Towards a Technique for Modeling New Forms of Collaborative Work Practices – The Facilitation Process Model 2.0

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Abstract

Collaboration Engineering (CE) is an approach for the design and deployment of repeatable collaborative work practices that can be executed by practitioners themselves without the ongoing support of external collaboration professionals. A key design activity in CE concerns modeling current and future collaborative work practices. CE researchers and practitioners have used the Facilitation Process Model (FPM) technique. However, this modeling technique suffers from a number of shortcomings to model contemporary collaborative work practices. We use a design science approach to identify the main challenges with the original FPM technique, derive requirements and design a revised modeling technique that is based on the current technique enriched by BPMN 2.0 elements. This paper contributes to the CE literature by offering a revised FPM technique that assists CE-designers to capture new forms of collaborative work practices.

1. Introduction

New forms of digital collaboration are emerging as a consequence of the increasing capabilities of information technology. For example, social media technologies allow distributed teams in and between organizations to effectively share information and build relationships. Social media technologies further support organizations to harness the potential of crowds to contribute to innovation processes and have access to a steady supply of knowledge workers. Another key example concerns recent developments in artificial intelligence (AI) [18]. New forms of AI go beyond being an 'on-demand' service during teams' joint problem solving and decision making. If fact, AI systems can serve as teammates that collaborate with humans to solve complex tasks (e.g. cognitive computing through IBM Watson in workshops to enrich the information basis and stimulate discussions for creating decision alternatives [18, 19], IBM's Dr. Watson that collaborates with human doctors in analyzing symptoms, run a patient's history for making a diagnosis [12], peer feedback by conversational agents for enhancing knowledge acquisition [10]). Successful collaboration typically does not happen naturally. It requires a concerted design effort to create and sustain productive collaborative work practices. Collaboration Engineering (CE) is a methodology to design and implement reusable collaborative work practices [5]. With the help of CE, often inefficient and unsystematic work practices can be made more efficient and repeatable [5]. In CE, a collaborative work practice is a series of re-usable collaborative activities performed by multiple teammates (practitioners) to achieve a goal [5]. Originally, CE and its design and deployment techniques and strategies were primarily developed to support same time, same place human-human-collaboration in small to large teams (up to approx. 100 people). Consequently, the existing CE methodology may have certain limitations when it comes to handling the rich variety of collaboration possibilities. This paper represents an initial effort to revise and update some of the core elements of the CE methodology to enable designers to systematically design the variety of today's collaborative work practices. We focus specifically on a central CE modeling technique: the Facilitation Process Model (FPM). An FPM depicts the logical sequence of activities in a collaborative work practice in a form that is not only easy to use for designers, but also easy to communicate to stakeholders that have no modeling expertise. Since the FPM technique may inter alia not be able to effectively model new forms of collaborative work practices such as crowdsourcing and AI-infused

URI: https://hdl.handle.net/10125/59462
ISBN: 978-0-9981331-2-6

teamwork, our guiding research question for this paper is: *What elements need to be part of FPM technique to handle the rich variety of collaboration?*

To answer our research question, we follow a design science research (DSR) approach. We start by deriving requirements for an updated version of the FPM technique based on several scenarios that aim to capture the breadth of today's collaboration possibilities. Then, we build on the theory of modeling languages and ensure that our revision aligns with this foundation. We further aim to leverage relevant available resources developed in process modeling domain, such as business process management [3]. Consequently, the resulting FPM 2.0 builds on the initial version of the FPM as well as on the Business Process Model and Notation (BPMN) 2.0. Using this combination, we are able to leverage the strengths of the BPMN and at the same time ensure that the key elements for modeling collaborative work practices are included.

The FPM 2.0 represents a body of theoretical knowledge of the type *design and action* [7]. More precisely, it represents a nascent design theory of the type *improvement* [8]. In terms of practical contribution, we provide an updated modeling language that guides designers of collaborative work practices in designing complex digital collaboration scenarios in a consistent and comprehensible way.

The remainder of this paper is structured as follows. In section 2, we provide an overview of CE and BPMN 2.0. In section 3, we describe our design science research approach. Section 4 consists of the FPM 2.0 development and section 5 describes an exemplary application. In section 6, we discuss our results and close with a conclusion and a brief outlook.

