model. Data within ACM solutions can be categorized in structured and unstructured data. Examples for structured data in the ACM context are execution data, supporting data, audit trail data and enterprise databases. Unstructured data includes documents, pictures, and communications like e-mail and social data. Table 4-2 shows the Data Categories within ACM. A detailed information model development is the outcome of this phase. Note that often corporate information models are available and existing models should be leveraged. The development of the Information Model ensures the identification of the case data.

Table 4-2 Data Categories within ACM

Data Categories	**Data Examples**
Structured	Execution data Supporting data Audit trail data Enterprise database
Unstructured	Documents Pictures Communications Social Media

The business analyst conducts interviews with the operative stakeholders with the goal to develop a high-level Information Model. Whiteboard technique embracing post-it notes is an interactive approach with the stakeholders. Based on the results, tools like mind maps or class diagrams can be used to represent the information entities and relationships.

4.3 VISUALIZATION

The case information needs to be available for the knowledge worker. Figure 4-3 (Swenson, Palmer, & Carlsen, Empowering Knowledge Workers, 2014) shows the importance of Visualization for the knowledge worker.

Source: Swenson, Palmer, & Carlsen, 2014 p. 336

Figure 4-3 Empowering knowledge Workers

Within the ACM solution, the knowledge workers receive all information through a specialized user interface, called ACM Workspace. In order to build this, the work patterns of knowledge workers are analyzed and UI elements are design to provide visibility in work status, tracking task lists/milestones, team collaboration, manage documents for a given case and to understand the next steps (Oracle Applications User Experience, 2014). To increase acceptance, testing with the knowledge workers is necessary. Modern user interfaces increase the user experience and user acceptance of the solution. Direct feedback from the users improves the acceptance of the UI, gives early insight in required information and

makes it cheaper to develop (Bank & Cao). The ACM Workspace ensures the usability of the ACM solution (Usability.gov, 2016). For an ACM Workspace, five main elements can be identified:

- Navigation and Search
- Documents
- Milestones and History
- Activities
- Case Information

Navigation and Search enables the knowledge worker to find information. Search functionality can be modified by filter, free text search or chronological.

Documents shows all documents of the case, such as contacts, pictures and e-mail collaboration.

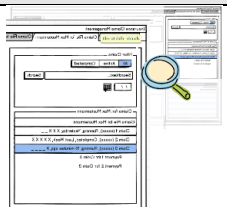
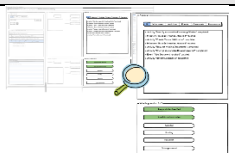
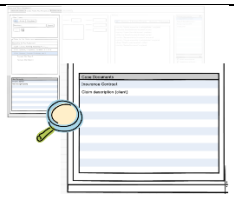
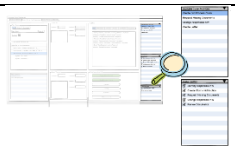
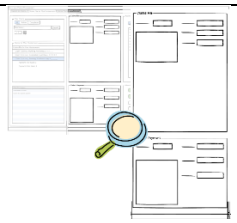
Milestones and History help the knowledge worker to understand the current progress of the case. Graphical representation of the milestones supports a good overview. An *Audit Trail* can also be attached, allowing the user to browsed information or selections like milestones, activities, events, comments and documents.

Activities helps the knowledge worker to understand what he can do next. These activities can be categorized in available activities, historic and future activities.

Case Information contains the domain-specific information, which usually varies based on the use case. *Case Information* is identified from the information model and usually extracted from existing systems through service abstraction.

From project experience, it is recommended to host a user interface workshop with the stakeholders in an early phase of the project. The workshop is prepared with the information gathered at the Business Modeling phase. The goal of the workshop is to get insight in the user requirements resulting in and ACM Workspace sketch. The user interface elements printed on posted notes allow an interactive workshop and result in rapid sketches. Good results can also be achieved with UI prototyping tools like Balsamiq for sketches and wireframes. Table 4-3 shows the ACM Workspace Templates.

Table 4-3 ACM Workspace Templates

ACM Workspace Element	Template	ACM Workspace Element	Template
Navigation & Search element		Milestones & History elements	
Documents element		Activities elements	
Claim details and related entities element		Mobile ACM Workspace	

4.4 ANALYSIS

Based on the information gathered in the previous steps, a high-level overview of the case system can be modeled. The analysis artifact proposed for this phase is called ACM Canvas. This model ensures the analysis of key solution functionality. ACM Canvas consists of:

- Stakeholder: Derived from the Organization Operative Model.
- Stage: Defined as a point, period or step in a process or development (Angus Stevenson, Christine A. Lindberg , 2010).
- Milestone: An action or event marking a significant change or stage in development. (Angus Stevenson, Christine A. Lindberg , 2010). A stage can consist of several milestones.
- Task: Work to be done or undertaken. (Angus Stevenson, Christine A. Lindberg , 2010). Tasks are categorized as human tasks and system tasks. Human tasks are accomplished by human stakeholders. System tasks are executed by IT systems.

Incremental information are the *Stages*, which consists of *Milestones* and the human & system *Tasks*. By composing the ACM Workspace, the business users can visualize the system, which supports the process to define the high-level case requirements. The starting point are the *Stakeholders* identified at the Organization Operative Model. Analysis of the Organization Operative Model and the required work for the case allows the identification of *Tasks*, which are matched with the responsible *Stakeholder*. Human and System *Tasks* are differentiated by decorators (human and engine icons). *Tasks* can be repeatable (circled arrow icon). *Tasks* are finally grouped by *Milestones*, which accumulate in *Stages*. A *Stage* can encompass one or multiple *Milestones*. Both elements represent the work progress for the case.

A workshop with the stakeholders is recommended. This workshop is prepared with the information gathered so far. An ACM Canvas template, as illustrated in Figure 4-4, is provided at a whiteboard. Stakeholders are listed at the left side of the canvas. Milestones and Stages are listed at the upper side. Tasks are arranged using posted notes (e.g. post-it), matching the corresponding stakeholders and milestone/stage. Human and system tasks can also use different colors (e.g. green and yellow). Posted notes allow interaction with the workshop participants to group, re-group and match them. Good results are achieved if the workshop combines the design of ACM Workspace and ACM Canvas in parallel. The workshop starts with a high-level user interface as an ACM Workspace template to motivate the stakeholders to describe their tasks. In an interactive approach, the ACM Canvas and ACM Workspace are developed and refined for the case details.

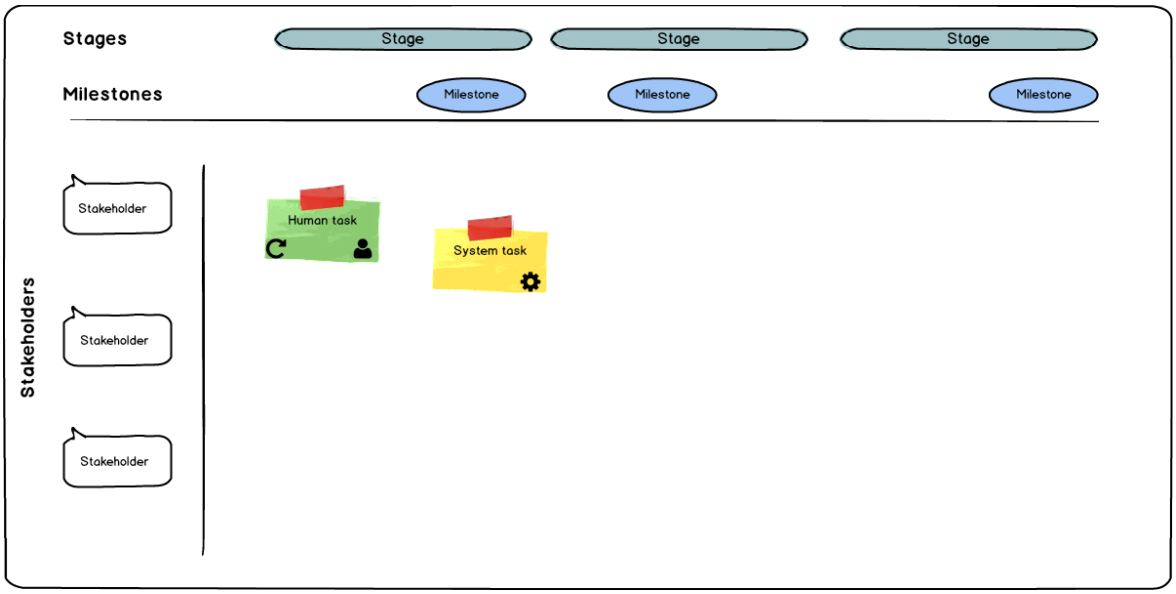


Figure 4-4 ACM Canvas template

4.5 DESIGN

Business analysts and the business stakeholders use the ACM Canvas to analyze the case. To implement an ACM solution, additional technical details are required for the developer. Technical requirements are often collected in a CMMN Model. A CMMN Model is much more complex and contains development details, acting as a facilitator between business and technology. However it is not suitable for business people to understand the case based on those technical details.

4.5.1 CMMN Model

The CMMN Model is defined in two steps. First step is performed by the business analyst and the business stakeholder. Together, they develop the business CMMN Model. The ACM Canvas Model is used as a starting point to draw the CMMN Model based on the CMMN notation. The business analyst with CMMN skills guides the business stakeholder. In a second step, the business analyst and the developer enrich the CMMN Model with implementation details. Results are collected in the technical CMMN Model. These two steps explain how CMMN creates a bridge between business and technology requirements.

4.5.2 CMMN Stakeholder Model

Based on the CMMN Model, the Stakeholder Model requires modifications to ensure a consistent executable model. CMMN includes a role model to represent the stakeholders.
Knowledge workers are authorized by CaseRoles to execute HumanTasks and trigger UserEventListeners. (Babich, et al., Case Management Model and Notation (CMMN), 2014). Out of the CMMN scope is also the assignment of roles to the actors/stakeholders. A role model is key to build an ACM solution. Therefore, it is necessary to refine the Organization Operative Model analyzed in a previous phase.
As part of the Organization Operative Model, external and internal stakeholders are defined. A role can be explicit or implicit. For software solutions, persons are defined in three categories: Stakeholders, Actors and Roles. A *Stakeholder* can be any person who is part of the business case. An *Actor* is a person who has access to the software solution. An *Actor* is represented by a *Role* in the software solution. User rights to execute tasks and trigger events in the ACM solution are specified, based on user roles.

In many cases, an identity management solution (IDM) already exists. This IDM solution can be used with the ACM solution. The required role with their associated tasks and events need to be represented in the IDM solution.

4.5.3 CMMN Rules Model

Similar to BPM, rules play also a key role in ACM. Within ACM, rules are used for decision logic and as a control plan element. In BPM, there are two types of rules: to model the process flow logic and to model the business decision logic. There are two types of rules: to model the process behavior (Control Rules) and to model the business decision logic (Decision Logic Rules). With the separation of business decision logic and rules to control plan elements, case consistency and transparency can be increased.

Decision Logic Rules in ACM are modeled with a DecisionTask. A *DecisionTask* can be used to invoke a decision and can be implemented with Decision Model and Notation (DMN) 1.0. Common business criteria to discover business decision rules are volatility, reusability, impact and compliance of the business case (Juric, et al., 2015). *Decision Logic Rules* can be organized and executed in rule engines.

In ACM, *Control Rules* are used to control the process behavior. Compared to BPM, in ACM, there is no priori sequential flow. Therefore, in CMMN, knowledge worker and process behavior is controlled by rules contained in Sentries and Decorators. These are attached to the CMMN elements.

A *Sentry* watches out for events to happen. A *Sentry* is a combination of an event and or a condition. If the sentry condition is evaluated true, the element is activated. The sentry defines the requirement to enter (entry criterion) and exit (exit criterion) the case element. With sentries, rules based on logical expressions (e.g. if, and, or operators) can be modeled in CMMN. Sentries are annotated at the CMMN element, but the rule condition details are not visible at the CMMN model.

Case elements can also have *Decorators*. CMMN defines the following decorators:

- Required: element execution is required as part of the case plan.
- Repetition: element execution can iterate.
- Manual activation: element is manually activated.
- Auto complete: element is automatically completed after fulfillment.

