Assessing suitability of adaptive case management

Spring 6-10-2017

ASSESSING SUITABILITY OF ADAPTIVE CASE MANAGEMENT

Jeroen Pillaerds
Deloitte Consulting, Amsterdam, Netherlands, JPillaerds@deloitte.nl

Rik Eshuis
Eindhoven University of Technology, Eindhoven, Netherlands, h.eshuis@tue.nl

ASSESSING SUITABILITY OF ADAPTIVE CASE MANAGEMENT

Research paper

Jeroen Pillaerds, Deloitte Consulting, Amsterdam, Netherlands, JPillaerds@deloitte.nl
Rik Eshuis, Eindhoven University of Technology, Eindhoven, Netherlands, h.eshuis@tue.nl

Abstract

Business Process Management (BPM) includes methods and techniques to support the execution of business processes. In recent years, Adaptive Case Management (ACM) has been proposed as new BPM technology for supporting knowledge-intensive processes. However, there is currently no structured way of quickly deciding upon the suitability of an ACM system to a specific business process. This paper presents a framework for assessing to which extent ACM is suitable for a particular business process. It distinguishes between process characteristics that ACM can support, characteristics that ACM can support but are not ideal, and characteristics that ACM cannot support. The framework also explains the rationale behind each assessment, and refers to alternatives in case ACM is not suitable for the process that needs to be supported. Thus, the framework provides a transparent and useful advice about which kind of BPM technology is most suitable to support a business process to the best extent. A preliminary evaluation of the framework has been carried out in collaboration with an IT consultancy company that advises its clients on BPM technology.

Keywords: Knowledge-intensive processes; Adaptive Case Management; Software selection.

1 Introduction

Organizations deliver products or services to their customers by performing business processes, which consist of activities, i.e., atomic units of work. Business Process Management (BPM) includes methods and techniques to support the design, execution and analysis of business processes (Dumas et al., 2013; Weske, 2012). A Business Process Support System (BPSS) is a generic software system that manages the execution of business processes, similar to the way a Database Management System manages data (Dumas et al., 2013). Traditionally, a BPSS only support structured business processes, which can be modeled in flowchart languages such as BPMN (OMG, 2011). Structured business processes are predictable, so they can be modeled in advance. The work that they coordinate is routine and has a high volume (Leymann and Roller, 2000). Workflow management systems are traditional BPSSes that focus on coordinating a specific, predefined set of activities that need to be performed according to a predefined order.

However, many processes are semi-structured, meaning that they describe work that is non-routine, so unpredictable. The structure of such a process depends on the specific case that is handled in the process (Di Ciccio et al., 2015). Applying traditional BPSSes to semi-structured processes leads to problems, since such BPSSes do not provide context information about the cases being processed and do not offer the flexibility that is needed to handle unexpected changes (van der Aalst et al. 2005; Reijers et al., 2003). Examples of semi-structured processes are handling complex insurance claims, invoice discrepancies, medical treatment, etc. Adaptive Case Management (ACM) has been proposed to support such semi-structured processes (Swenson, 2010). Though ACM was originally positioned as an alternative to (traditional) BPM (Swenson, 2010), there is now growing consensus that ACM is actually part of BPM, and that ACM systems are actually a particular type of BPSS (Swenson, 2014).

ACM is often linked to Knowledge-intensive Processes (KiPs) (Di Ciccio et al., 2015; Swenson, 2010). A KiP is a business process whose structure and execution heavily depends on knowledge

workers performing various interconnected knowledge-intensive decision making tasks (Di Ciccio et al., 2015). ACM is considered to support KiPs better than traditional BPM (Marin et al., 2015).

Before an organization can use ACM, it needs to identify the business processes for which ACM is suitable. Selecting processes for BPM support in general is time consuming, which in the worst case might lead to failure of the BPM project (Becker et al., 1999; Cho and Lee, 2011). A few frameworks for assessing structured business processes in the context of workflow automation have been defined (Becker et al., 1999; Cho and Lee, 2011; Reijers, 2006), but these are not applicable to ACM, as we explain in Section 2.

The goal of this paper is to design a framework that assesses the suitability of ACM to a particular business process. By applying the ACM assessment framework, users should be able to quickly estimate whether or not ACM is suitable for a particular process, based upon the characteristics of the process. The framework also should explain the rationale behind each assessment, and refer to alternatives in case ACM is not suitable for the process that needs to be supported. The provided assessment can be the starting point for more detailed analyses that are carried out subsequently. The framework was developed and evaluated in collaboration with Deloitte Consulting Amsterdam, which gives advice on BPSSes to its clients.

This paper is organized as follows. Section 2 gives background about ACM and BPM in general and discusses related work. Section 3 explains the followed research approach. Section 4 discusses the characteristics of KiPs as found in the literature, as well as the evaluation of these KiP characteristics with representative employees of vendors of ACM systems, resulting in a refined list. Section 5 presents the assessment framework. First, it presents an analysis of how well different types of BPSS supported the different KiP characteristics. Based upon this analysis, the assessment framework is developed. Section 6 ends with discussion and conclusions.

2 Background and related work

We analyze different BPSS types and discuss related work on assessing suitability of BPM for business processes.

2.1 Business Process Support Systems

Adaptive Case Management has its roots in Case Management (CM) (Swenson, 2010), also known as case handling (van der Aalst et al., 2005). A case is an information product along with all contextual information re garding that product. A case worker gradually extends and refines the case. The product is typically complex, making it more easy to specify upfront *what* goal should be achieved for the case than specifying *how* that goal should be achieved. The case worker has considerable freedom in defining the activities necessary to reach the desired goals for the case. After performing the activities, a process has been implicitly defined, but this process is not predictable upfront.