2. Theoretical Background

2.1 Collaboration Engineering

CE is an approach to design collaborative work practices for high value recurring tasks and to deploy them to practitioners (non-collaboration-experts) such that they can be self-sustaining in executing them [20]. A design principle of the CE approach is to minimize cognitive load for the practitioners while transferring to them relevant facilitation skills and knowledge about group dynamics and collaboration technology [5]. The CE approach results in a number of artifacts that represent the design of a collaborative work practice. These artifacts are used as vehicles of communication among designers and between designers and stakeholders. for example, they are used to present collaboration processes to organizations and to support the training of practitioners that will execute the CE processes [15]. Since the early 2000s, CE researchers have developed various techniques to model and document repeatable collaboration processes. One of the most used modeling techniques is the Facilitation Process Model (FPM). The FPM is a process model that captures the logical flow of a process in terms of its constituent activities. Activities may produce outputs that can serve as the input for a subsequent activity until the desired group product is created and the collaboration goal is achieved [15]. An FPM captures relevant information about two key process aspects: the individual activities and the flow between these activities. For each *activity*, the following information is captured: the activity's name, the pattern of collaboration that will result from the execution of the activity, the activity's starting time and its duration, the activity output, and the name of the thinkLet that is used to execute the activity [20]. Each activity in an FPM can result in one or more of the following patterns of collaboration: generate, reduce, clarify, organize, evaluate, and build commitment [14]. A thinkLet is a facilitation best practice – it captures all information required to create a pattern of collaboration in a predictable, transferable way [4]. For the *activity flow*, the following information is captured: the sequence number of each activity, and decisions and decision criteria that make affect the process flow. An FPM represents each activity as a rectangle with rounded corners that has been divided into five fields (see Figure 1).

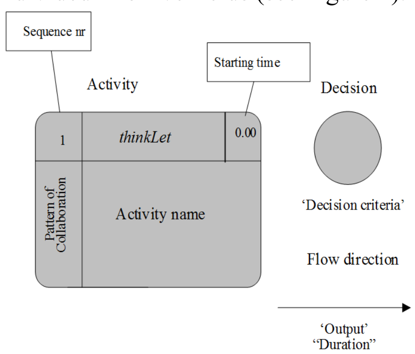


***Figure 1. FPM modeling elements* [20].**

An example of an FPM is given in Figure 2; this represents a part of a Risk & Control Self Assessment process [5].

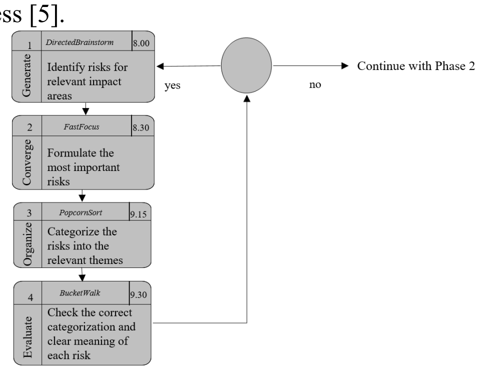


Figure 2. FPM example.

2.2 Modeling Languages

A model provides a limitated representation of an existing or conceptualized reality. It captures the reality's elements that are essential for purpose of the model. Models are expressed in a modeling language (ML). A ML is any artificial language that can be used to express information, knowledge, workflows or systems in a structure that is defined by a consistent set of elements with rules [17]. For example, every business process model requires a ML to be expressed.

The quality of a ML depends on a variety of criteria. Frank [6] distinguish between *formal*, *user-* and *use-specific criteria*. *Formal criteria* of a ML are necessary for analyzing and transforming process models. They can be further distinguished in correctness and completeness, uniformity and redundancy, and reusability and maintainability. *User-specific criteria* of a ML are necessary to address different target groups with different use frequencies. They can be divided into simplicity, and comprehensibility and clarity. *Use-specific criteria* address the utility of a model in a specific application domain and can partly compete with the user-specific criteria. For example, a very simple ML might not be able to fully capture all modeling purposes. Frank [6] divides use-specific criteria into powerfulness and appropriateness, and operationalizability. For a more detailed description of the criteria see Table 1.

Criteria	Description
Formal:	
Correctness and complete-ness	The ML is be able to identify certainty syntactical and semantical flaws of incorrectly constructed models. It thereby also defines the scope for correct models. (yes/ no)
Uniformity and redundancy	The ML uses a clear and comprehensive description and avoid redundant information. (yes/ no)
Reusability and maintain-ability	The ML description is formulated on an abstract level so that the ML or parts of it can be reused and do not have to be modified for similar contexts. (yes/ no)
User-specific:	
Simplicity	The less complex the ML, the fewer user-mistakes can be expected. Thus, the ML considers a parsimonious amount of concepts, symbols and rules for its syntax and semantics. (yes/ no)
Comprehens-ibility and clarity	The ML bases on concepts and symbols that are familiar to a wide range of users. (yes/ no)
Use-specific:	
Powerful-ness and appropriate-ness	The ML enables users to model every relevant property of a situation in the desired detail and precision. (yes/ no)
Operation-alizability	In addition to analysis purposes, models are used for implementations. Therefore, the ML includes information on how to implement the used concepts and symbols. (yes/ no)

Table 1. Quality-Criteria of a Modeling Language.