4.6 IMPLEMENTATION

The Implementation phase consist of three steps. First, developed models are bottom-up reviewed. In a second step, development details are defined for the developer in an Implementation Spreadsheet. In the last step, the actual implementation (coding) takes place. Coding is not described in this methodology, as it may vary broadly depending on adopted ACM platform and technology. However, the Implementation Spreadsheet artifact should fully specify the developers coding work.

4.6.1 Work Review

A bottom up check of the project can validate the consistency of the project. Based on the developed rule sets, technical and business CMMN Model and descriptions, ACM Canvas, Information Model, and Organization Operative Model should align with the company means and ends of the Business Motivation Model. Deviations should be recognized and addressed within the models. Validation of the CMMN Model against the user interface model is also a good approach, checking if CMMN elements are represented in the ACM Workspace and vice-versa.

4.6.2 Implementation Spreadsheet

CMMN Model is the map for the developer to build the ACM solution. The Implementation Spreadsheet is the artifact used to specify the coding details for actual ACM solution. It provides a checklist to ensure completeness and consistency for the coding details. Implementation details might vary in projects based on the software tool selection.

The Implementation Spreadsheet is initially populated with information collected from CMMN Model about stages, roles and events.

Next, case activities are considered. A case activity is represented as a task in CMMN. In the Implementation Spreadsheet, the *General Activity Information* tab gives an overview of all case activities and contains, for each activity:

- Type
- Case stage
- Purpose
- Fulfilling Capability

Purpose is defined as the reason for which something is done or created (Angus Stevenson, Christine A. Lindberg, 2010).

Fulfilling Capability identifies, for instance, a service (software component) operation that is providing the required functionality (Erl T., 2009) at the activity. In many cases, existing company capabilities can be reused to build ACM solution. The goal is to match the existing capabilities with the require capabilities for the ACM project.

Finally, for each case activity, the developer collects details regarding:

- Activity Data
- Activity Conditions
- Behavior
- Implementation
- Stakeholder
- User Interface

Activity Data relates to input data required and output data produced in the activity. These are usually specified in the Information Model. Developers can use XML Schema specifications to fully specify these data objects.

Activity Conditions can be pre-condition and a post-condition. Precondition is the event required before the activity starts. Post-condition is the event generated after the activity is completed. For each of these, an event type is analyzed based on sentries identified within the CMMN model. Table 4-4 shows the conditions types for CMMN.

Table 4-4 Activity Conditions Types

Types	Description	Example
Case Lifecycle Event Rules	Case Event Condition => Activity Event Action (C=>A)	Activate activity "Identify responsible knowledge workers" when Case is opened and knowledge worker is identified
Case Milestone Event Rules	Milestone Event Condition => Activity Event Action (M=>A)	Activate activity "Create Claims Notification" when milestone "Responsibilities Identified" is reached
Case Activity Event Rules	Activity Event Condition => Milestone Event Action (A=>M)	Reach milestone "Base Information Attached" when activity "Create Claims Notification" is completed
	Activity Event Condition => Activity Event Action (A=>A)	Activate activity "Request Missing Documents" when activity "Create Claims Notification" has been completed
User Defined Event Rules	User Defined Event Condition => Activity Event Condition (E=>A)	Activate activity "Review Documents" when event "New Document received" occurs
	User Defined Event Condition => Milestone Event Condition (E=>M)	Reach milestone "Claims processed" when event "All Claims completed" occurs

Behavior relates to activation required, repetition and availability rules identified by decorators within the CMMN model.

Implementation details include the implementation method, interface location, operation and description. Implementation method can usually be either a service or a BPM process. In case of the service method the WSDL interface location (hyperlink) and the service operation

is defined. In case of the BPM process, the BPMN workflow operation is defined. A third example for an implementation method is a decision task with can be implemented in DMN. Each activity is assigned to a role (*Stakeholder*) and permission for execution is granted to respective users and roles. The analysis is based on the stakeholders identified within the CMMN model.

The case activities are matched with the *User Interface* elements previously identified. This analysis is based on the ACM Workspace. The goal is the developer understands which user interface elements are combined with which case activity. The user interface models are part of the deliverables for the developer.

The Implementation Spreadsheet can be configured with pre-defined values, containing the element types in the ACM implementation tool. This allows the selection of values for spreadsheet cells from drop-down menus. This ensures consistence and transparence during the implementation process.

5. VALIDATION

The proposed ACM Methodology is validated with a Case Study. Each phase of the Methodology is described, software artifacts are presented and a Proof-of-Concept implementation is also developed.

5.1 CASE STUDY

This dissertation uses a claim management regulation case from the insurance industry. In many industries, similar business cases arise for customer claim management. This sample is also published by the OMG CMMN notation (Babich, et al., Case Management Model and Notation (CMMN), 2014).

With the creation of a new claim, first information, e.g. damage of a car, is available. The responsible knowledge worker of the insurance company has the goal to regulate and process the claim. He can receive and request additional information and documents. Two days after the claim was created, he receives a notification that also a person was injured. Personal injury might raise the claim value significantly, therefore the systems suggests him to request a police report. Based on the additional information and an exchange with an experienced colleague, who handled similar cases in the past, he decided to request a report from an expert who investigates the accident, and a report from the doctor who examined the patient. The accident report, which also includes pictures, unveils that both drivers were speeding. In the meantime, the police launched an official investigation that resulted in legal proceedings. Based on the judgment, the knowledge worker will determine fault.

The example shows that additional information becomes available during the case. Based on this information the knowledge worker decides on the activities. IT can support the knowledge worker with a central repository of all case information e.g. reports, pictures and communications, and a claim history. Search functionality helps the knowledge worker to access the information. The IT system can also present similar previous cases to support the knowledge worker in his decisions. The claim history & audit trail makes the case auditable. Based on the unfolding information, the path of the outcome is unpredictable as each case is unique. The knowledge worker can make the decision of which activity to execute to achieve his milestones and goals.

5.2 USING THE ACM METHODOLOGY

5.2.1 Business Modeling

Business Motivation Model

A business analyst conducts a series of interviews with the management, business department and knowledge workers. The vision of the insurance company is to become the leading provider with the best customer services. The goals are to be the market leader, and the most profitable company. These goals are supported by the objectives to reduce the claim regulation cost by 20%, and to increase the customer satisfaction by 20% in 2016.

To achieve this vision, the company has the mission to manage claim processing best in order to increase customer satisfaction and detect fraud. The long-term strategy is to train the best knowledge workers and support claim processing with an ACM system. The short-term tactic is to rely on the skills of the knowledge worker to make claim payment decisions. The business policy is to detect potential fraud in claims. To govern this policy, the rules apply that claim decisions can be done only by a claim supervisor with at least three years of experience. In claims with a value above a certain threshold, a second claim supervisor is required for the payment decisions.

Externally, the business is impacted by governmental regulations and new digital competitors. The business has the opportunity to grow also their market size by digital transformation.

At the same time, the business is threatened to lose market share, by the new arising digital competitors. Internally, the business is impacted by the number of experienced knowledge workers as a resource for claim processing. The strength is the long-term experience of those knowledge workers to detect fraud. The weakness is the number of knowledge workers to facilitate the company's growth and the increasing number of claims. To measure the metrics, the business has decided on the key performance indicator (KPI) of the number of detected frauds and the amount of claim payments as percentage of the insurance contract value. Figure 5-1 shows the business case plan for the insurance claim management case.

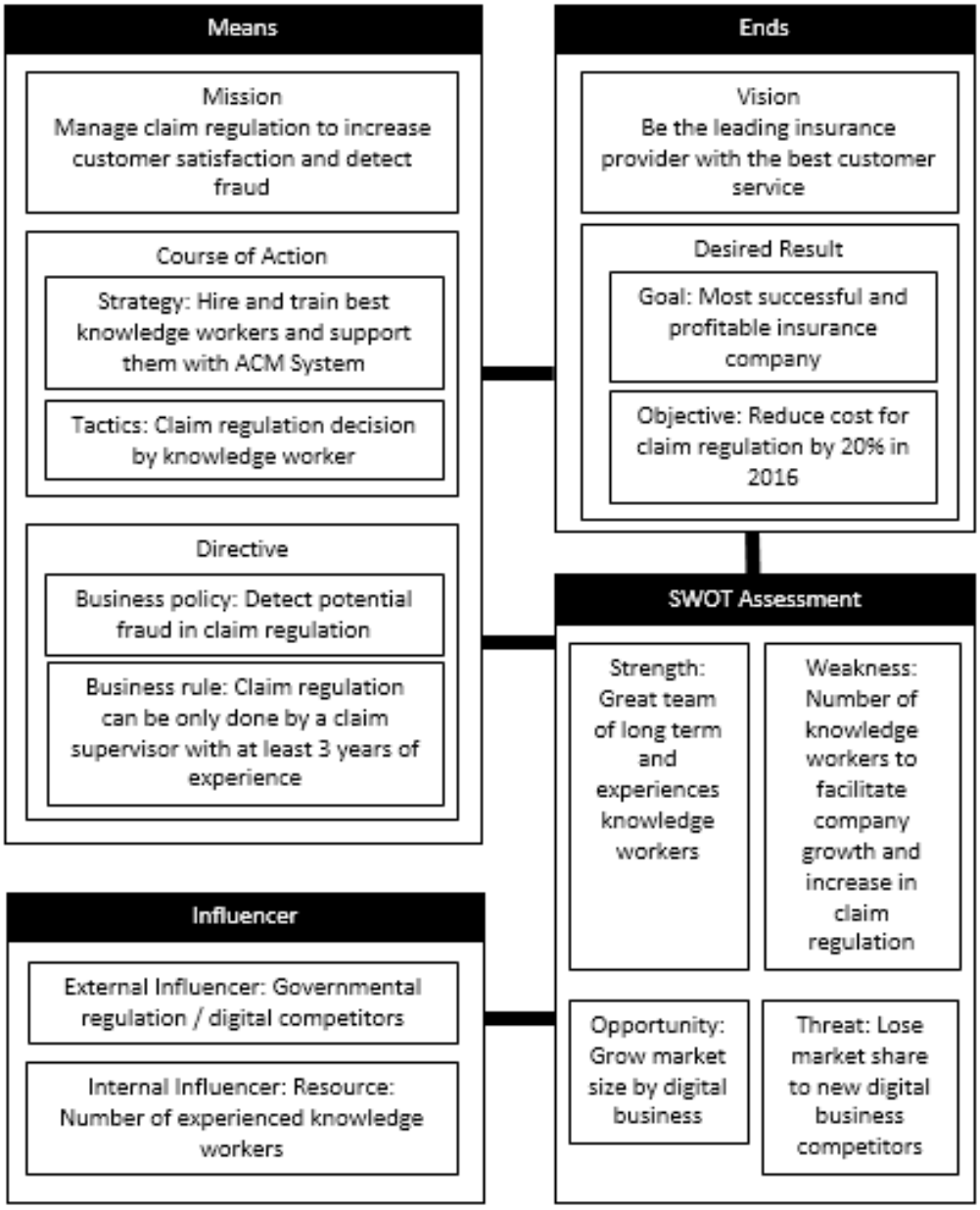


Figure 5-1 BMM for insurance claim management

Organization Operative Model

The goal of the operative organization is to process insurance claims. Management defined the means, end, course of actions and directive. A case owner and a case controller defines and monitors the overall claim processing of the insurance company. The case owner is also responsible for the claim processing budget in a unified role as the case controller. The case manager acts as the knowledge worker, making the decision to accept or reject the claim payment. He is supported by another employee, the clerk assistant, who collects the initial

claim data. An additional employee, the clerk, performs formal check of the claim data, if necessary, requests missing documents, and creates a booking entry.

Roles can be categorized as explicit and implicit. An explicit role can be mapped on an actual job role or group. For example, the person who has the role to procure is the procurement manager. Implicit roles are represented by rules. For example, the person who works in the customer department is mapped via a rule as a case employee role. Table 5-1 shows the stakeholders and responsibilities of the Organization Operative Model.