In recent years, a distinction is made within CM between Production Case Management (PCM) and ACM (Marin et al., 2015; Motahari-Nezhad and Swenson, 2013). Similar to ACM, a PCM system supports knowledge workers that need to achieve case-specific goals by providing the workers with flexibility to decide themselves how to obtain those goals. However, a PCM system restricts this flexibility by modeling business rules and legal regulations upfront (Motahari-Nezhad and Swenson, 2013). The range of tasks and options in a PCM system is bounded and specified in advance.

Unlike PCM systems, an ACM system allows the knowledge worker to make on the fly adaptations to the system, for instance by adding new tasks that are to be performed. An ACM system therefore supports more unpredictable processes than a PCM system and is therefore more flexible. But it relies more heavily on knowledge workers than a PCM system to (implicitly) define the process that needs to performed in order to make progress on the case.

Finally, groupware systems support collaboration between users performing business processes (Ngwenyama and Lyytinen, 1997). Groupware is intended for knowledge workers to share infor-

mation in a flexible way, which emphasizes the data-centric nature of groupware systems. These collaborative features are bounded by rules that mediate group interactions and work practices, like organizational policies, protocols (Ngwenyama and Lyytinen, 1997). Groupware systems are neither process nor case-driven, so there is no implicit or explicit process that drives the collaboration.

Table 1 summarizes the differences between the discussed types of BPSS.

	WF management	**PCM**	**ACM**	**Groupware**
Main focus	Process	Case	Case	Collaboration
Progress occurs through	Process sequence	Data	Data	Data
Dependency on knowledge worker	Low	Medium	High	High

Table 1. ACM and other types of Business Process Support Systems

2.2 Related work

Only a few papers address suitability of BPM to a particular business process. Frameworks have been defined that help to assess the potential of business process for workflow automation (Becker et al., 1999; Cho and Lee, 2011). The frameworks use criteria, grouped into technical, organizational, and economical criteria (Becker et al., 1999) or derived from balanced scorecards (Cho and Lee, 2011). The scores for single criteria are aggregated into an overall score. These frameworks only consider workflow management systems, whereas the framework in this paper takes other types of BPSS into account. Moreover, the criteria are fairly detailed, requiring quantitative estimates, which makes it difficult to quickly score business processes. In contrast, the ACM assessment framework developed in this paper is intended to quickly assess which type of BPSS is suitable for a business process. However, the assessment is not sufficiently detailed for developing a business case. The criteria identified by Becker et al. (1999) and Cho and Lee (2011) can be used subsequently for that purpose.

A checklist has been proposed to assess the level of process-orientation of an organization that has already decided to implement a workflow management system (Reijers, 2006). The aim of the checklist is to help predict the success of a workflow management system implementation. The ACM assessment framework presented in this paper supports the phase before, when an organization is investigating which particular type of BPSS is most suited for its business processes. Moreover, this paper targets ACM rather than workflow management systems.

Another related work studies the problem of selecting a concrete BPSS for a business process (Bider and Perjons, 2015). That paper develops a paradigm-independent modeling approach to identify from a business process its requirements regarding a BPSS, and it relates these requirements to capabilities of concrete BPSSes. In contrast, the ACM assessment framework presented in this paper assesses the type of BPSS most suitable for a process. Modeling the process and selecting a concrete BPSS is done in a subsequent phase in our approach. Finally, Di Ciccio et al. (2015) provide general characteristic of KiPs and evaluate the suitability of existing process management systems developed in the BPM research community for KiPs. However, their approach does not assess whether ACM is suitable for a particular business process and also other types of BPSS are not considered by them.

3 Research approach

We performed the research by following a design science approach (Hevner et al., 2004; Peffers et al., 2008), since the goal is to design an artifact, i.e., a framework for assessing the suitability of ACM for a particular business process. We describe in this section the steps taken in the design search process (Hevner et al., 2004); the outcome of the steps, i.e., the subartifacts, are described in Section 4 and 5.

Since ACM is intended to support knowledge workers performing Knowledge-intensive Processes (Herrmann and Kurz, 2011; Marin et al., 2015), we started the design search process with a literature review on Knowledge-intensive Processes (KiPs). Purpose of the review was to identify KiP characteristics that are important from the perspective of BPM. The used keywords were “knowledge-intensive process”, its synonym “knowledge-intensive business process”, and “process management.”

To build upon mature, peer reviewed research, we searched at the start of this research (early 2015) for papers published in conference proceedings and in academic journals, using Scopus and Web of Science. We retrieved around 50 unique papers. One of these was a recently published literature survey on KiPs (Di Ciccio et al., 2015), which turned out to contain a thorough overview of KiP characteristics. We therefore decided to use that paper as a basis. However, we discovered that this survey did not cite some of the recent papers on KiPs and process management that we had found in our search. We therefore used in addition three other recent papers (Isik et al., 2012; Marjanovic and Freeze, 2012; Sarnikar and Deokar, 2010) that also analyze KiP characteristics and that were not cited in the survey of Di Ciccio et al. (2015). We also skimmed other papers on KiPs that we had found and that were not cited in the survey, but these turned out to be not relevant for the purpose of this research.

To evaluate which KiP characteristics found in the literature influence the suitability of ACM, we decided to perform qualitative, as opposed to quantitative, research. Qualitative research was chosen since the research to be performed is of an explorative nature and there is little existing research in this specific field. Next, qualitative research allows small sample sizes, intense contact with the field of study, can be used to gain an integrated view on the problem (Gray, 2004). Therefore, we used qualitative research to identify the KiP characteristics as accurately as possible. In particular, we performed explorative semi-structured interviews with vendors of ACM systems. Semi-structured interviews are well suited for exploration of the perceptions and opinions of respondents regarding complex issues and enable probing for more information and clarification of answers (Barriball and While, 1994). By using semi-structured interviews it is also possible to interview multiple sources and providing the possibility to adjust the interview to people from a different environment (Teece and Teece, 1986).

