COMBINING PROCESS MODELLING AND CASE MODELLING

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Abstract – Adaptive Case Management deals with processes that are not predefined or repeatable, but depend on evolving circumstances and decisions regarding a particular situation. While case management is often considered as different from conventional business process management, in reality they cannot be strictly separated. A structured business process can contain parts which deal with non-routine cases. The Object Management Group (OMG) published the Business Process Model & Notation (BPMN) as well as the Case Management Model & Notation (CMMN). There is an ongoing debate whether these two languages should be combined are kept independent.
After a short introduction into CMMN and BPMN we analyse an application process as it is typical for public administration in order to identify strengths and weaknesses of both BPMN and CMMN. We show that typical processes contain both structured and non-structured parts and neither BPMN nor CMMN alone is adequate to model the process. Finally, we propose recommendations for a meta-model, which combines elements of BPMN and CMMN.

1. – Introduction

The benefits of Business Process Management (BPM) --reduction of cycle time, automation of routine processes, standardization and compliance, business integration and end-to-end performance visibility-- are well established in many companies and public administrations. However, an important class of business processes has been unable to enjoy them: case management[1] [1]. Case management processes are not predefined or repeatable, but instead, depend on evolving circumstances and decisions regarding a particular situation, a case [2]. Human judgment is required in determining how to proceed [3].

Case management processes are a common occurrence in public administrations and many industry segments. In a case management survey it was observed that two third of a knowledge worker's day is spent in unstructured and often unpredictable work patterns [4]. In government we can find case management in particular in decision processes, where human judgment is required. It is well established in many segments of benefits administration, like disability, welfare assistance, student financial aid and grants programs [1].

Adaptive Case Management (ACM) has been proposed as alternative data-centred approach for the management of such case processes [2], in contrast to the activity-centred approaches for structured business processes [4]. However, while case management is often considered as different from conventional business process management (see [4]), in reality they cannot be strictly separated. A structured business process can contain parts which deal with non-routine cases requiring additional investigation by different people, for example the underwriting in

[1] Also called Adaptive Case Management (ACM)

financial services [1]. Nevertheless, in 2013 the OMG published the new Case Management Model and Notation (CMMN) [5], a modelling language specific for case management which is separate from Business Process Model and Notation (BPMN) [6], which is a standard for business process modelling.

In this research we investigate, whether and how business process modelling and case modelling should be integrated. We analyse a concrete case and show that neither BPMN nor CMMN alone are appropriate to model all aspects. We analyse the commonalities and differences of BPMN and CMMN and suggest an integrated meta-model that allows to model structured and non-structured aspects of a business process in a single environment.

2. – Related Work

Adaptive Case Management (ACM) has recently received growing attention [7]–[9]. In this section the differences between Adaptive Case Management (ACM) and Business Process Management (BPM) are briefly described.

BPM focuses on business processes consisting of activities in a flow. According to The business process defines the flow of control, all the possible paths and permutations are defined in advance [4]. As an activity occurs, the state of the process changes (see Figure 1). As the state changes, it is transferred from one activity to the next, control flows similarly from one activity to the next.

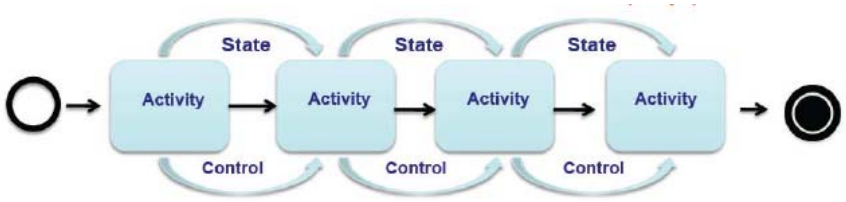


Figure 1: States in BPM [10]

ACM, on the other hand, focuses on cases consisting on events and outcomes. More precisely a case is a collection of processes and isolated tasks, the number and identity of which cannot be fixed by a predefined template or rules. While the circumstances , which define how and when the case is completed are known, it is not possible to fully predetermine all the tasks needed to complete the case, as stated by Palmer [4]. A case evolves over time in the direction of achieving a goal and it can take unpredictable directions. The activities to reach the completion of the case are determined by the content and context and each of them creates information to add to the case. This defines the state of a case as shown in Figure 2. In particular where human judgment is predominant, ACM is a more appropriate approach.