Table 5-1 Stakeholders and responsibilities at Organization Operative Model

Stakeholders	**Responsibility**	**Role**
Management	Defines and governs case means and case end	CEO
Case Owner	Domain expert responsible for case transparency, case optimization and case performance	
Case Controller	Business operation expert responsible for case budget (e.g. risk department)	
Case Manager	Knowledge worker & process holder who makes process decisions	Supervisor
Case Employee	Knowledge worker (e.g. in front / mid / back office)	Clerk & clerk assistant
Administrator	Maintains case & case infrastructure	

Information Model

In the insurance business, the claimant is person who files the claim. A claimant can file multiple claim files and each claim file has one claimant. A claim file can result in a claim. Both claimant and claim file are also in relation via the insurance contract. The claim can result in a payment. The knowledge worker interacts with the claimant. Both, claimant and knowledge worker, inheritance the structure of a person. Additional partners, e.g. police department, can be part of the data model. Most of the case information, e.g. accident pictures and e-mail communication, can be stored in the document class. Figure 5-2 shows the information model for the claim regulation represented in an UML class diagram (Bock, et al., 2015).

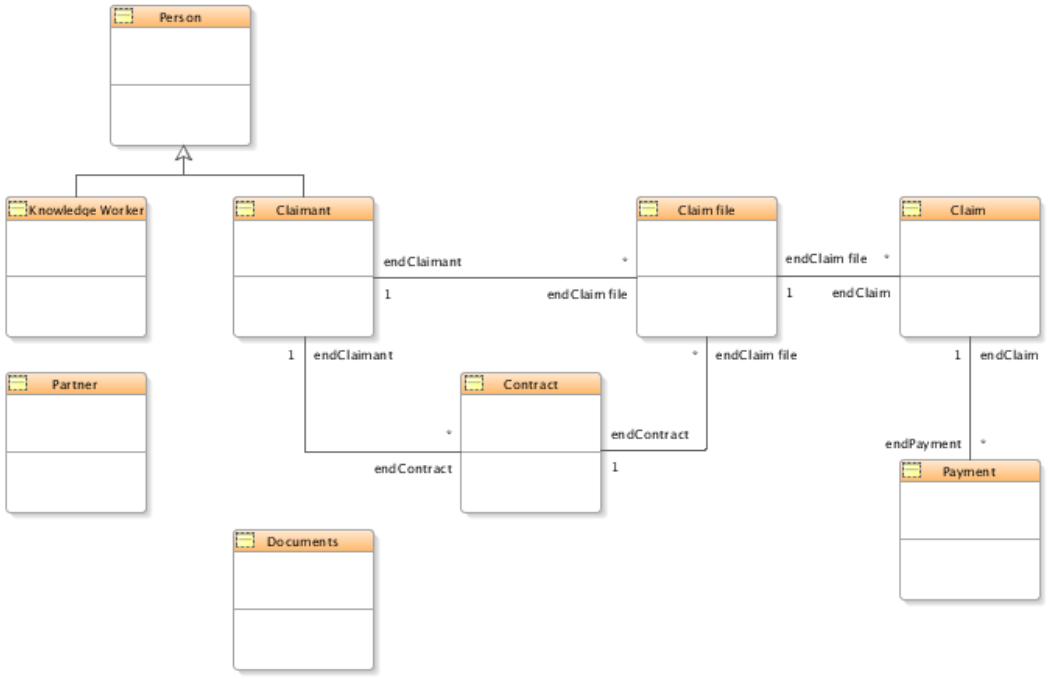


Figure 5-2 Information Model claim regulation

5.2.2 Visualization

The combination of the five UI elements result in the ACM Workspace. Figure 5-3 shows the user interface for the claim management solution.

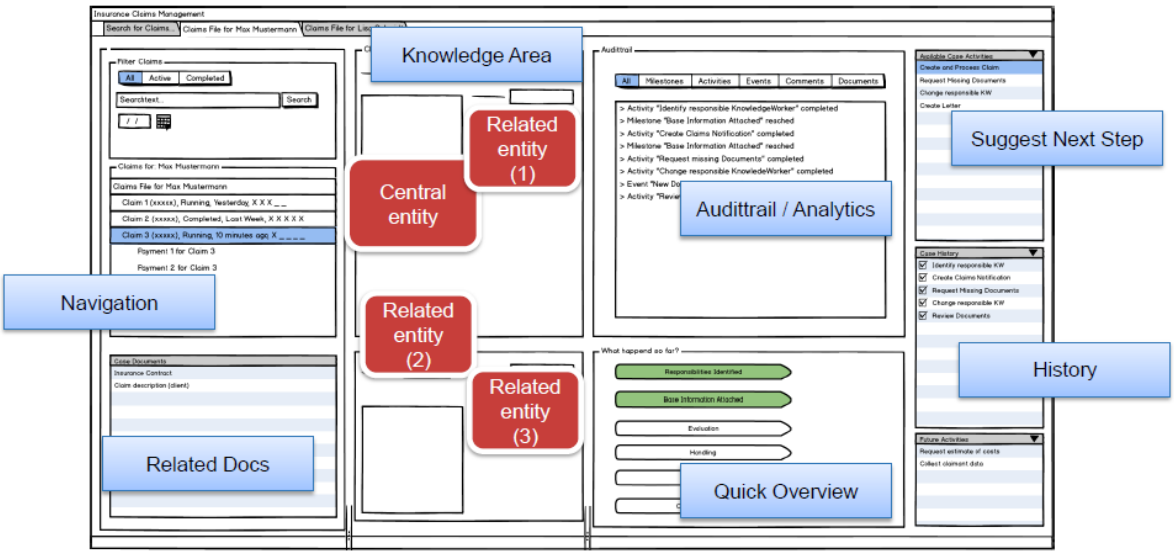


Figure 5-3 ACM Workspace claim regulation

5.2.3 Analysis

As part of the Organization Operative Model the clerk assistant, clerk and supervisor are defined. The company has the mission to manage claim regulation to increase customer satisfaction and detect fraud. Claim regulation can be refined in the stages Claim Evaluation, Claim Handling and Claim Regulation. To accomplish each stage, according milestones are defined.

The tasks for each stakeholder are assembled. The clerk assistant collects all claimant data, once completed the system notifies the claimant. The clerk performs a formal check of the claimant data. If required, the clerk can request missing documents. Those human tasks can be repeatable until the formal check is successful. The supervisor can accept or reject the claim. Based on the result, the clerk might create a booking entry. In the case of a claim acceptance, the system performs a payment. Results are shown at Table 5-2.

Table 5-2 Case Stages and Milestones

Stage:	Claim Evaluation	Claim Handling	Claim Regulation
Milestones:	claim evaluated	claim handled	claim decided claim regulated
Stakeholder	**Tasks:**		
	Human Tasks		System Tasks
Clerk assistant	Collect claimant data		Notify client
Clerk	Perform formal checks (repeatable) Request missing documents (repeatable) Create booking entry		Request estimate of cost Commission an appraiser
Supervisor	Accept claim Reject claim		Perform payment

The tasks are in a chronological order, but this is not a defined rigid structured process flow like in a BPM process. Figure 5-4 shows the high-level ACM Canvas for claim regulation. Based on this ACM Canvas, the CMMN Model can be developed in the next phase.

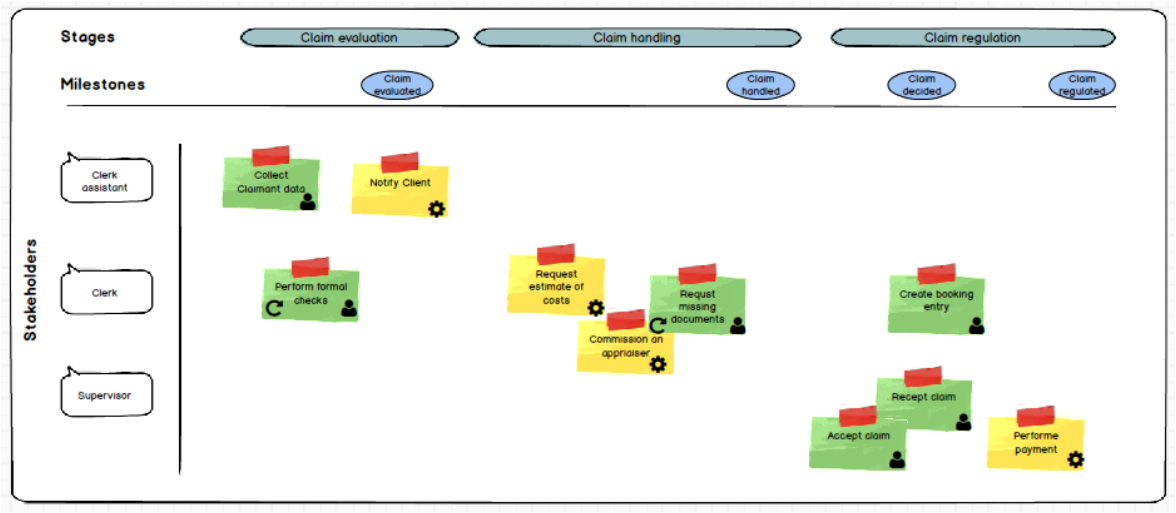


Figure 5-4 ACM Canvas for claim regulation

5.2.4 Design

To illustrate the CMMN Model the claim regulation example is used. In a first step the CMMN Model is developed by the business analyst together with the operative organization business owners. In a second step the CMMN model is enriched with technical details for the developer. These two steps explain the bridge function of the CMMN Model between business and technology.

A case plan model is the frame for the CMMN Model, represented by a folder shape. On the top left the name of the case plan model is noted. In the Information Model the case name was defined as *Claim file* (figure 5-5).

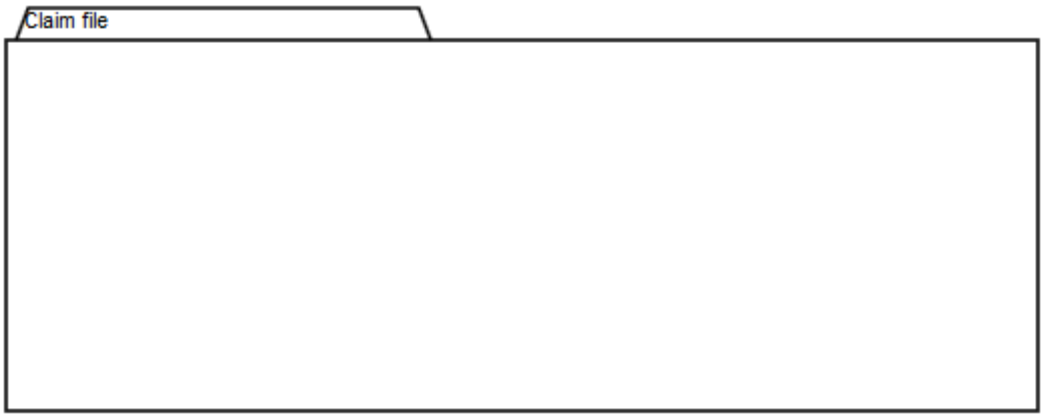


Figure 5-5 Claim File

In the interview between the business analyst and the operative organization an additional task to *identify the responsible knowledge worker* (figure 5-6) is discovered. In the CMMN notation four different task types are available (blocking, non-blocking, process and case task). The knowledge worker identification task is linked to a process therefore the process task is chosen. As this step is mandatory the task is decorated with an exclamation mark.

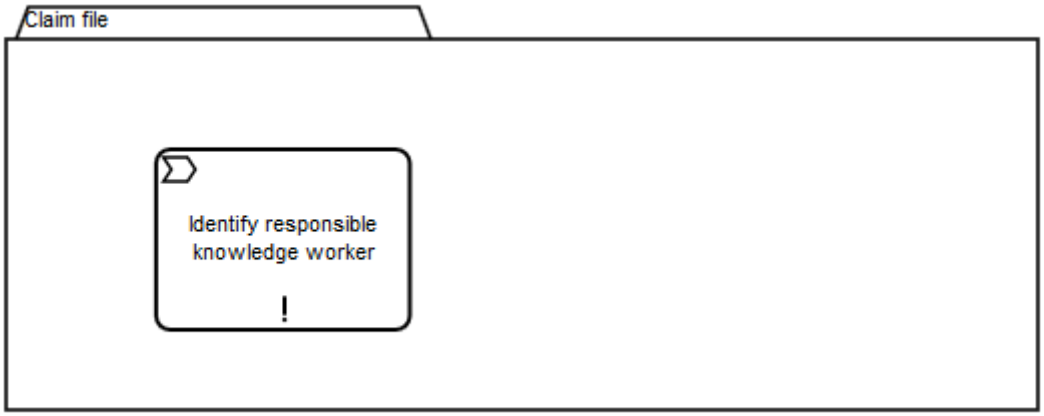


Figure 5-6 Process task *Identify responsible knowledge worker*

The task *identify the responsible knowledge worker* has the goal to identify the responsibilities knowledge worker. The identification of the knowledge worker is represented as a milestone. The task *Identify responsibilities knowledge worker* is connected with the milestone *Responsibilities identified* (figure 5-7). Connectors are used to express dependencies, connectors do not represent a sequential flow.