One of the most common ML standards in the field of business process modeling is BPMN 2.0 (Business Process Model and Notation). BPMN 2.0 was developed by the Object Management Group (OMG) and was first released in 2013 [17]. BPMN 2.0 is a graphical representation for specifying business processes [9]. In recent years, BPMN 2.0 has become the leading standard for business process modeling. Many organizations are adopting BPMN 2.0 as their organization-wide modeling standard. For example, a recent survey with 150 BPM providers revealed that BPMN 2.0 was the most widely used process modeling notation and this trend is expected to continue [1]. BPMN 2.0 aims to provide a standard notation that all business stakeholders can easily understand including the business analysts who create and refine the processes, the technical developers responsible for implementing them, and the business managers who monitor and manage them. BPMN 2.0 can therefore bridge the gap between business process design and implementation. The main elements used by BPMN 2.0 are pools, lanes, activities, arrows, gateways, and events that each have a description and rule for being used: The *pool* is a general kind of container for a complete business process. The pool can consist of different *(swim) lanes* that are used to model a collaboration between different actors, i.e. the interplay of several partners' processes. Each partner's process is shown in a separate lane. A *rounded rectangle* represents an activity. Similar to the FPM technique, an activity symbolizes that something gets done. The connecting *arrows* are used for modeling the sequence flow. They represent the sequence in which the different events, activities, and other elements are traversed. Activities can also be followed by a gateway. A *gateway* has a diamond shape and indicates that from that point onward one of several outgoing sequence flows is activated. The *conditions* on the outgoing flow determine which flow is selected. These conditions can be written directly into the diagram, next to the sequence flows. Finaly, BPMN 2.0 uses events. Every process consists of a *start event* (a circle) and an *end event* (a circle with a thick border). Apart from these core elements, BPMN 2.0 consists of various constructs that assist with the visualization of complex processes in more detail.

In contrast to business processes that focus on structuring tasks in a specific sequence, collaboration processes focus more explicitly on the interaction between the different collaborators. Thus, business processes lack some important features that are necessary for designing new collaborative work practices. For example, BPMN 2.0 is not able to capture thinkLets and Patterns of Collaboration. A thinkLet describes an elementary group process from a leader's point of view by providing explicit, stricpted prompts for the group, and by guiding the practitioner through the decisions that must be made based on the group's behavior. By this means, people engage in a specific pattern of collaboration that can not be visualized by BPMN 2.0. Whereas business process modeling tries to divide a process into subprocesses that pursue a particular business goal, CE focuses more on how individuals and subgroups have to work within these subprocesses in order to increase the quality of the outputs.

Notwithstanding these differences, we will use the BPMN 2.0 modeling elements and its rules to explore the extent to which the FPM can be developed further to be able to serve as a ML for collaborative work practices.

3. Research Methodology

We follow a Design Science Research (DSR) approach to develop FPM 2.0. More specifically, we rely on Hevner's three cycle view to structure our research process (see Figure 3).

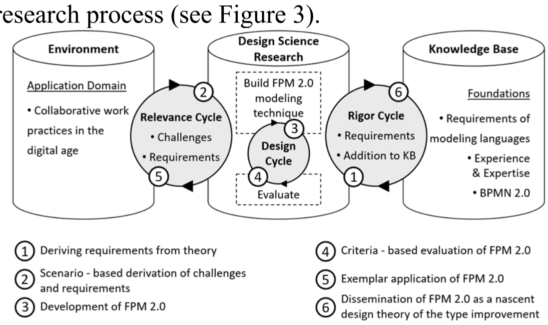


Figure 3. Research approach.

The *Relevance Cycle* connects the application domain of the research project with our design science activities. The *Rigor Cycle* makes sure that the design science activities consider the existing knowledge base of scientific foundations, experience, and expertise. The central *Design Cycle* iterates between the core activities of building and evaluating our design artifact [11].

In step 1, we start the *Rigor Cycle* and present our kernel theories that serve as a foundation for FPM 2.0. In step 2, we start the *Relevance Cycle* and outline scenarios of different collaborative settings we faced in practice, highlight challenges we had by applying the original FPM technique, and formulate related requirements for deriving a FPM 2.0 technique. In step 3, we start the *Design Cycle* and develop the FPM 2.0 technique. In step 4, we complete the *Design Cycle* and report the results of a criteria-based evaluation to show that the FPM 2.0 technique copes with ML criteria from theory. In step 5, we apply the FPM 2.0 to an example of a collaborative work practice. In step 6, we discuss our results and our contribution that resembles a nascent design theory of the type 'improvement' as it provides a new modeling technique for collaborative work practices.