The interviewees have been chosen according to snowball sampling (Biernacki and Waldorf, 1981). This is a way of sampling through referrals made among people who share or know of others who possess some characteristics that are of research interest. We choose snowball sampling since there is only a small number of ACM vendors. We searched for representative employees of ACM vendors who were in the network of Deloitte Consulting, for whom the framework was developed. Alternatively, we could have approached ACM vendors identified by research firms such Forrester (Le Clair et al., 2014). However, these firms only consider ACM vendors of reasonable size, disregarding small local vendors. To ensure that the software products from the vendors qualify as ACM systems, we used the software requirements identified in the recent literature on ACM (Herrmann and Kurz, 2011; Motahari-Nezhad and Swenson, 2013). We required that the interviewees worked on the intersection between business and IT, such that they were able to look at the problem from both an organizational and a technical perspective. In the end, we interviewed five key employees of ACM vendors. We performed separate interviews with these persons. To avoid group thinking, we did not choose for a group interview (focus group).

Each interview was recorded, transcribed, and reviewed by the interviewee. The interviews transcripts have been coded and compared to each other to identify common topics of interest, resulting in a list with mentioned influential characteristics of business processes. The coding of these interviews has been based on the KiP characteristics derived from literature. However, when additional characteristics were mentioned, a new code for these characteristics was developed. The list of influential characteristics was then fed back to the previously interviewed vendors in order to receive feedback. This feedback has been processed to eventually get a valid set of characteristics that influence the suitability of ACM systems to business processes.

To ensure that in case ACM is not suitable, other types of BPSS can be recommend, we have analyzed in the next step the differences of ACM systems with other types of BPSS. We have taken the identified process characteristics for ACM systems as point of reference for this analysis. Based on academic reference literature on BPM, we have explored to which extent workflow management systems, PCM systems and groupware systems support the identified KiP characteristics.

Based on specific differences identified in the previous step, we finally developed an ACM assessment framework which shows through means of a set of carefully chosen questions whether ACM is suitable to support the analyzed process. In case ACM is not suitable, the framework suggests alternative

types of BPSS that fit the analyzed process better than ACM. Each of the questions can be answered with either yes or no. This way ambiguity and room for interpretation is minimized, whereas users can quickly analyze a process. The answers to these questions, for a specific process, are compared with a reference sheet for each type of BPSS, which contains the ideal outcomes for each question. When the outcome of this question matches the ideal outcome for a BPSS the suitability of a systems becomes higher. When the outcome of a question does not match the value for a certain BPSS the suitability either drops, or a BPSS type is ruled out: it is impossible to manage the process with such a system.

We have performed a preliminary evaluation of the framework by letting three Deloitte consultants apply the framework to four textually descibed real-world business processes. We required that for each process its owning organization had accepted and implemented one of the BPSS types. Due to space limitations, we can only briefly discuss (in Section 6) the outcome of the preliminary evaluation.

4 Characterizing Knowledge-intensive Processes

To identify the characteristics of KiPs, we reviewed the literature and evaluated the found characteristics with vendors of ACM systems.

4.1 Literature review

As stated in the introduction, KiPs are often linked to ACM. In this subsection, four key papers on KiPs (Di Ciccio et al., 2015; Isik et al., 2012; Marjanovic and Freeze, 2012; Sarnikar and Deokar, 2010) are analyzed to identify a core set of characteristics that are specific to KiPs (see Table 2).

The first characteristic states that KiPs are driven by knowledge rather than by the completion of activities in a prescribed order (Di Ciccio et al., 2015; Isik et al., 2012; Marjanovic and Freeze, 2012). There is a need for both explicit (sources that can be formalized in some sort of knowledge base) and implicit (capabilities and experience of workers) knowledge in a KiP (Di Ciccio et al., 2015). Especially this implicit knowledge stresses the central role of the knowledge worker in the process which has a large impact on its outcome, as also pointed out by the other articles (Marjanovic and Freeze, 2012; Sarnikar and Deokar, 2010). Although the knowledge worker plays a central role in the KiP, still parts of the KiP can be automated (Isik et al., 2012).

Second is the need in KiPs to share information between process participants with different roles to make process progression (Di Ciccio et al., 2015; Marjanovic and Freeze, 2012; Sarnikar and Deokar, 2010). Information sharing can be between individuals and between organizations (Sarnikar and Deokar, 2010). Isik et al. (2012) do not explicitly mention the sharing of knowledge although they acknowledge the fact that KiPs depend heavily on human involvement and information.

A third characteristics that stands out in the literature is the fact that in a KiPs the knowledge worker may not know the structure of the process before executing it, and the process might change during execution (Di Ciccio et al., 2015; Marjanovic and Freeze, 2012). This also includes that the knowledge worker may not know which tasks he/she has to perform or which data sources (including other knowledge workers) he/she has to consult before executing the process (Di Ciccio et al., 2015; Marjanovic and Freeze, 2012) and the events that are going to take place (Di Ciccio et al., 2015). Note that KiPs can be unpredictable but do not have to be according to experts (Isik et al., 2012).

The fourth characteristic is that KiPs evolve as the process progresses (Di Ciccio et al., 2015). Each action and decision made by knowledge workers alters the knowledge available and state of the process. Based on this new knowledge and state, the process is assessed and next actions are determined in order to reach a pre-defined goal (Di Ciccio et al., 2015; Marjanovic and Freeze, 2012; Sarnikar and Deokar, 2010). KiPs can evolve over time but can be pre-defined as well (Isik et al., 2012).