Task and milestone, stages and the case plan model can be decorated with requirements. The notation offers sentries: entry criterion and exit criterion requirements. A milestone can be only decorated with an entry criterion. Therefore the milestone *responsibilities identified* is decorated with an entry criterion.

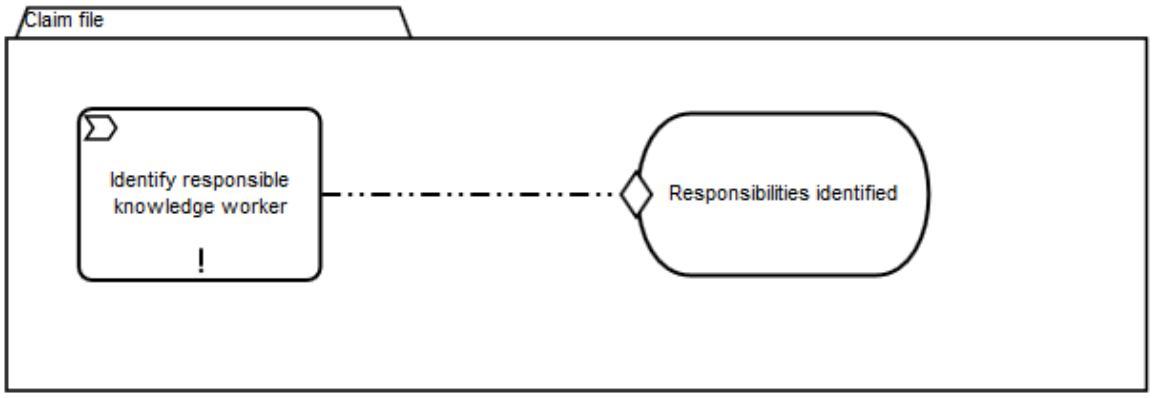


Figure 5-7 Milestone *Responsibilities identified*

A stage can be described as an episode of the case. A stage *Identify Responsibilities* (figure 5-8) is created, which contains the task *Identity Responsibilities knowledge worker*.

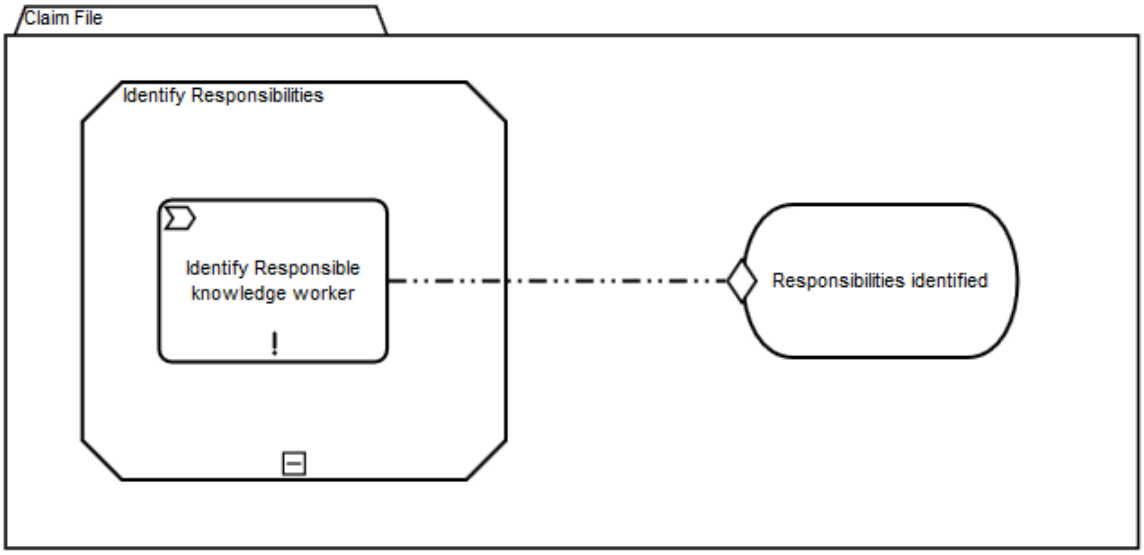


Figure 5-8 Stage *Identify Responsibilities*

In the business event a knowledge worker is sick or leaves the company the responsible knowledge worker need to be changed. To model this the task *Change Responsibilities* (figure 5-9) is created. The business event that the knowledge worker needs to be change might or might not occur. The concept of applicable and discretionary tasks is used. An applicable task is always part of the case. Applicable tasks are represented with a solid boarder. A discretionary task might become part of the case. Discretionary tasks are represented with a dotted boarder. The task *Identify Responsible knowledge worker* is

applicable and the task *Change Responsibilities* is discretionary. The task *Change Responsibilities* is a blocking human task type, this means the task *Change Responsibilities* is waiting until the work associated with the task is completed. Also the task *Change Responsibilities* is connected with the milestone *Responsibilities identified* and decorated with the entry criterion, the milestone *Responsibilities identified* needs to be completed to change the responsibilities. The business event that the responsibilities change might occur more than once, therefore the task is decorated to be repetitive.

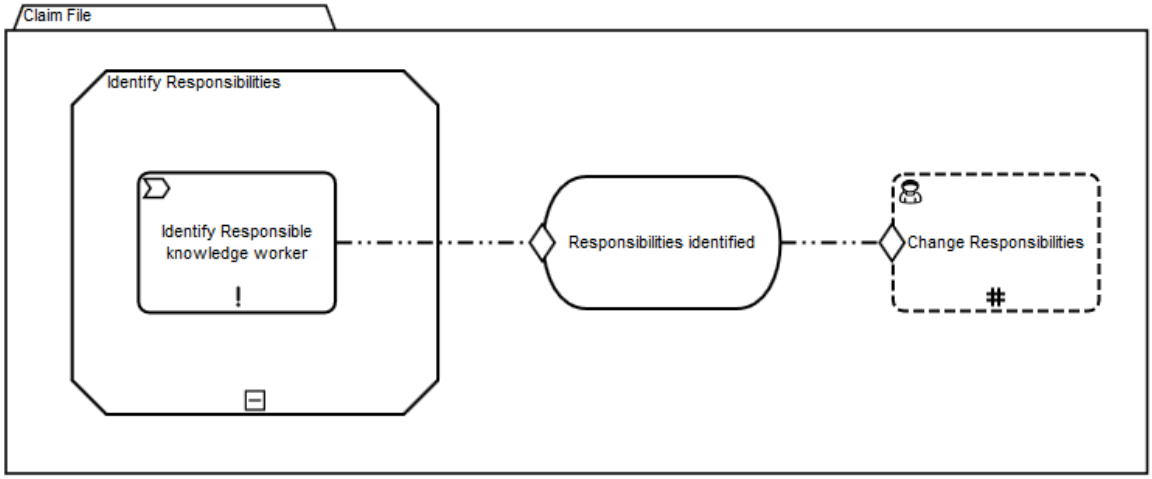


Figure 5-9 Human task *Change Responsibilities*

The knowledge worker starts the task *Create Claims Notification* once the milestone *Responsibilities identified* is fulfilled. The task *Create Claim Notification* is blocking task which is required. Each claimant mandatory receives a notification. Therefore the task *Create Claims Notification* gets an entry criterion and a required decorator. The task is connected to the milestone *Responsibilities identified* and part of the stage *Attache Base Information* (figure 5-10).

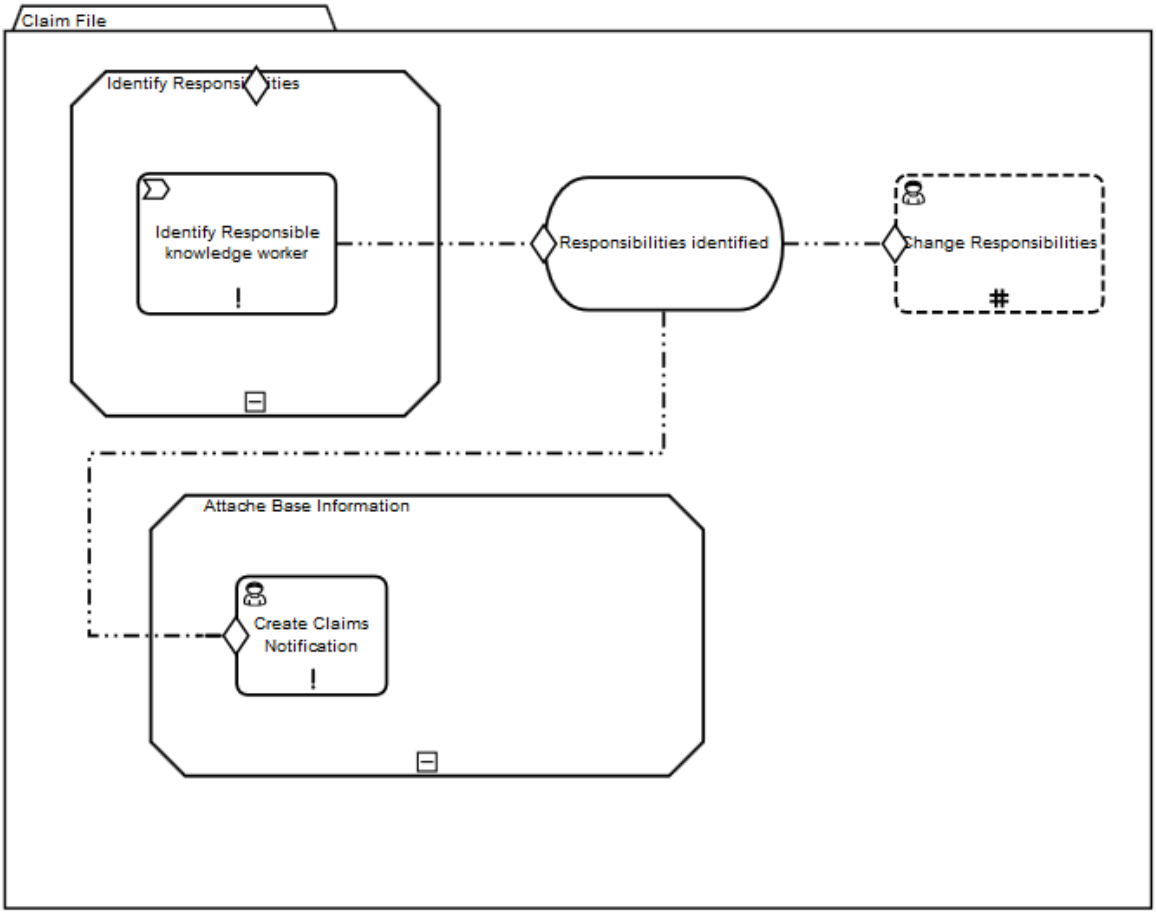


Figure 5-10 Stage *Attache Base Information*

The knowledge worker reviews the case. If required he can *Request Missing Documents* (figure 5-11) from the claimant multiple times. Therefore a discretionary process task Request Missing Documents is created. The human task *Create Claims Notification* is decorated on top with a planning table icon. This planning table icon manages the run-time effort within the stage. Any time in the case the knowledge worker might create a letter. For example to request a doctor certificate, the knowledge worker might create a letter anytime. Therefore the case needs a discretionary process task *Create Letter*.