Figure 2: States in ACM [10]

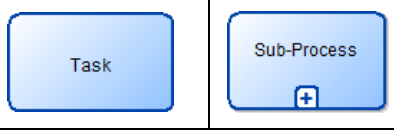
Modelling cases has specific requirements compared to process modelling, because with ACM sequence and pathways of execution are not predetermined [4]. In the standard process modelling language BPMN there is the possibility to indicate subprocesses [6] as adhoc, but there is no further support to express specific aspects of cases. As a consequence, the OMG developed the Case Management Model and Notation CMMN [5] as a separate modelling language.

There is an ongoing debate whether a new modelling language is necessary for case management or whether case modelling can be an extension of business process modelling. While Swenson claims that "BPMN is incompatible with ACM" [11], Silver argues that BPMN and CMMN should be merged [12]. He proposes to extend BPMN with case-specific element of CMMN. To illustrate his argument, he shows an example with case elements added to BPMN. Also IBM works on a case extension of their business process modelling in tool [13] offering the possibility to add discretionary tasks in business processes, instantiating them at runtime either manually by a user or by a few defined preconditions. In other words IBM's BPM 8.5.5 seamlessly blends runtime and non runtime processes, and all combinations thereof, in a single product. Other approaches combine CMMN and BPMN in the same tool by reusing model elements (see for example [14]). In contrast, we focus on developing an integrated language with elements from both CMMN and BPMN.

3. – Overview of BPMN and CMMN

In this section we give a short overview of BPMN [6] and CMMN [5]. This section is not intended as an introduction into the languages but serves as a reference.

For convenience we show in Table 1 the main elements of BPMN, which can be divided into 4 categories: flow objects, connectors, artefacts and swimlanes. The focus of BPMN is to model the control flow of business processes (with flow objects and sequence flow connector), the assignment of activities to participants (using swimlanes) and information flow (using data objects and message flow).

Element Name	Element Icon	Element Description
Flow Objects		
Activities		An activity is work that is performed within a business process. There are 2 types of activities: **Tasks** which are units of work and **Sub-Processes which** are activities that can be refined.
Events		Events are states that affect the flow of the process; one can distinguish Start, Intermediate or End Events. They can trigger activities (catching) or are its result (throwing).

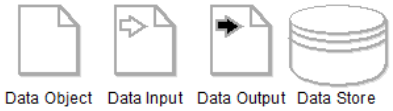
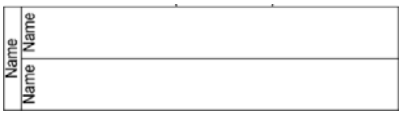
Gateways		Gateways represent points of control: they split and merge the flow of a process: **Exclusive Gateways** route the sequence flow to exactly one of the outgoing branches. **Event-based Gateways** route to the subsequent event which happens first. **Parallel Gateways (AND)** activate all outgoing branches. **Inclusive Gateways (OR)** activate at least one branch.
Connectors		
Sequence Flow		A Sequence Flow is used to show the order that activities within a Pool.
Message Flow		Interaction between Pools is handled through **Message Flow**.
Association		Data Associations connect Data Objects to Activities.
Artefacts		
Data Object		Artifacts provide the capability to show information beyond the basic flow-chart structure of the Process. Data Objects can be used to define Inputs and Outputs of activities or Data Stores which represent repositories or databases.
Swimlanes		
Pool		A pool is a container for a business process or a participant in a collaboration
Lanes		A lane is an optional subdivision of a process level. They are typically used to associate process activities with particular actors. Each participant that performs activities in a business process has a lane. A lane can represent a role, an organizational unit or a system.

Table 1: BPMN Modeling Elements

The modeling elements of CMMN are shown in Table 2. Case management allows planning of tasks at run-time. This can be modelled in CMMN using discretionary tasks. The worker can add one or more instances of discretionary tasks to the plan [5, p. 14f]. Planning tables support the human worker in planning. A planning table contains applicability rules for the discretionary tasks. During planning only Discretionary Items, for which the Applicability Rule evaluates to “true”, must be shown to the Case Worker.

Control flow in CMMN is not modelled via gateways but via Sentries. A Sentry is assigned to task, stages and milestone. A Sentry is a combination of an event and a condition. When the event is received, a condition is checked. If the condition evaluates to true, the Plan Item is activated.