Fifth, it is widely accepted across literature that KiPs are goal oriented (Di Ciccio et al., 2015; Marjanovic and Freeze, 2012). This means that the process progresses along a set of goals. The knowledge created in a KiP is intended to achieve organizational goals (Marjanovic and Freeze, 2012). The other two KiP papers (Isik et al., 2012; Sarnikar and Deokar, 2010) do not mention anything about KiPs be

Characteristic	Description	Di Ciccio et al. (2015)	Isik et al. (2012)	Marjanovic and Freeze (2012)	Sarnikar and Deokar (2010)
C1. Knowledge driven	Progress is made through satisfaction of knowledge requirements, experiental knowledge, and the impact of a knowledge worker on the process.	x	x	x	x
C2. Collaboration oriented	Process creation, management and execution occur in a collaborative multi-user environment were human-centered and process-related knowledge is co-created, shared, and transferred between individuals and enterprises.	x	x	x	x
C3. Unpredictable	It might not be possible to define tasks, their sequence, events that will occur, and required data sources before initiating the process. Also, the process might change during execution.	x	x	x	x
C4. Emergent process	The process evolves gradually based on the state of the process, its environment, and the knowledge that becomes available by achieving goals.	x	x	x	x
C5. Goal-oriented	The process evolves through achieving certain goals and milestones, instead of completing activities.	x		x	
C6. Emergent goals	The goals evolve gradually, based on the state of the process and knowledge that becomes available by achieving earlier goals.	x		x	
C7. Event driven	The process is dynamic and able to react to events that affect the process state, process-related data and knowledge, and process execution context and environment.	x			x
C8. Rule driven	Participants may be influenced by or may have to comply with constraints and rules that drive the performance of actions and decision making.	x			
C9. Non-repeatable	The process varies every time when executed. Although parts of the process may be similar, the complete structure of the process varies.	x	x	x	x
C10. Requiring diverse data sources	The process requires information and data from different data sources, including both structured and unstructured data.		x	x	

Table 2. Characteristics of Knowledge-intensive Processes according to the literature (x = mentioned)

ing goal oriented. They do mention, however, as described before, that KiPs are not process oriented and therefore not process driven. Implicitly, one might conclude therefore that the process has to be goal driven. This assumption is based on the consensus in the literature that processes are either goal or process-driven (Herrmann and Kurz, 2011).

Sixth, goals can be pre-defined but not necessarily (Di Ciccio et al., 2015; Marjanovic and Freeze, 2012). Just like the process itself, these goals can be emergent and dependent on the earlier knowledge obtained while executing the process.

Seventh, KiPs are affected by events which can occur in any sequence and which require the process to be dynamic (Di Ciccio et al., 2015; Sarnikar and Deokar, 2010). An event is defined as "a change that affects process state, process-related data and knowledge, and process execution context and environment" (Di Ciccio et al., 2015). A knowledge worker has to react to such events, influencing his/her decision making (Di Ciccio et al., 2015). The other KiP papers do not explicitly mention this characteristic. An explanation for this might be that they see this included in a term as unpredictability, which also includes unpredicted influences from the environment on the process.

Eight, the decision making of knowledge workers is subjective to business rules (Marjanovic and Freeze, 2012) which exist as explicit knowledge in the process. Rules and constraints can be explicit but they can also be "implicitly embedded in participants' personal work practices" (Di Ciccio et al., 2015). The other authors do not mention this criterion. The decision making of knowledge workers is influenced by rules and constraints, e.g. because of external regulations (Isik et al., 2012).

As a ninth characteristic, the process performed to handle a certain case is usually unique and hardly repeatable (Di Ciccio et al., 2015; Sarnikar and Deokar, 2010). Often parts of the processes can prove to be reusable, however the complete process is not (Di Ciccio et al., 2015). Processes are only repeatable on a high level, but they vary very much on a more detailed level (Isik et al., 2012; Marjanovic and Freeze, 2012).

Tenth, a KiP can need explicit information from various data sources, which the knowledge worker has to combine and base his/her decision upon (Isik et al., 2012; Marjanovic and Freeze, 2012). These sources can contain either structured or unstructured data (Marjanovic and Freeze, 2012) and can be internal or external (Isik et al., 2012).

We conclude from this discussion that the studied articles unanimously support characteristics C1, C2, C3, C4 and C9. Remarkably, the claim that knowledge-intensive processes are goal-oriented (C5) is only weakly supported. A possible explanation for this could be that goal-orientation is not mentioned explicitly since it is implied by the fact that KiPs are unpredictable and emergent. Similar remarks apply to C6. The dependency on events (C7) and rules (C8) is only mentioned in some papers (Di Ciccio et al., 2015; Sarnikar and Deokar, 2010), which again may imply that they are derived from the other characteristics. The characteristic of diverse data sources (C10) is also not unanimously supported, perhaps because some authors may view it as a technical requirement. However, knowledge workers do have to deal with different kinds of information from multiple sources, which include both people and technical sources (Isik et al., 2012; Marjanovic and Freeze, 2012).

In sum, there is consensus in the literature about the fact that ACM systems are especially suitable for managing knowledge-intensive processes. As becomes clear from the review, the literature (Di Ciccio et al., 2015; Isik et al., 2012; Marjanovic and Freeze, 2012; Sarnikar and Deokar, 2010) does not fully agree on the definition of KiPs and their characterization. There is consensus about five characteristics of Knowledge-intensive Processes, but there are five other characteristics that are not unanimously supported. More in general, to the best our knowledge, there is no academic paper that has yet analyzed which specific characteristics of a process make it suitable for ACM or another type of BPSS. In the sequel, we use the identified KiP characteristics as starting point to develop a framework that assesses suitability of ACM for a particular business process and that suggests alternative types of BPSS if needed.

4.2 Evaluation

To evaluate the characteristics, in total five vendors were interviewed: Pega, IBM, Be informed, ISIS Papyrus and Formetis. Three of these are categorized as leaders in the ACM field and one as a strong performer by Forrester (Le Clair et al., 2014). The last one is not mentioned in the research of Forrest er. Based on the interviews, we identified process characteristics relevant for knowledge-intensive processes according to these vendors.