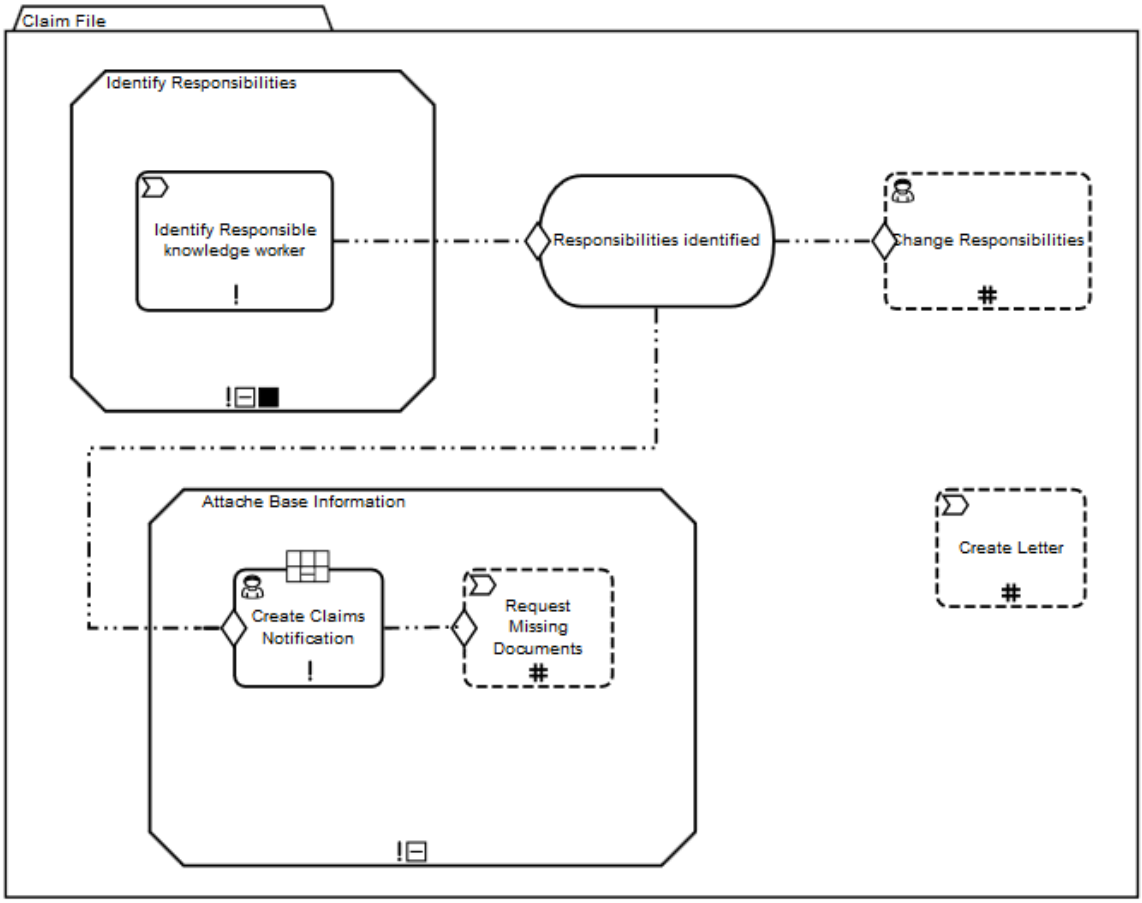


Figure 5-11 Process task *Request Missing Documents*

In the business event the claimant response to the process task to send the missing documents an event *New Document received* (figure 5-12) is created. In case something happens during a case CMMN offers event listeners. Events may trigger, for example, the enabling, activation and termination of stages and tasks, or the achievement of milestones. CMMN offers three types of events: Event listeners, timer event listeners and user event listeners. The event *New Document Received* triggers a task *Review Documents*. This non-blocking task is repeated each time a document is received.

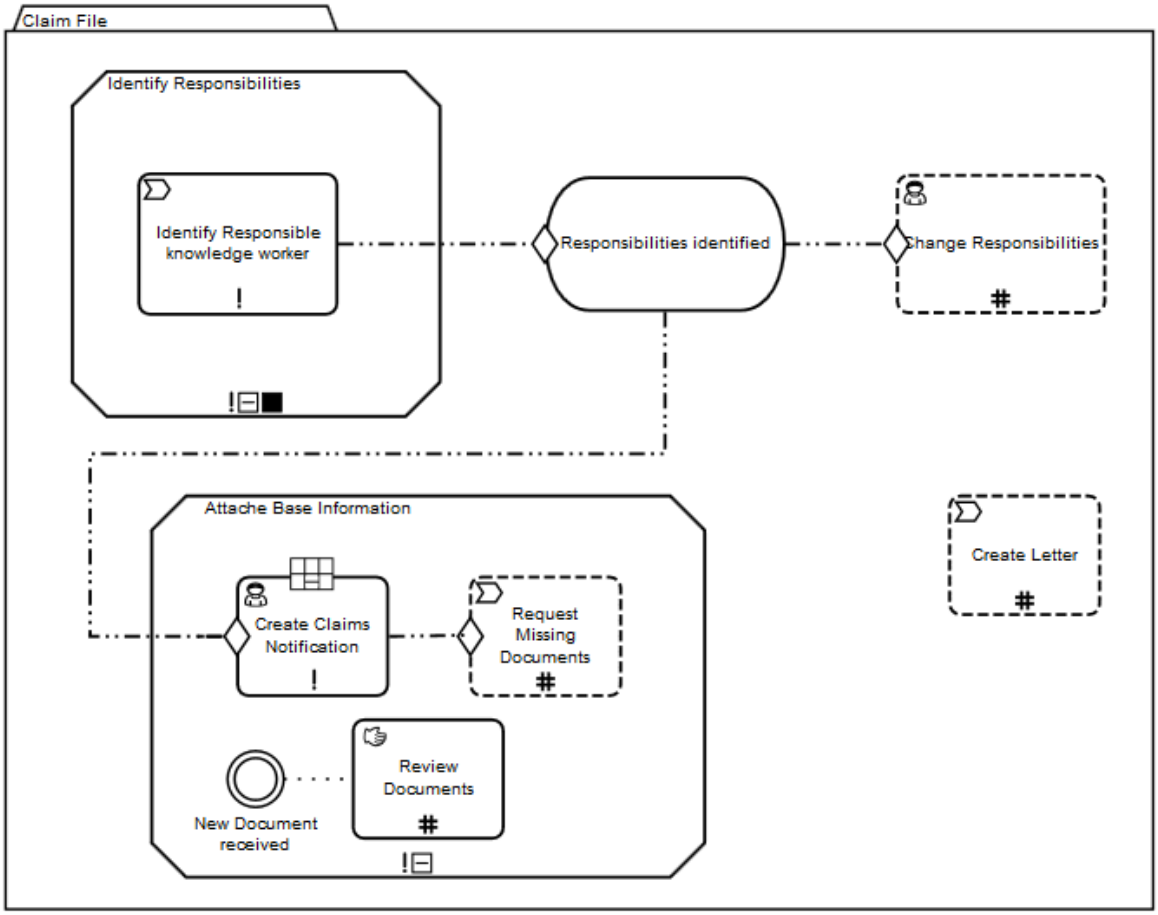


Figure 5-12 Event *New Document received*

The knowledge worker achieves the milestone *Base Information attached*. The final stage is to create and process the claim. Only now the process task to *Create and Process claim* becomes available. Process tasks are used to call out another case. Once the knowledge worker creates and process the claim the milestone *claim processed* is reached. This final milestone completes the claim file. In CMMN an exit criterion for the task is evaluated to true.

The knowledge worker should also have the possibility to cancel the case any time. Therefore a human event listener *cancel case* is added which triggers the case file exit criterion.

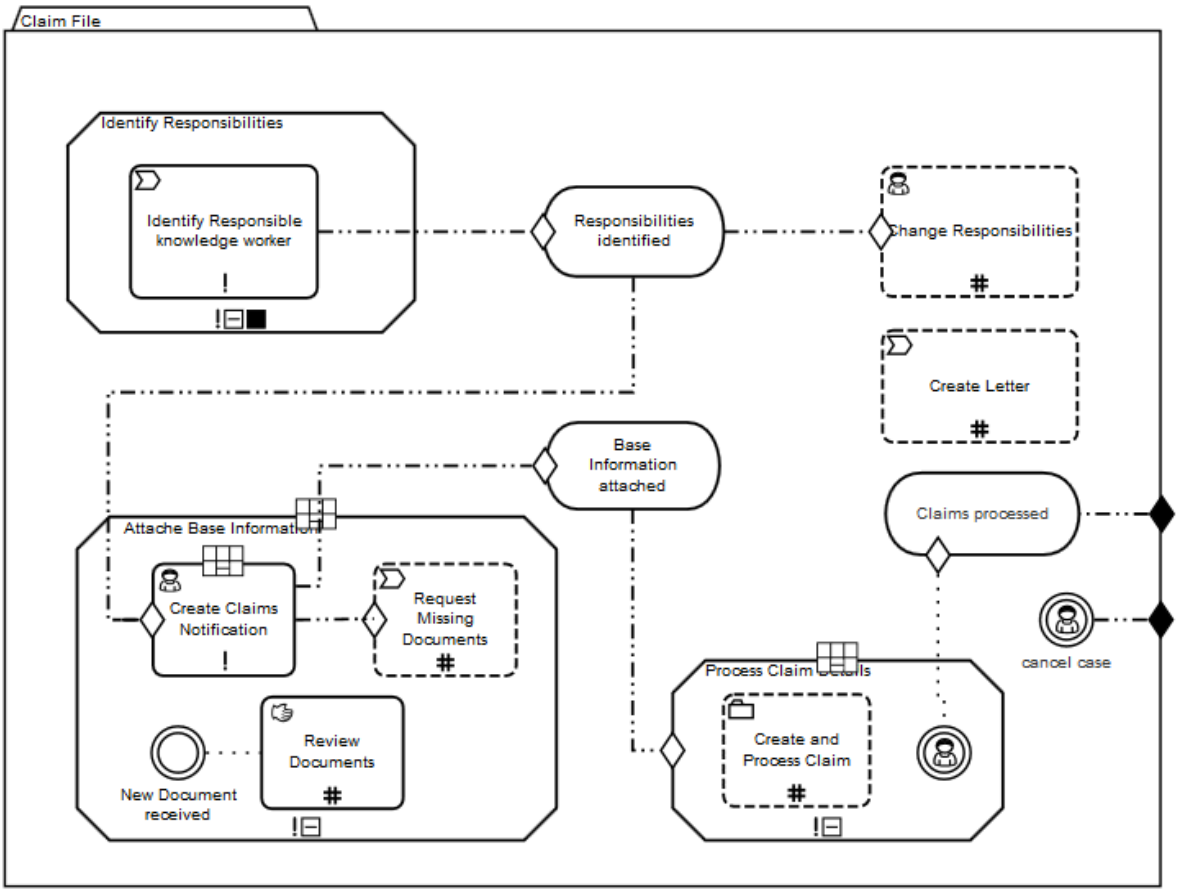


Figure 5-13 CMMN Model for claim regulation

Figure 5-13 shows the CMMN Model for claim regulation. The model contains technical details required for the implementation. The business CMMN Model, derived from the ACM Canvas, is enriched with technical information by the business analyst and the developer. For example, the technical description of the model contains the sentry rules, which are not expressed in the visual CMMN Model. Therefore the CMMN Model is enhanced:

- Case activated via “Claims Management User Interface“ (Case UI)
- Case UI: The activities *Identify responsible Knowledge Workers* and *Create Letter* are displayed. The EventListeners *New Document Received* as well as *Cancel Case* are ready to catch incoming events.
- Action: The ProcessTask *Identify responsible knowledge worker* (manually started from the Case UI) will trigger an automated process to determine the responsible knowledge workers.
- Result: After this activity completes, the Stage *Identify responsibilities* is closing itself (note the AutoComplete decorator). The Milestone *Responsibilities identified*

is completed because its Sentry is evaluated to true (Rule: Activity *Identify responsible knowledge workers* is completed)

- Case UI: The HumanTask *Change responsible Knowledge Workers* (repeatable) and *Create Claims Notification* are now available and can be started.
- Action: The knowledge worker starts the HumanTask *Create Claims Notification*.
- Result: Milestone *Base Information Attached* is completed because its Sentry is evaluated to true (Rule: Activity *Create Claims Notification* is completed) and the HumanTask *Request Missing Documents* becomes available on the Case UI. The *New Document Received* event can still be received (note that stage *Attach Base Information* has no AutoComplete decorator and no ExitCriterion). Stage *Process Claim Details* becomes active because its Sentry is evaluated to true.
- Case UI: The CaseTask *Create and Process Claim* (repeatable) becomes available and can be started by the knowledge worker multiple times to trigger another cases.
- Result: After receiving event *All claims completed* the Milestone *Claims processed* is completed because its Sentry is evaluated to true (Rule: Event received)
- Case instance and its Stages are closed. (Kress, et al., 2014)

CMMN Stakeholder Model

A police officer can submit a police report to the insurance, which is received by the clerk assistant. The police officer is an external stakeholder, he does not get access to the claim regulation solution, therefore he is not an actor and no role is assigned to him in the system. The clerk assistant is an employee at the insurance company. Therefore, he has an internal role as a clerk assistant actor. The clerk works as a knowledge worker for the insurance company. Therefore, he has internal role as a clerk actor. Both actors, the clerk assistant and the clerk, have assigned the same role in the system as a clerk. Therefore, both have the same system rights to execute HumanTasks and trigger UserEventListeners in the ACM solution, for example to create claims notifications or to review received documents. The supervisor also works as a knowledge worker for the insurance company. Therefore, he has an internal role as a supervisor and is assigned the supervisor role in the ACM solution. Tables 5-3 and 5-4 illustrate this.