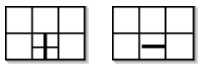
Element Name	Element Icon	Element Description
Case Plan Model		The behavior of a Case is captured in a **Case Plan Model**. For each Case model, a Case Plan Model is required and it comprises all elements that represent the initial plan of the case as well as all elements that support the further evolution of the plan through run-time planning by case workers.
Plans Items		
Task		A Task is **a unit of work**. Task can specialized into **three types of Tasks.** Tasks can be specialized to **human tasks, case tasks** (calling another case) and **process tasks** (call to a business process)
Discretionary Task		**Discretionary Tasks** are available to the Case worker to be applied to his/her discretion. Any task type can be discretionary. They are depicted like tasks but with dashed lines.
Plan Fragments/Stages		
Plan Fragment		A Plan Fragment is a container of Plan Items and Sentries.
Stage		Stages are Plan Fragments that can be tracked. They may be considered “episodes” of a Case.
Milestones		
Milestone		A Milestone is a Plan Item Definition that represents an achievable target, defined to enable the evaluation of the progress of the Case.
Event Listeners		
Event Listener		An event is something that “happens” during the course of a Case. Event Listeners are used to model events that do not happen to Plan Items. They can be specialized as: **Timer** or **User** Event Listeners.
Other Items		
Planning Table		The **planning tables** make the Discretionary Items dynamically applicable for planning. Only Discretionary Items, for which the Applicability Rule evaluates to “true”, are shown to the Case Worker.
Sentries		Plan Items may have associated Sentries. They define the criteria according to which the Plan Items are enabled (or entered) and terminated (or exited). If depicted by a shallow “Diamond” they are **entries** and if depicted by a solid “Diamond” they are **exits**.
Case File		All information, or references to information, that is required as context for managing a Case, is defined by a Case File. A Case File onsists of Case File Items that may represent a piece of information of any nature, ranging from unstructured to structured, and from simple to complex.
Connector		A Connector has the shape of a dotted line and it can be used to visualize dependencies between Plan Items.

Table 2: CMMN Modeling Elements

4. – Case Study - Application Processes in Public Administration

In this section we present a case study to demonstrate the necessity of combining case management and business process management in public administrations.

In public administrations we often find processes where citizens or companies file an application that has to be handled by human workers. Examples are applications for building permission, social welfare, student financial aid, or grants programmes. Many of these processes can be regarded as knowledge work [15]. Thereby, workers are often involved in different cases at the same time and collaborate with each other in order to achieve a common goal [16].

As an example of such an application process we analyse the admission process for the Master of Science programmes at the School of Business FHNW.

- The process starts when the application from a candidate is received.
- First the study assistant checks eligibility of the candidate.
- The dean validates the eligibility as proposed by the study assistant.
- Candidates who obviously are not eligible are rejected. The other candidates are invited for an interview, which is made by the interview team.
- Then the admission commission decides whether the candidate is accepted.
- For accepted candidates the administration determines the tuition fee.
- The study assistant informs the candidate about acceptance and tuition fee.

This process can be represented in BPMN as given in Figure 3

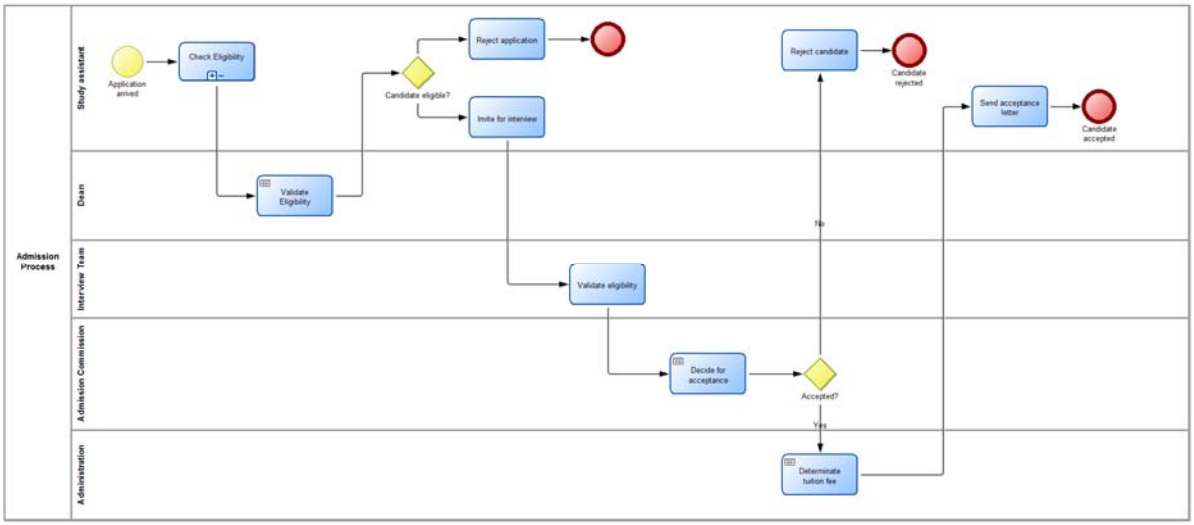


Figure 3: Application Process in BPMN 2.0

Check Eligibility is an adhoc subprocess which consists of the following tasks:

- The study assistant checks for completeness of the documents.
- The candidate's transcript of records is analyzed to determine whether the bachelor degree is acceptable and whether the average grade is at least "good".
- If the grading system is from a foreign university, it has to be mapped to the Swiss grading system.
- It is checked whether the university, from which the candidate got the bachelor degree, is accredited. If the university is unknown, the study assistant can access several information sources he/she can ask public authorities in the country to confirm the status of the university.