Table 3 lists the characteristics of the interviewees. As Table 3 shows, the interviewees have different functions. This relates to the size of the corresponding company: in smaller companies, the job de-

scription of an employee usually incorporates more responsibilities than in a larger company. We selected interviewees having at least three year of work experience at the vendor, so that the interviewee is well aware of the organization's ACM systems and is more likely to have a clear view on the organization's definition of ACM and the capabilities of the organization's system. We also required that the interviewee has experience in implementation of the organization's ACM system to their client's business processes, to make sure the interviewee has experience with applying ACM to business processes. Thirdly, the interviewee needs to have participated in evaluation procedures with clients to assess whether the implementation of ACM was considered successful.

Company	Function	Work experience at vendor	Experience with implementing ACM system	Experience with evaluating ACM system
Pega	Principal Alliances solutions consultant	4 yrs	✓	✓
IBM	ECM client solution professional	16 yrs	✓	✓
Be Informed	Chief Operating Officer	9 yrs	✓	✓
ISIS Papyrus	Academy Manager	16 yrs	✓	✓
Formetis	Director	18 yrs	✓	✓

Table 3. Interviewed vendors

The interview consisted of general, open-ended questions. After an introduction of interviewer and interviewee the interviewees were first asked about their roles in their company, and whether they were suitable for conducting the interview. Next, questions were asked about the core business of the organization and their history with ACM, and their expert opinion on the characteristics of the processes that ACM is suitable for. If a certain KiP characteristic discussed in Section 4.1 was not mentioned, their opinion about it was explicitly asked for.

For analyzing the interviews, the KiP characteristics mentioned in literature were used to code the output in a structured way. Additional characteristics mentioned by interviewees were labeled separately and included in the remaining interviews. To ensure the validity of the interviews the results of the interviews were communicated to the interviewees and the feedback that was received has been processed accordingly. This also enabled us to use new variables that were mentioned in interviews performed later amongst earlier performed interviews.

The interviewed vendors unanimously supported the characteristics of knowledge-intensive processes, as listed in Table 2. This increases the validity of the identified process characteristics. However, each vendor did emphasize different characteristics as key. For instance, to assess whether ACM is suitable, IBM emphasized predictability (C3) as key property, while ISIS Papyrus stressed collaboration (C2). This suggests that each vendor uses a certain ranking of the KiP characteristics. We did not analyze this issue in further depth.

Next to the common KiP characteristics, the vendors added three characteristics to the identified characteristics in literature: *transparent, client oriented* and *large volume.* Moreover, the vendors refined C2: they mentioned that collaboration (C2) can also be between the organization and the client triggering the KiP. The three extra defined characteristics are explained here.

The transparency or provenance of a process (C11) is a characteristic that is not mentioned in literature, but was mentioned by Formetis and after that confirmed by the other vendors. The need for transparency of these processes has to do with the desire to make it transparent which knowledge worker did which task, and why that knowledge worker did decide to do that task. ACM is especially suitable for these kind of processes since the worker is able to model every task (s)he performs himself and therefore does not have to perform undocumented tasks "outside of the system".

What is also remarkable is that all vendors specified that ACM systems are especially suitable for demanding customers and therefore have to be client oriented (C12). This characteristic is based on the fact that the clients of these processes typically need a custom-made solution. Since ACM provides a lot of flexibility, it is able to provide a more custom-made solution than workflow management.

Lastly, the vendors disagreed about the frequency with which the process is executed. Pega, Formetis and IBM all agreed that ACM is most suited for processes with a high frequency. However, ISIS papyrus and Be Informed stated that ACM is made for processes with a low frequency. The arguments for a high frequency are that it has to be lucrative enough for a company to implement an ACM system. On the other hand, it is argued ACM is especially suitable for unique processes with a low frequency, since it has the abilities to perform processes that have never been performed before.

5 Design of the ACM assessment framework

Based upon the analysis of KiP characteristics and the way they are supported by existing BPSS types, we designed a framework to assess the suitability of an ACM system for a business process. We identified the following requirements for the ACM assessment framework by interviewing four business consultants of Deloitte Consulting that are BPM experts:

- The ACM assessment framework is understandable for its users (DR1).
- The ACM assessment framework addresses relevant process characteristics (DR2).
- The ACM assessment framework shows which BPSS types are suitable to a process (DR3).
- The ACM assessment framework shows which BPSS type fits best to the process (DR4).

The first requirement ensures that the framework is transparent for its users (e.g. process owners), allowing them to understand why a specific assessment is given. The second requirement states that the assessment has to consider relevant characteristics of the business processes that need BPSS support. The third and fourth requirement imply that the framework determines which types of BPSS are most suitable for a specific business process and also which ones are not that suitable.

The ACM assessment framework is designed to meet these requirements. First, we analyze how well non-ACM types of BPSS, i.e., workflow management, production case management, and groupware systems, support the identified KiP characteristics. The analysis is based on the BPM reference literature, since especially workflow management and groupware systems are in a mature stage and are well embedded in the literature. Based on this analysis, we develop the assessment framework.

5.1 Analysis of differences between BPSS types for the KiP characteristics

Table 4 summarizes the differences beween the BPSS types for the identified process characteristics. Workflow management systems differ a lot from the other BPSS types. This mainly has to do with the fact that a workflow management system is process-oriented system and does not include data, except data used for routing cases, like doing a credit check if the loan amount exceeds a certain threshold (Dumas et al., 2013; Weske, 2012). Also the processes coordinated by workflow management systems are explicitly modeled, which means every possible choice and task has to be known upfront. This makes them unsuitable for unpredictable, emergent processes (van der Aalst et al., 2005).