Table 5-3 Stakeholder at the claim regulation case

Stakeholder	Role Type	Actor	Role
Police	External	-	-
Clerk Assistant	Internal	Clerk Assistant	Clerk
Clerk	Internal	Clerk	Clerk
Supervisor	Internal	Supervisor	Supervisor

Table 5-4 HumanTasks and UserEventsListeners at the claim regulation case

Role	HumanTask	UserEventListener
Clerk	Create Claim notification Request missing documents Review Documents Create letter	
Supervisor	Change responsibilities Create and process claim	Cancel Case

CMMN Rules Model

In the BMM model from the Business Modeling phase, a business rule was identified. In cases with a value above a certain threshold, e.g. 200 k€, a second claim supervisor is required for the regulation. Therefore, the human task Change Responsibilities changes into a decision task as shown in Figure 5-14. Condition detail is "if *case value* > 200 k€". This decision logic rule can be implemented using DMN.

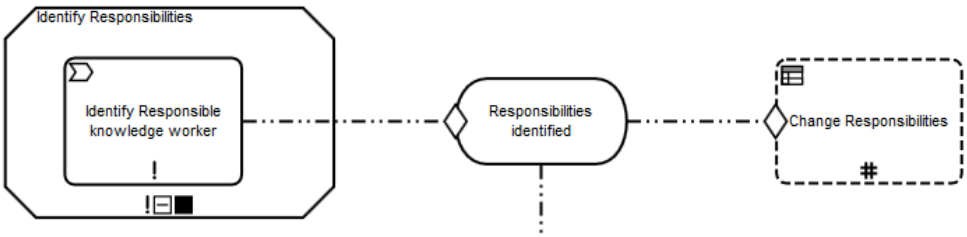


Figure 5-14 Decision logic rule in claim regulation case

The claim regulation case makes use of many control rules to manage the behavior of the ACM solution. To support the developer during the implementation phase, the sentries, including their rules and decorators, shown in Table 5-5, are added to the CMMN Model.

Table 5-5 Control Rules in claim regulation case

Case Model Element	Sentry type	Rule	Decorators
Responsibilities Identified	Entry Criterion	Activity Identify Responsible knowledge workers completed	
Change Responsibilities	Entry Criterion	Milestone Responsibilities Identified completed	repetition
Create Claim Notification	Entry Criterion	Milestone Responsibilities Identified completed	repetition
Request Missing Documents	Entry Criterion	Create Claim Notification completed	repetition
Review Documents	Entry Criterion	Event New Document received is triggered	repetition
Base information attached	Entry Criterion	Activity Create Claims Notification completed	-
Claim processed	Entry Criterion	Event All Claim completed is triggered	-
Cancel case	Exit Criterion	Event Cancel case is triggered	-

5.2.5 Implementation

Work Review

In a bottom-up check the models are validated to ensure consistency. For example, the CMMN model is compared with the ACM Workspace. The human task Create Claims Notification in the CMMN Model is represented in the ACM Workspace at Case Activity and, once selected, at Case History. The milestone Base Information Attached in CMMN

Model is represented in the ACM Workspace at Milestones & History and maybe at Quick Overview. Figure 5-15 shows the validation of the CMMN Model against the ACM Workspace.

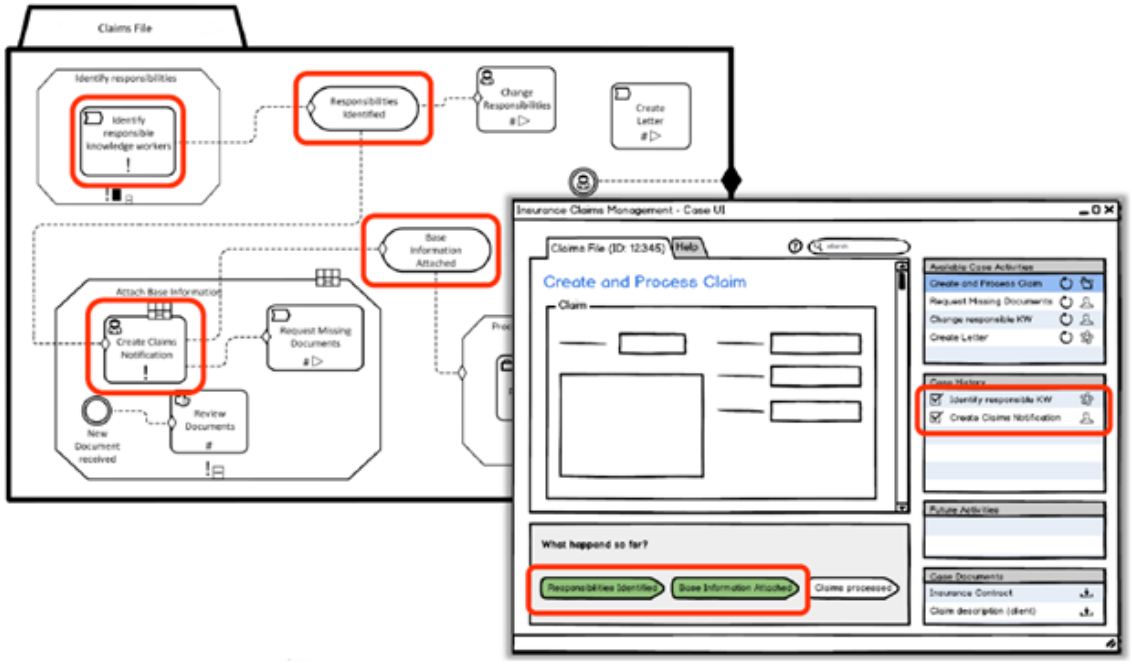


Figure 5-15 Validation CMMN Model against ACM Workspace

Implementation Spreadsheet

The Implementation Spreadsheet is initially completed with information about Claim Stages, Claim Roles and Claim User Events, as shown on Table 5-6.

Table 5-6 Stages, Roles and Events

Stages Claim	Roles Claim	User Events Claim
Identify responsibilities	Clerk	new document received
Attach base information	Supervisor	cancel case
Process Claim details		all claim completed

General Activity information for the case is the collected in the spreadsheet, as illustrated in Table 5-7.

Table 5-7 General Activity Information

Case Activity Name	**Activity Type**	**Belongs to Stage**	**Fulfilling Capability**	**Purpose**
Identify responsible knowledge worker	Process Task	Identify responsibilities	case assignment	identify responsible knowledge worker
Create claim notification	Human Task	Attach base information	claim management	get case information
Request missing documents	Process Task	Attach base information	document management	get case information
Review documents	Human Task	Attach base information	document management	review case documents
Create and process claim	Case Task	Process Claim details	claim management	process claim details
Create letter	Process Task		letter creation	inform claimant
Change case responsibilities	Human Task		case assignment	identify responsible knowledge worker

Input and output activity data are shown in Table 5-8. To preserve the overview, only the input and output class name is listed. Table 5-9 shows activity conditions. Table 5-10 shows the behavior.

Table 5-8 Activity Data

Case Activity Name	**Input**	**Output**
Identify responsible knowledge worker	Contract	knowledge worker
Create claim notification	Claim	Claim
Request missing documents	Claim	missing documents
Review documents	Claim	document state
Create and process claim	Claim	Claim
Create letter	Claim	letter
Change case responsibilities	Contract	knowledge worker

Table 5-9 Activity Conditions

Case Activity Name	**Precondition**	**Precondition Type**	**Post-condition**	**Post-condition Type**
Identify responsible knowledge worker	Case started	C => A	Milestone Responsibilities identified reached	A => M
Create claim notification	responsibilities identified	M => A	Base information attached	A => M
Request missing documents	Create claim notification	A => A		
Review documents	document received	E => A		
Create and process claim	base information attached	M => A		
Create letter				
Change case responsibilities	case started	M => A		

Table 5-10 Behavior

Case Activity Name	Activation Rule	Required Rule	Repetition Rule	Availability Rule
Identify responsible knowledge worker	automatically	mandatory	once	conditionally
Create claim notification	automatically	mandatory	once	conditionally
Request missing documents	manually	mandatory	multiple	conditionally
Review documents	automatically	optional	multiple	conditionally
Create and process claim	manually	optional	multiple	conditionally
Create letter	manually	optional	multiple	always
Change case responsibilities	manually	optional	multiple	conditionally

An example for the service implementation method is the identity responsible knowledge worker activity. The WSDL including the hyperlink and the service operation is defined. A description helps the developer to understand the service. An example for process implementation method is the request missing documents activity. The process task is defined as a BPMN model including the operation. Implementations details are shown in Table 5-11. Tables 5-12 and 5-13 presents the Stakeholders and User Interface implementation details.

Table 5-11 Implementation

Case Activity Name	Implementation method	Interface location	Operation
Identify responsible knowledge worker	Assignment service	WSDL hyperlink	getResponsibleKnowledgeworker
Create claim notification	(empty because human task)		
Request missing documents	BPMN model		BPMN workflow with notification
Review documents	(empty because human task)		
Create and process claim	(empty because human task)		
Create letter	BPMN model		BPMN workflow with notification
Change case responsibilities	Assignment service	WSDL hyperlink	getResponsibleKnowledgeworker

Table 5-12 Stakeholders

Case Activity Name	Fulfilled By Role	Permissions
Identify responsible knowledge worker	n/a	
Create claim notification	clerk	write claim details
Request missing documents	clerk	write claim details
Review documents	supervisor	write claim details
Create and process claim	clerk	process claim
Create letter	clerk	process claim
Change case responsibilities	supervisor	

Table 5-13 User Interface

Case Activity Name	Screen Mockup	Description
Identify responsible knowledge worker	n/a	
Create claim notification	Create Claim mockup	Documents, milestones, status
Request missing documents	Create Claim mockup	Documents, milestones, status
Review documents	Review claim documents	
Create and process claim	Process claim	
Create letter	Notify claimant	
Change case responsibilities		

5.3 PROOF-OF-CONCEPT IMPLEMENTATION

Finally, the Case Study was fully implemented based on the described Adaptive Case Methodology. Oracle BPM Suite and a custom ACM Workspace built in Java. Figure 5-16 and Figure 5-17 show the ACM Workspace of the Case Study Implementation, while Figure 5-18 shows the SCA elements linked to the ACM Workspace. Figure 5-19 and Figure 5-20 show the case in Oracle JDeveloper including the case milestones and outcomes and activities.

This Case Study and the ACM Methodology was developed and validated for real world customers. Customers include an insurance company and a third party software vendor. The insurance company developed a claim management ACM solution. The third party software vendor developed an ACM Workspace for knowledge workers. Based on the customers feedback the methodology was improved and evolved. In both cases the software was successful developed based on the proposed ACM Methodology.

As the proof-of-concept was built on Oracle technology, the Oracle Product Management and Oracle Development team validated solution implementation.