In this sense the application process is a good example to compare the adequacy of BPMN and CMMN. It contains elements that are typical for both BPM and ACM. The main process is a standard routine process. It follows a predefined flow, thus the use of BPMN is an appropriate choice.

However, modelling the Check Eligibility subprocess in BPMN reveals some problems. It is a non-routine process consisting of activities whose execution depends on the situation as well as the competences and experiences of the person who executes the tasks. For example, it is up to the study assistant, who executes the activity "Check Accreditation of University", which activities need to be performed and whether additional steps are required. If the study assistant already knows the university which an applicant comes from (maybe from a previous case) he/she would not need to access any information sources for the university checking. Conversely, if the study assistant does not know the university and he/she is not able to find information about it in any of the proposed information source, he/she can decide to follow additional procedures or to find new information sources in order to get the information needed. Thus, human judgment is required in determining how to proceed.

Furthermore, the order of the tasks is not fixed, tasks can overlap and they can depend on each other. If for example, the study assistant finds out during the task "Analyse Application Documents" that the bachelor degree is acceptable, the tasks "Analyse Transcript of Record" is not necessary anymore.

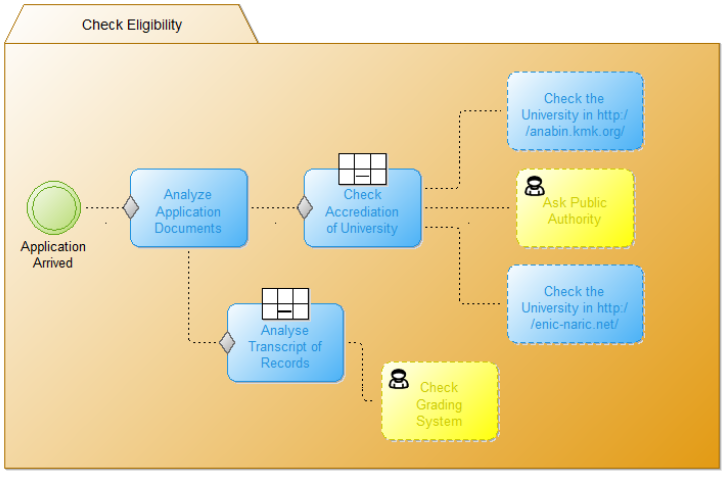


Figure 4: Check Eligibility in CMMN

For this non routine part of the process we need another kind of modelling. CMMN would allow to model this subprocess by using discretionary tasks and Sentries (see Figure 4). In particular the discretionary tasks, whose execution depends in the individual human worker, cannot be modeled adequately in BPMN.

5. – Appropriateness of BPMN and CMMN for Modeling the Application Process

The case study presented in section 4 has been modelled by a combination of BPMN and CMMN. The overall process is modelled in BPMN while for the sub-process CMMN was regarded as adequate. In this section we have a more detailed look at the model. We show present arguments for the separation of the model and also explain advantages and limitations of each of the modelling languages.

5.1 – Modeling Control Flow in BPMN and CMMN

In BPMN the order of activities is modeled with a dedicated arrow for the sequence flow. In CMMN there is only one type of relation. To model a sequence flow, the connector associates a tasks with the Sentry of the successor task. A Sentry is a combination of an event and a condition. The task is triggered when the event is received and the condition evaluates to true. Thus, the BPMN sequence flow on the left of Figure 5 and the CMMN connection on the right of Figure 5 are equivalent, if the condition of the Sentry is either empty or always true.

Figure 5: Modeling sequence flow in BPMN and CMMN

The conditions of a Sentry can also be used to model gateways. To model an exclusive gateway in CMMN, the Sentry conditions of the subsequent gateways must be exclusive. Thus, the process flow of the admission process in Figure 3 could be modeled in CMMN. But while in BPMN it can be directly whether a gateway is exclusive, in CMMN this is hidden in the Sentries.