For the other BPSS types, the differences are more subtle. PCM and ACM are rather similar, since they both emerged from case management (Motahari-Nezhad and Swenson, 2013). The inclusion of information for both types of systems enables the possibility to provide knowledge workers with aggregate information and let them make their own decisions in order to proceed in the process (van der Aalst et al., 2005; Herrmann and Kurz, 2011). Furthermore, for both ACM and PCM systems the processes that are supported do not need to be explicitly and completely modeled upfront. The supported process can therefore be unpredictable and emergent. However, this is also where the main difference between those two systems exists. PCM is only suitable to processes in which all possible tasks have to be known upfront, although their sequence can differ (Motahari-Nezhad and Swenson, 2013). Also the goals and the events that can occur should be known upfront. Whereas ACM provides the possibility to model both tasks and goals ad-hoc (Motahari-Nezhad and Swenson, 2013). This means that ACM systems can be applied to processes for which some goals and tasks cannot be defined upfront. ACM is able to cope with a more dynamic environment than PCM, whereas PCM-supported processes are usually more repeatable, which implies being more predictable and having a higher frequency.

Lastly the differences between ACM and Groupware systems are discussed. Again the difference lies in the predictability but for slightly different reasons. Although both systems support processes which have to be defined ad hoc, groupware is not process-oriented (van der Aalst et al., 2005). This is why groupware is best applied to unstructured processes that are very rarely performed. Regarding transparency, in groupware it is often less traceable which actions led to which outcomes and were performed by who. ACM systems document this to a high extent (Herrmann and Kurz, 2011).

	Workflow management	**Production case management**	**Adaptive case management**	**Groupware**
C1. Knowledge driven	*Information has a low relevance in the process and is only used for routing, no dependency on implicit knowledge worker.*	*Progress is made through satisfaction of knowledge requirements, experiential knowledge and the impact of a knowledge worker on the process.*	*Progress is made through satisfaction of knowledge requirements, experiential knowledge and the impact of a knowledge worker on the process.*	*Progress is made through satisfaction of knowledge requirements, experiential knowledge and the impact of a knowledge worker on the process*
C2. Collaboration oriented	*There is no to little exchange or creation of knowledge between coworkers.*	*Process creation, management and execution occur in a collaborative multi-user environment where human-centered and process-related knowledge is co-created, shared and transferred between individuals and enterprises and clients*	*Process creation, management and execution occur in a collaborative multi-user environment where human-centered and process-related knowledge is co-created, shared and transferred between individuals and enterprises*	*Process creation, management and execution occur in a collaborative multi-user environment where human-centered and process-related knowledge is co-created, shared and transferred between individuals and enterprises*
C3. Unpredictable	*The process is predictable from end-to-end and context and influential events can be mapped.*	*The process is not entirely predictable however all possible tasks should be known in advance.*	*It might not be possible to define tasks, their sequence, events that are going to take place, and required data sources before initiating the process and the process might change during execution.*	*It might not be possible to define tasks, their sequence, events that are going to take place, and required data sources before initiating the process and the process might change during execution.*
C4. Emergent	*The required activities and their sequence are known a priori*	*The process evolves gradually based on the state of the process and knowledge that becomes available by executing tasks and achieving goals.*	*The process evolves gradually based on the state of the process and knowledge that becomes available by executing tasks and achieving goals.*	*The knowledge workers have no predefined tasks to choose from but instead have to determine new tasks in order to reach their goals*
C5. Goal-oriented	*The process evolves through means of sequential tasks rather than the accomplishment of goals.*	*The process evolves through achieving certain goals and milestones, instead of completing activities.*	*The process evolves through achieving certain goals and milestones, instead of completing activities.*	*The process evolves through achieving certain goals and milestones, instead of completing activities.*
C6. Emergent goal	*Since the process is not goal oriented the goals are not emergent.*	*The goals and milestones are known in advance.*	*The goals evolve gradually, based on the state of the process and knowledge that becomes available by achieving earlier goals.*	*The goals evolve gradually, based on the state of the process and knowledge that becomes available by achieving earlier goals.*

Table 4. Process characteristics for different types of Business Process Support Systems

	Workflow management	Production case management	Adaptive case management	Groupware
C7. Dynamic environment	*The process are not influenced by events that cannot be mapped upfront.*	*The process is not influenced by events that cannot be mapped upfront.*	*The process is dynamic and can react to events that affect the process state, process-related data and knowledge, and process execution context and environment.*	*The process is dynamic and can react to events that affect the process state, process-related data and knowledge, and process execution context and environment.*
C8. Compliance	*There are rules defined but these are implicit. The rest of the process is defined explicit.*	*Workers may be influenced by or have to comply with constraints and rules that drive actions performance and decision making.*	*Workers may be influenced by or have to comply with constraints and rules that drive actions performance and decision making.*	*Workers may be influenced by or have to comply with constraints and rules that drive actions performance and decision making.*
C9. Non-repeatable	*Processes are highly repeatable, the same actions have to be performed in order to reach an output.*	*The work to reach a certain output is usually repeatable although variations are possible.*	*The structure of the process usually varies every time when executed, though parts of the process may be similar.*	*The process is not repeatable and no process elements can be used.*
C10. Requiring diverse data sources	*Data is only structured and used for routing instead of being interpret by the knowledge worker.*	*The process requires information and data from different data sources including both structured and unstructured information.*	*The process requires information and data from different data sources including both structured and unstructured information.*	*The process requires information and data from different data sources including both structured and unstructured information.*
C11. Transparency	*It might be needed to trace the process and see which worker performed which action.*	*It might be needed to trace the process and see which worker performed which action to achieve which goal.*	*It might be needed to trace the process and see which worker performed which action to achieve which goal.*	*It is not required to track who performs which action and what the outcomes are.*
C12. Client oriented	*The customer orders are standardized.*	*There is limited variation in the customer orders.*	*The process has a demanding client and has to provide tailor made solutions.*	*The process has a demanding client requiring tailor made solutions.*
C13. Frequency	*The process is executed with a high frequency.*	*The process must be executed with a high frequency.*	*The process can be executed with a low frequency.*	*The process is executed with a very low frequency and often unique.*

Table 4 (continued). Process characteristics for different types of Business Process Support Systems

5.2 Assessment framework

In order to meet the four requirements on the ACM assessment framework, we decided to focus on the concrete observable differences between different types of BPSS as described in the previous subsection. For each difference as stated in Table 4, we decided to formulate a closed question and the specific "ideal" answers to these questions for each of the four types of BPSS (Table 5).