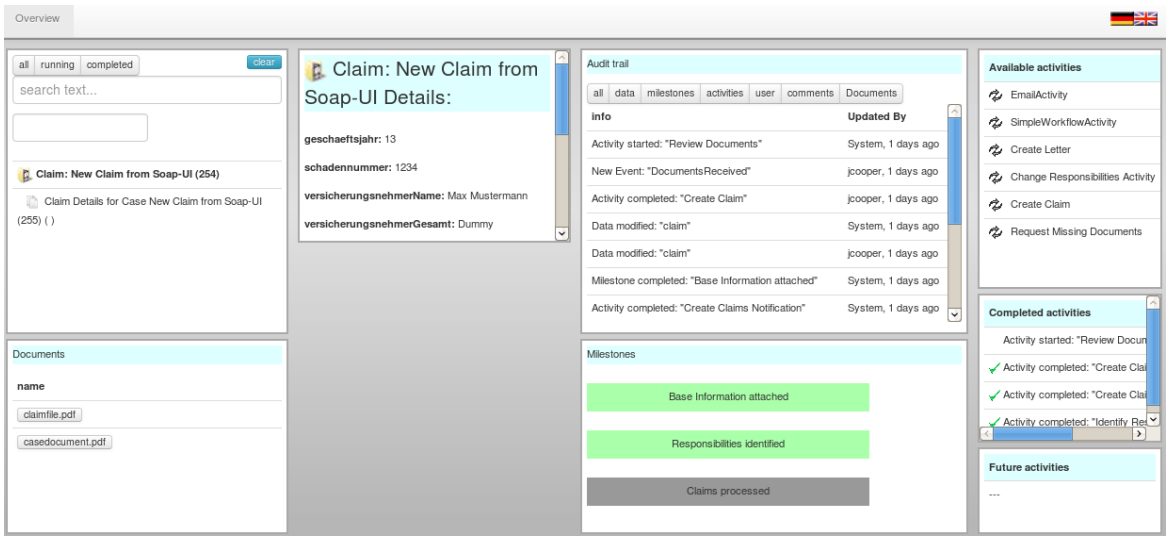


Figure 5-16 ACM Workspace Case Study Implementation

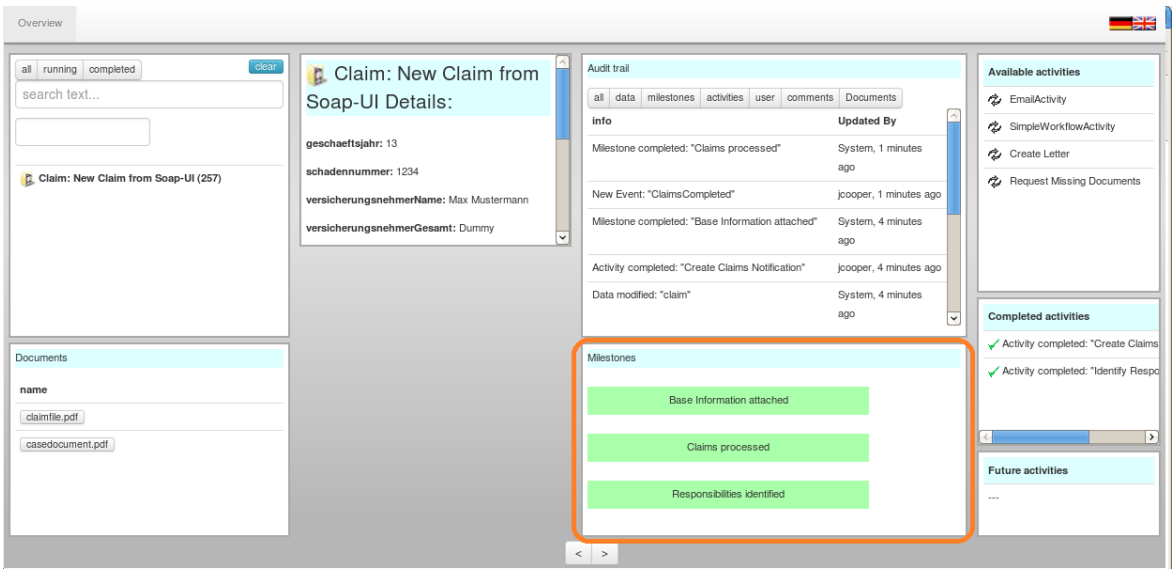


Figure 5-17 ACM Workspace Case Study Implementation all Milestones achieved

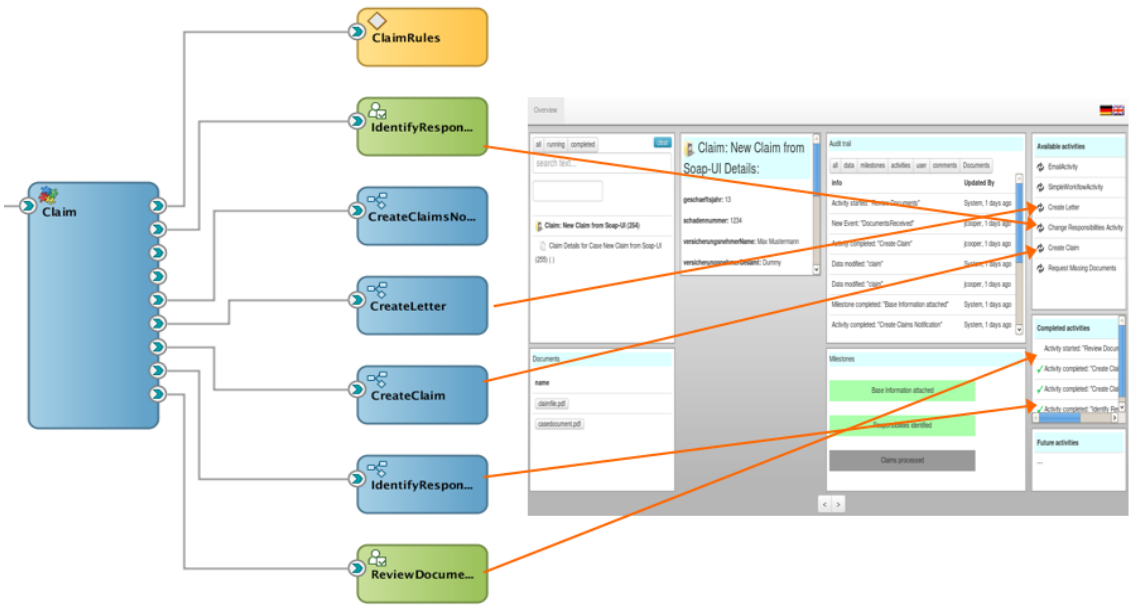


Figure 5-18 SCA Elements linked to ACM Workspace

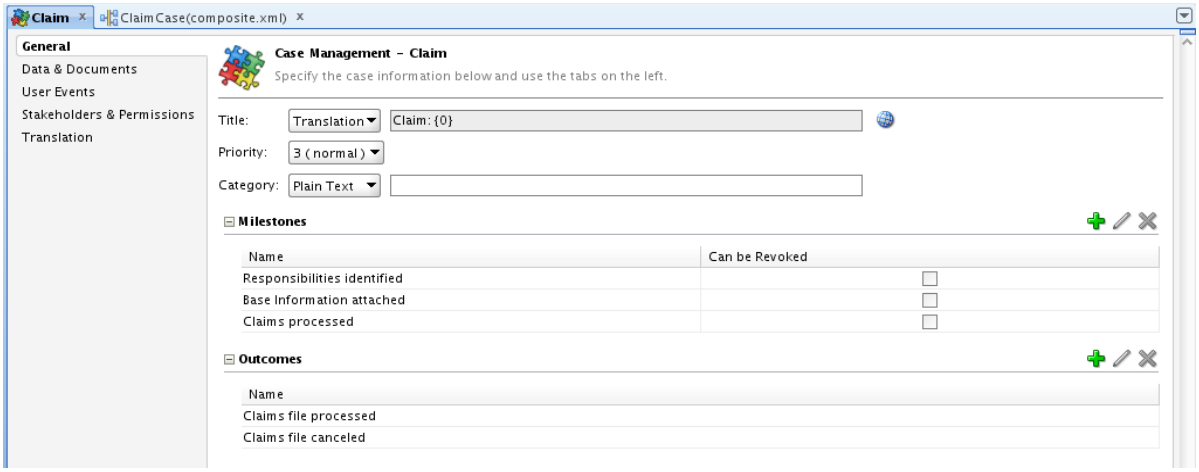


Figure 5-19 Case Management in JDeveloper with Milestones and Outcomes

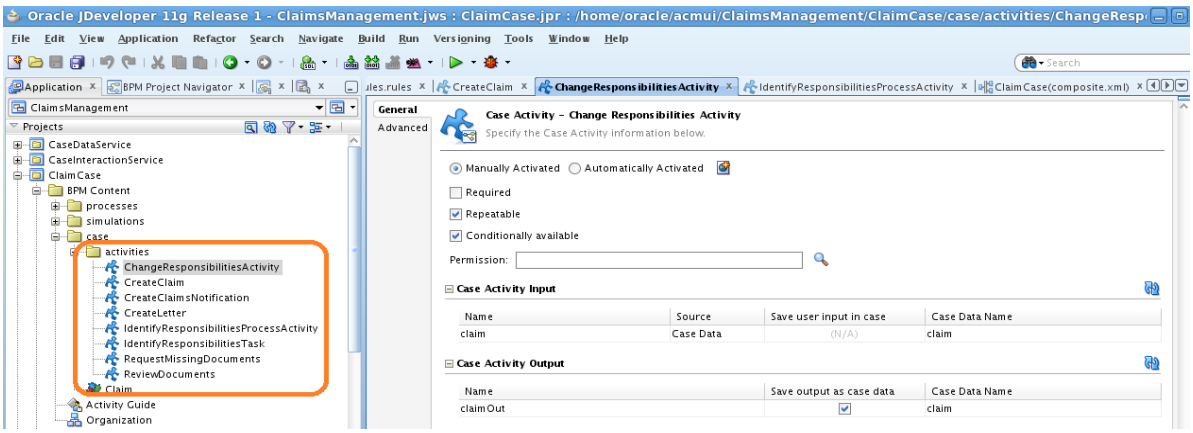


Figure 5-20 Case Management in JDeveloper with activities

6. ANALYSIS

The ACM Methodology has it strengths in the combination and adoption of existing techniques and models, for an Adaptive Case Management project. Characteristic IT methodology phases are leveraged and adapted. Each phase has a defined purpose and a specially designed software artifact as outcome, supported by templates. By leveraging CMMN, the ACM Methodology bridges the gap between the operational models and the development team. Validated by a Case Study, industry experts and customer implementations, the ACM Methodology has a proven success record. Oracle based ACM projects are a good fit, however, further implementation technologies need to be evaluated.

The focus of the proposed ACM Methodology is not to streamline each phase. In that sense, the Methodology is described using the waterfall approach. The advantage of such approach resides in the ability to describe each phase interest and elucidate dependencies among them. Further research can improve the ACM Methodology by application of agile approaches.

The Business Motivation Model supports the alignment of the ACM solution with the company goals. This is key as knowledge workers often support key company processes and competitive differentiators. In relations to the ACM solutions the Business Motivation Model should not be used to define new company Ends. It should reflect the existing company vision. Based on the Business Motivation Model, Key Business Indicators (KPIs) for the ACM solution can be defined. Future research and work can enrich the ACM Methodology with a set of KPIs.

It has been observed that business sponsors and knowledge workers stakeholders, identified in the Organization Operative Model, provide important support to the methodology application, while also contributing to project visibility and sponsorship at company top-management levels. An approach to develop or re-use an existing company executable stakeholder model from the beginning, to avoid duplication efforts might be evaluated.

Many companies have defined their information model. ACM solutions can leverage this existing information models. Within IT many techniques and methodologies exist to analyze

and develop an Information Model, which should be used within the phase. The Information Model Phase ensures the data first approach within an ACM solution.

Visualization of the ACM Workspace by sketches allows the knowledge worker to visualize and understand the ACM solution. The ACM Workspace is the key user interface for the knowledge workers. Therefore, it is a useful tool to involve the operative stakeholders in an early phase of the project. User Experience experts offer detailed methods to develop sketches and wireframes. It is recommended to include them in the Visualization phase. The ACM Methodology leverages design templates to build the ACM Workspace. The development of the ACM Workspace and the ACM Canvas can be combined in one workshop, as the both approach the same stakeholders.