As a consequence, BPMN is preferable for modeling structured processes. Although the flow of a process can also be modeled in CMMN, the meaning of the connection is hidden in the Sentry. Thus, the graphical model in CMMN is less expressive than a BPMN model.

5.2 – Assigning Tasks to Roles

The lanes in BPMN visualize, who is responsible for which activity. Lanes can represent organisation units, roles or systems. In the admission process the lanes are used to assign tasks to the study assistant, the dean, the interview team and the administration.

CMMN is lacking a visual modeling element for assigning tasks to roles. Instead, CMMN has a role concept. Roles in CMMN authorize case workers or teams of case workers to perform Human Tasks, plan based on Discretionary Items, and raise user events [5]. The assignment of tasks to roles, however, is not visualized but represented via attributes of tasks.

5.3 – Discretionary Tasks

Sections 5.1 and 5.2 show some advantages of BPMN for modeling structured processes and for assigning tasks to people. However, BPMN does not have a specific expression to model tasks, whose execution depends on the judgment and preference of the worker. In BPMN all tasks are integrated in a sequence flow. Whether a task is executed depends on conditions about data or on events.

We could use gateways. In the same situation it can happened that one worker would execute an activity but another would not need to execute the activity because of his/her experiences or knowledge. This kind of dependence on the individual worker is not typical use of gateways.

For cases, however, planning tasks at runtime is typical. In the subprocess Check Eligibility (see Figure 4), the human worker can decide at runtime whether he/she want to access an information source for checking the accreditation of a university. He/she might have a preference for a specific source, maybe because of an more or less intuitive interface. If the human worker already knows the university, he/she might decide not to access an information source at all. This can be modeled in CMMN with discretionary task (see Figure 4).

However, individually adding and selecting tasks might be appropriate also in a structured process. An example is the task "Decide for acceptance". Although it is part of the structured BPMN process, the human workers - dependent on their individual skills and experiences - can do additional research to decide the case. This would be possible to model as discretionary tasks in CMMN which are not available in BPMN.

5.4 – Modeling Decision Logic

In the process model of Figure 3 we see several processes which are tagged as business rules tasks. These tasks are decision tasks and the business rules represent the decision logic. Von Halle and Goldberg provide arguments why separating the decision logic from the process flow is good modeling style [17]. Decision logic could be represented as busienss rules, or as a decision model [17]. Business rules tasks are appropriate to link process model and decision logic. Business rules tasks are available in BPMN but lacking in CMMN.

6. – Proposal for a combined Process and Case Modeling Language

The analysis of the previous Section revealed that neither CMMN nor BPMN alone are able to model the application process of the case study in a suitable way. As a consequence, we propose to specify a modeling language that combines elements of the two modeling languages. From the analysis we derived the following requirements for the combined business process and case modeling language:

- The language should allow visualizing the control flow. This makes process flow easy to understand and support the communication with the different stakeholder of a process. The sequence flow connector and the gateways of BPMN are suitable for making the control flow explicit.

- Lanes are a commonly accepted approach to visualize the assignment of tasks to participants (roles, organization units and systems).

- It should be possible to connect discretionary tasks to any kind of human task - even those embedded in a structured process flow. This allows knowledge workers to flexibly

- It should be possible to model tasks which are not embedded in a process flow and which can be triggered at any time based on events and conditions. Sentries of CMMN are adequate to satisfy this requirement.

- BPMN and CMMN have different types of tasks. The new language should include the task types of both BPMN and CMMN. In particular, business rules tasks should be part also of non-structured process part.

- Three types of rules should be supported by the modeling languages:

    - business rules representing decision logic which is applied while executing a task

    - activation rules that determine whether a task is triggered -this corresponds to the Sentries of CMMN

    - applicability rules support the human user in planning the discretionary task

Silver has argued that BPMN covers about 90% of what is needed for business processes [13]. Following his argument, it would be a good approach to start with BPMN and add the necessary case aspects. If BPMN would be a subset of the new language, the huge number of already existing BPMN models could still be used. This is an important advantage and would increase the chance that the new language is accepted by process managers.

7. – Conclusion

We have shown that in practice neither Case Management nor Business Process Management alone are adequate to deal with application processes, which are typical for public administrations. While BPMN is suitable to model control flow, it lacks possibilities to support planning at run-time. The latter, however, is the strength of CMMN. But CMMN lacks the visualization of control flow and task assignments.

A combination of the control flow elements of BPMN with the discretionary tasks and planning elements of CMMN seems to be a suitable language to deal with any kind of processes. A concrete specification and implementation of such a modeling language will be the challenge for future research.

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