By answering the questions for a specific business process, the business process is implicitly characterized. The framework automatically calculates the percentage of compliance of these process characteristics with different BPSS types. Posing these questions forces process owners to think about their processes, and helps them to provide insights about which types of BPSS are suitable for supporting their business process. The output of the ACM assessment framework shows the percentage of questions that are answered in line with a certain BPSS type. This way the BPSS type with the best fit can be presented to the user. It should be kept in mind that this framework only gives a suggestion about which BPSS types can be applied best. This can serve as a basis for a further, more detailed investigation into the benefit of applying the selected BPSS type to a business process (Becker et al., 1999; Cho and Lee, 2011).

Process characteristic	Questions	WfM system	PCM system	ACM system	GW system
C1. Knowledge driven	*C1.1 Is the process based on documents and/or dossiers?*	N	Y	Y	Y
	C1.2 Does the worker have to make decisions in which he is not directly supported by the system (so based on his own experience and expertise)?	N	Y	Y	Y
C2. Collaboration oriented	*C2.1 Is there collaboration between employees based on exchange of information?*	N	Y	Y	Y
C3. Unpredictable	*C3.1 Is the sequence of activities known in advance?*	Y	N	N	N
	C3.2 Are all possible tasks that can be executed known in advance?	Y	Y	N	N
C4. Emergent	*C4.1 Does information obtained during the process determine the next course of tasks?*	N	Y	Y	Y
C5. Goal-oriented	*C5.1 Does the process work towards goals, rather than the completion of tasks?*	N	Y	Y	N
C6. Emergent goal	*C6.1 Are the milestones/goals and their sequence known in advance?*	N	N	Y	N
C7. Dynamic environment	*C7.1 Is the decision making of knowledge workers influenced by events whose occurrence or sequence of occurrence cannot be determined in advance?*	N	N	Y	Y
C8. Compliance	*C8.1 Does the process adhere to internal business rules?*	Y	Y	Y	N
	C8.2 Does the process adhere to legal regulations?	N	Y	Y	N
	C8.3 Can business rules change during the execution of the process?	N	N	Y	N
	C8.4 Can legal regulations change during the execution of the process?	N	N	Y	N
C9. Non-repeatable	*C9.1 Can recurring process elements be defined in the overall process?*	Y	Y	Y	N
C10. Requiring diverse data sources	*C10.1 Does the knowledge worker need to derive information from different data sources in order to make progress?*	N	Y	Y	Y
C11. Transparency	*C11.1 Is it important for stakeholders to track the tasks performed by an employee?*	Y	Y	Y	N
	C11.2 Is it important for stakeholders to track the decision making of employees?	Y	Y	Y	N
C12. Client oriented	*C12.1 Does the client need a custom-made solution?*	N	Y	Y	Y
	C12.2 Does the client need to be informed about the state of his order frequently?	N	Y	Y	N
C13. Frequency	*C13.1 How frequently is the process executed?*	H	H/M	H/M/L	L

Table 5. Assessment framework (GW=groupware, Y=Yes, N=No, H=High, M=Medium, L=Low)

The suitability of each BPSS type is calculated by the percentage of questions that are answered according to the ideal situations presented in the framework. Some of the ideal answers to the questions in Table 5 are marked gray. For a BPSS type to be applicable, the answers marked in gray must be given; if not, the suitability drops to zero. These answers have been identified in the literature review and in the interviews with the ACM vendors. For all the other answers, i.e., not marked gray, the resulting questions can be answered differently, but this results in a lower score for the BPSS type, indicating that this BPSS type is less ideal for the aspect covered by the question.

Finally, we reflect upon the design requirements. An evaluation of the ACM assessment framework in practice is needed to check whether DR1 is met. DR2 is met by using the KiP characteristics as basis for the questions in the framework. DR3 is satisfied since the framework does not only show the BPSS that is best suited for the process but also the scores of other types of BPSS that could be applied instead. DR4 is met by calculating the percentage of process characteristics the BPSS supports.

6 Discussion and Conclusion

This paper presents a framework that helps users to assess to which extent ACM is suitable for a particular business process. The ACM assessment framework uses simple and concrete questions about the business process to give an assessment. The framework distinguishes between process characteristics that ACM can support, characteristics that ACM can support but are not ideal, and characteristics that ACM cannot support. If ACM is not suitable for a process, the framework also provides feedback about related BPSS types that can be used instead, such as PCM or groupware. Thus, the framework provides transparent and useful advice about which type of BPSS is most suitable to support the business process to the best extent. The advice can be used as starting point for a more detailed analysis based on existing BPM assessment frameworks (Becker et al., 1999; Cho and Lee, 2011).

The paper shows that the KiP characteristics as defined in the literature can indeed be supported by ACM systems. Next, we have identified additional KiP characteristics: the need for transparency, the orientation towards the client and the frequency with which the processes are executed. The paper gives a clear overview to which extent other BPSS types can support these KiP characteristics, while assessing the concrete advantages that can be gained by applying ACM systems to the right processes.

Limitations are that the framework was developed based on input from vendors from ACM systems, who may have a bias towards the capabilities of ACM. However, the vendors gave their input based on a review of scientific literature, so we do not expect the results are overly biased. To mitigate this risk further, the framework can be refined by involving vendors of other types of BPSS. A related limitation is that the framework was developed for ACM, so it may miss important aspects of business processes that are relevant for other types of BPSS like workflow management.