The ACM Canvas Model was developed as a tool that can be easily understood by business people. This is usually not the case for the CMMN Model, which contains many technical details for the developer. This justifies the additional work required to develop both models, as many information are duplicated within each of them. Indeed, the ACM Canvas makes the development of the CMMN Model quite straightforward. Therefore, it has been observed that the ACM Canvas helps to bridge the gap between the business stakeholder and the developer.

The Work Review phases in a button-up approach ensures consistency of the ACM Methodology outcomes. Future work can defines metrics to measure and guide this review.

The CMMN Model guides the architect within the design phase. Although this artifact contains several implementation decisions, it still does not include sufficient information to fully specifying the solution implementation. The Development Spreadsheet was designed to cover this issue. Besides the additional details provided, this artifact also helps on dividing work packages. Further research is required to reduce the overhead of maintaining three different artifacts: ACM Canvas Model, CMMN Model and Development Spreadsheet.

With the raise of DMN and accompanied increase of experience, best practices for the CMMN Rules Model can be developed. Might be worth to investigate the include DMN within the ACM Canvas Model as part of the Analysis phase.

Additional implementation technologies, highlighted in the introduction, can be validated in future customer projects. These customer projects can ratify the ACM Methodology in various industries.

With the evolution of ACM solutions predictive analytics technology might arise. This can include predictive modeling and predictive mining. Predictive modeling could be leveraged within the Analysis phase. Predictive mining could support the knowledge worker in the decision making. Future work can research and include predictive analytics technologies in the ACM Methodology.

Process mining technologies might be leveraged to modernize existing solutions. With process mining technologies the knowledge worker behavior can be visualized and help to understand if a BPM or ACM concept is appropriate. Also, key knowledge worker activities or the required adaptivity level can be analyzed. Therefore including process mining in the Analysis phase might be evaluated.

It is expected that the proposed methodology will contribute to industry experts on the development of ACM solutions. Additional customer projects from various industries can help to mature the proposed ACM Methodology.

7. CONCLUSIONS AND FUTURE WORK

As the need for IT solutions supporting complex and knowledge worker-based business cases increases, new approaches and technologies arise. ACM appears as one of the most appealing innovations in that context. Given ACM's unique features and characteristics, a tailored methodology for ACM solution development is presented. This methodology defines useful and practice-proven methods and tools for the development process encompassing multiple phases in a typical IT solution. The methodology is developed and structured from hands-on experience in actual ACM projects. Although the focus of the methodology is not in the excellence for each phase, the overall application of the described methods to each of the proposed phases has been used to deliver successful ACM solutions. In order to demonstrate this, the methodology is fully illustrated with a Case Study which is derived from an actual customer project.

For each of the five phases - Business Modeling, Visualization, Analysis, Design, and Implementation - artifacts, based on best practices, are defined that support the solution development progress. Key methodology deliverables that are tailored to the ACM approach are also described and included ACM Workspace (user interface), ACM Canvas (analysis tool) and CMMN Model (design). Combined with the Implementation Spreadsheet (development checklist) they guide the developer and knowledge worker towards a successful Adaptive Case Management solution.

As Adaptive Case Managed is a fairly new discipline the method is developed under the characteristics of a waterfall approach. Once maturity is gained a more agile approach is recommended. For example by each activity each methodology phase can be executed.

In the new knowledge age, knowledge workers make the difference. It is up to us to support them!

REFERENCES

Agile Alliance. (2015, February). *Agile Alliance*. Retrieved from https://www.agilealliance.org

Angus Stevenson, Christine A. Lindberg . (2010). *New Oxford American Dictionary.* Oxford University Press Inc.

Appian, B. F. (2013). Adaptive Case Management in a Worksocial World. *KMWorld Magazine*.

Babich, A., Man, H. d., Buelow, H., Carpenter, B., Chapman, M., Cummins, F., . . . Vincent, P. (2013). *Case Management Model and Notation (CMMN).* Object Management Group.

Babich, A., Man, H. d., Buelow, H., Carpenter, B., Chapman, M., Cummins, F., . . . Vincent, P. (2014). *Case Management Model and Notation (CMMN).* Object Management Group.

Bank, C., & Cao, J. (n.d.). *UX Design Process & Documentation.* UXPin.

be informed. (2016, June). Retrieved from Dynamic Case Management: http://www.beinformed.com/dynamic-case-management.html

Beck, K., Beedle, M., Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., . . . Thomas, D. (2001). *Manifesto for Agile Software Developmen*. Retrieved from http://agilemanifesto.org/

Bock, C., Cook, S., Rivett, P., Rutt, T., Seidewitz, E., Selic, B., & Tolbert, D. (2015, March). *OMG Unified Modeling Language*. Retrieved from http://www.omg.org/spec/UML/2.5/

Clair, C. L., & Miers, D. (2014). *The Forrester Wave: Dynamic Case Management, Q1 2014.* Forrester.

CMS. (2005, February 17). *Selecting a development approach.* Retrieved from https://www.cms.gov/Research-Statistics-Data-and-Systems/CMS-Information-Technology/XLC/Downloads/SelectingDevelopmentApproach.pdf

Davenport, T. H. (2006). *Thinking for a Living: How to Get Better Performance and Results from Knowledge Workers.* Your Coach Digital.

Drucker, P. F. (2001). *Management Challenges for the 21st Century.* HarperBusiness.

EMC. (2016, June). Retrieved from Dynamic Case Management: https://www.emc.com/campaign/dynamic-case-mgmt/index.htm

Erl , T., Bennett , S. G., Carlyle , B., Gee, C., Laird , R., Manes, A. T., . . . Santas, F. (2011). *SOA Governance: Governing Shared Services On-Premise and in the Cloud.* Prentice Hall.

Erl, T. (2009). *SOA Design Patterns.* Prentice Hall.

Erl, T., Chelliah, P., Gee, C., Kress, J., Maier, B., Normann, H., . . . Winterberg, T. (2014). *Next Generation SOA: A Concise Introduction to Service Technology & Service-Orientation.* Prentice Hall.

Fish, A. N. (2012). *Knowledge Automation: How to Implement Decision Management in Business Processes.* Wiley.

Gu, Q., & Lago, P. (2011). *Guiding the selection of service-oriented software engineering.* Springer Link.

Hall, J., Healy, K. A., & Ross, R. G. (2015). *Business Motivation Model.* Object Management Group.

Hill, J. B., Chin, K., & Dunie, R. (2014). *Critical Capabilities for Case Management.* Gartner.

IBM. (2016, June). Retrieved from Case Manager: http://www-03.ibm.com/software/products/en/casemana

ISIS Papyrus . (2016, June). Retrieved from Adaptive Case Management: http://www.isis-papyrus.com/e15/pages/business-apps/acm.html

Jeston, J., & Nelis, J. (2008). *Business Process Management Practical Guidelines to Successful Implementations.* Burlington: Elsevier Linacre House.

Jones, S., & Morris, M. (2005). *A methodology for service architectures.* OASIS.

Juric, M. B., Bernhardt, S., Normann, H., Schmiedel, D., Schmutz, G., Simpson, M., & Winteberg, T. (2015). *Design Principles for Process-driven Architectures Using Oracle BPM and SOA Suite 12c.* Birmingham: Packt Publishing.

Kress, J., Maier, B., Normann, H., Schmiedel, D., Schmutz, G., Trops, B., . . . Winterberg, T. (2013). Industrial SOA. *Service Technology Magazine*.

Kress, J., Meier, B., Normann, H., Schmiedel, D., Schmutz, G., Trops, B., . . . Winterberg, T. (2014). *Adaptive Case Management (ACM) in Practice.* Retrieved from www.soaCommunity.com: http://soacommunity.com/index.php/thought-leadership/adaptive-case-management

Lane, S., Gu, Q., Lago, P., & Richardson, I. (2013). *Towards a framework for the development of adaptable service-based applications.* Springer Link.

Le Clai, C., & Moore, C. (2009). *Dynamic Case Management An Old Idea Catches New Fire.* Forrester.

Mahal , A. (2010). *How Work Gets Done: Business Process Management, Basics and Beyond.* Technics Publications.

Moore, A. (2013). *Moving Along from BPM to Case Management.* KMWorld Magazine.

Motahari-Nezhad, H. R., & Swenson, K. D. (2013). *Adaptive Case Management: Overview and Research.* IEEE International Conference on Business Informatics.

OpenText Case360. (2016, June). Retrieved from OPENTEXT: http://www.opentext.com/what-we-do/products/business-process-management/alternative-process-solutions/opentext-case360

Oracle. (2016, June). Retrieved from Oracle BPM Intelligent Adaptive Processes: http://www.oracle.com/us/technologies/bpm/overview/index.html

Oracle Applications User Experience. (2014). *Simplified User Experience Design Patterns for the Oracle Applications loud Service.* Mc Graw Hill Education.

Pega. (2016, June). Retrieved from Case Management: https://www.pega.com/case-management

Pucher, M. J. (2012, May). *What is Adaptive Case Management (ACM)?* Retrieved from https://acmisis.wordpress.com/what-is-adaptive-case-management-acm/

Puttini, R., Tofanello, A., Vidigal, A., Areal, A., Alves, G., Chaim, R., & Mazzarolo, C. (2012). *A Service-Oriented Software Development Methodology.* Brasília: University of Brasilia.

Pyöriä, P. (1997). Knowledge Worker Roles and Actions – Results of Two Empirical Studies. *Journal of Knowledge Management*.

Shields, P. M., & Rangarajan, N. (2013). *A Playbook for Research Method.* New Forums Press .

Silver, B. (2011). *Bpmn Method and Style with Bpmn Implementer's Guide.* Cody-Cassidy Press.

Silver, B. (2012). *Case Management: Adressing unique BPM requirements.* BPMS Watch.

Slama, D., & Nelius , R. (2011). *Enterprise BPM: Erfolgsrezepte für unternehmensweites Prozessmanagement.* dpunkt.

Slama, D., & Nelius, R. (2011). *Enterprise BPM.* dpunkt.verlag.

Smiers, L., Koster, J., Deb, M., & Palvankar, P. (2015). *Oracle Case Management Solutions.* Auerbach Publications .

Swenson, K. D., Fischer, L., Kress, J., Palmer, N. G., Dugan, L., Utschig-Utschig, C., . . . Bider, l. (2015). *Thriving On Adaptability: Best Practices for Knowledge Workers.* Future Strategies.

Swenson, K. D., Palmer , N., Pucher, M. J., Webster, C., & Manuel, A. (2012). *How Knowledge Workers Get Things Done.* Future Strategies.

Swenson, K. D., Palmer, N., & Carlsen, S. (2014). *Empowering Knowledge Workers.* Future Strategies.

Swenson, K. D., Palmer, N., Silver, B., Fischer, L., & Koulopoulos, T. (2011). *Taming the Unpredictable Real World Adaptive Case Management: Case Studies and Practical Guidance.* Future Strategies.

Swenson, K. D., Palmer, N., Sinur, J., Khoshafian, S., Chow , L., Fischer, L., . . . Schmiedel, D. (2016). *Best Practices for Knowledge Workers - Digital Edition.* Future Strategies.

Swenson, K. D., Ukelson, J. P., Shepherd, T., Matthias, J. T., Pucher, M. J., Khoyi, D., . . . Lee, C. (2010). *Mastering the Unpredictable: How Adaptive Case Management Will Revolutionize the Way That Knowledge Workers Get Things Done.* Megan-Kiffer.

Telecommunication Development Bureau. (2015). *ICT Facts and Figures 2005, 2010, 2014.* International Telecommunication Union.

United States. Navy Mathematical Computing Advisory Panel. (1956). *Symposium on advanced programming methods for digital computers : Washington, D.C., June 28, 29, 1956.* Office of Naval Research, Dept. of the Navy.

Usability.gov. (2016, February). *User-Centered Design Basics*. Retrieved from Usability.gov - U.S. Department of Health & Human Services: http://www.usability.gov/what-and-why/user-centered-design.html

Wanless, S. (2010). *The 7 key components for an effective case management methodology.* BeyeNETWORK.