Another limitation is that the framework has not yet been tested in practice. We did perform a preliminary evaluation with three consultants of Deloitte who evaluated four different business scenarios, one for each BPSS type. Each scenario consisted of a textual description of a real-world business process for which an organization had accepted and implemented the BPSS type. The consultants were not involved in the collection of the business scenarios. 90% of the questions were answered uniformly, resulting in the same, correct assessment of the three consultants for three of the four scenarios. The other scenario resulted in one consultant recommending a different BPSS type than the intended one.

There are several other interesting directions for further work. First, the developed framework can be extended with more concrete financial factors such that a cost-benefit assessment can be provided. Second, to tailor the framework to user preferences, the questions can be weighted, such that users can influence the ranking of the outcomes of the framework. Third, the developed framework assesses characteristics of a single business process. However, it is also useful to extend the framework to assess the suitability of ACM to a range of business processes and to assess the suitability of ACM in the context of the enterprise architecture of a company. Finally, applying the framework in practice and gathering data on the actual implementation and performance of the chosen BPSSes allows to further evaluate and refine the framework.

References

van der Aalst, W. M. P., Weske, M., and Grunbauer, D. (2005). "Case handling: a new paradigm for business process support," *Data & Knowledge Engineering* 53(2), 129–162.

Barriball, K. L., and While, A. (1994). "Collecting Data using a semi-structured interview: a discussion paper," *Journal of Advanced Nursing* 19, 328–335.

Becker, J., Uthmann, C. von, Muehlen, M. zur, and Rosemann, M. (1999). "Identifying the Workflow Potential of Business Processes.," in *32nd Annual Hawaii International Conference on System Sciences (HICSS-32), January 5-8, 1999, Maui, Hawaii, USA*.

Bider, I., and Perjons, E. (2015). "Design science in action: developing a modeling technique for eliciting requirements on Business Process Management (BPM) tools.," *Software and System Modeling* 14(3), 1159–1188.

Biernacki, P., and Waldorf, D. (1981). "Snowball Sampling: problems and techniques of Chain Referral Sampling," *Sociological Methods & Research* 10, 141–163.

Cho, C., and Lee, S. (2011). "A study on process evaluation and selection model for business process management," *Expert Systems with Appications* 38(5), 6339–6350.

Di Ciccio, C., Marrella, A., and Russo, A. (2015). "Knowledge-intensive Processes: Characteristics, Requirements and Analysis of Contemporary Approaches," *Journal on Data Semantics* 4(1), 29–57.

Dumas, M., Rosa, M. L., Mendling, J., and Reijers, H. A. (2013). *Fundamentals of Business Process Management*, Springer.

Gray, D. E. (2004). *Doing Research in the Real World*. London, SAGE.

Herrmann, C., and Kurz, M. (2011). "Adaptive Case Management: Supporting Knowledge Intensive Processes with IT Systems," in *S-BPM ONE-Learning by Doing-Doing by Learing*, Ingolstadt: Springer Berlin Heidelberg, 89–97.

Hevner, A. R., March, S. T., Park, J., and Ram, S. (2004). "Design Science in Information Systems Research," *MIS Quarterly* 28(1), 75–105.

Isik, Ö., Van den Bergh, J., and Mertens, W. (2012). "Knowledge Intensive Business Processes: An Exploratory Study," in *45th Hawaii International Conference on System Sciences*, Hawaii.

Le Clair, C., Miers, D., Cullen, A., and Keenan, J. (2014). "The Forrester Wave: Dynamic Case Management," Forrester.

Leymann, F., and Roller, D. (2000). *Production workflow - concepts and techniques*, Prentice Hall.

Marin, M. A., Hauder, M., and Matthes, F. (2015). "Case Management: An Evaluation of Existing Approaches for Knowledge-Intensive Processes," In *Proc. 4rd International Workshop on Adaptive Case Management and other non-workflow approaches to BPM (AdaptiveCM)*, Innsbruck, Austria.

Marjanovic, O., and Freeze, R. (2012). "Knowledge-Intensive Business Process: Deriving a Sustainable CompetitiveAdvantage through Business Process Management and Knowledge Management Integration," *Knowledge and Process Management* 19(4), 180–188.

Motahari-Nezhad, H., and Swenson, K. (2013). "Adaptive Case Management: Overview and Research Challenges," in *Proc. IEEE 15th Conference on Business Informatics*, IEEE.

Ngwenyama, O. and Lyytinen, K. (1997). "Groupware environments as action constitutive resources: A social action framework for analyzing groupware technologies," *Computer Supported Cooperative Work* 6(1), 71-93.

Object Management Group (OMG) (2011). "Business Process Model and Notation (BPMN) Version 2.0."

Peffers, K., Tuunanen, T., Rothenberger, M. A., and Chatterjee, S. (2008). "A Design Science Research Methodology for Information Systems Research," *Journal of Management Information Systems* 24(3), 45–77.

Reijers, H. A. (2006). "Implementing BPM systems: the role of process orientation," *Business Process Management Journal* 12(4), 389–409.

Reijers, H. A., Rigter, J. H. M., and van der Aalst, W. M. P. (2003). "The Case Handling Case," *International Journal of Cooperative Information Systems* 12, 365–391.

Sarnikar, S., and Deokar, A. (2010). "Knowledge Management Systems for Knowledge-Intensive Processes: Design Approach and an Illustrative Example," in *43rd Hawaii International International Conference on Systems Science (HICSS-43 2010), Proceedings*, Koloa, 1–10.

Swenson, K. (2014). "One Common Definition for BPM," *Thinking Matters*, January 28 (available at https://social-biz.org/2014/01/27/one-common-definition-for-bpm/; retrieved April 18, 2017).

Swenson, K. (2010). *Mastering the unpredictable*, Tampa: Meghan-Kiffer Press.

Teece, E., and Teece, J. (1986). *Elements of Research in Nursing*, (4th ed.), St Louis: C.B. Mosby.

Weske, M. (2012). *Business process management: concepts, languages, architectures*, Springer Science & Business Media.

Yin, R. (2003). *Case study research: design and methods*, California: Sage Publications.