4. FPM 2.0 Development

Experiences in recent CE research studies that focused on practical implementations suggested that the current FPM technique had reached its limits in terms of its usefulness to model new forms of collaborative work practices [16, 18]. Specifically, the current FPM technique was developed when traditional face-to-face collaboration was the norm for most collaborative work practices. In today's work place, people collaborate regularly at different times from different locations. Below, we use a time and place matrix to illustrate representative scenarios that outline the limits of the current FPM technique. This way, we address the relevance cycle of Hevner's [11] three-cycle view of DSR. Moreover, we derive challenges from these limits, formulate requirements for FPM 2.0, and subsequently develop the new FPM 2.0 technique.

4.1 Analysis and Requirements

Recent developments such as globalization and digitization enable new forms of collaborative work practices. Table 2 provides some examples of scenarios of traditional and new forms of collaborative work practices.

		Time	
		Synchronous	***Asynchronous***
Place	***Same Place***	*Scenario 1*: Co-located innovation ideation workshop, Agile sprint standup meeting	*Scenario 2*: Agile story board management in SCRUM team
	Different Place	*Scenario 3*: Agile backlog creation meeting; Citizen science effort to count birds across the country on a dedicated date	*Scenario 4*: Collaborative writing of academic paper with international team of authors; Community crowdsourcing effort to explore ways to improve city parks

Table 2. Place-time matrix and representative scenarios.

Note that these scenarios are placed in the matrix as an example; in practice, some scenarios can be organized such that they can be executed in different place/time situations. Each of these scenarios can also consist of combinations of time/place settings to reach the desired collaboration goal. For example, stakeholders in an agile backlog creation process can collaborate partly in a synchronous and partly in an asynchronous way. A community crowdsourcing effort can kick-off with a same time same place meeting and then proceed asynchronously online for a certain duration. Such combinations of time and place settings set requirements that a collaboration process ML has to fulfil. The current FPM is not capable to represent all relevant aspects to model the above scenarios or scenario combinations. In Table 4, we list the main challenges and requirements of collaborative work practices derived from the scenarios in Table 3 and identify whether the current FPM is capable of depicting them.

Characteristics of Collaborative Work practices	**Current FPM**	
	Fulfilled	**Not fulfilled**
Sequence Flow	X	
Activity Result	X	
Activity Result Subsets		X
Varying Composition of Team, Subteams		X
Criteria to Assign Individuals to Activity		X
Activity Duration	X	
Activity Iteration		X
Parallel Activities		X
Decision Gate	X	
External Input for an Activity		X
Interruptions, Breaks		X
Subprocesses		X

Table 3. Identification of white spots in current FPM.

Collaborative work practices may have a variety of characteristics. The current FPM can model some of them. However, as depicted in Table 4, there are also situations where the current FPM falls short and gives rise to some challenges (CH):

Challenges (CH)	***Requirements (R)***
CH1: Activity Result Subsets The outcomes of an activity may have to be divided into subsets that are further worked on in different subsequent activities. This is for example the case in a crowdsourcing effort, where after an initial plenary idea gathering that yields hundreds of ideas, the results are re-structured into sets of 100 ideas each and assigned to subteams to extract the 10 most promising ideas from	**R1:** FPM 2.0 should be able to define the characteristics of activity outcomes in terms of structure and distribution over subsets.
CH2: Varying Team Composition CH1 also shows that collaborative work practices can have different compositions in terms of teams and subteams. This is evident in collaborative writing sessions, where different teams of authors are working on different chapters of a document [13]. CH2 also occurs in educational contexts of peer learning when subgroups brainstorm ideas for a solution and smaller breakout groups elaborate the ideas to create a sophisticated solution statement. Moreover, AI systems can take on the role as stakeholder.	**R2:** FPM 2.0 should allow a modeler to indicate which stakeholders, including AI, should execute an activity.
CH3: Activity Assignment Criteria Both in co-located and distributed settings there may be a need to assign certain individuals to specific activities. For example, in the labor market model of crowdsourcing (e.g. Amazon's MTurk) a problem owner can define which quality threshold or specific skills an individual must have to be allowed to execute a task. In collaborative design sessions subgroups may be formed based on interest and capabilities – one subgroup may focus on a company's logo and tagline design, while another subgroup creates a prototype of its webpages.	**R3:** FPM 2.0 should be able to capture what criteria are to be met for an individual to be allowed to execute an activity.
CH4: Activity Iteration When a large number of ideas from an open innovation effort has to be assessed in terms of each idea's creativity and business worthiness, the idea set may be processed by a team of judges in chunks of 25 ideas at a time or by several teams of judges in chunks of 25 ideas at a time. This can not be modeled elegantly in the current FPM other than by creating some iteration logic with dec points.	**R4:** FPM 2.0 should be able to capture how an activity is executed a fixed or context-dependent number of times.
CH5: Parallel Activities A collaboration process may require a number of activities to be executed in parallel and completed before a next activity can commence. For example, in a community crowdsourcing effort parallel ideation efforts may take place to improve a city's center from a recreational, safety, and economic development perspective. The next activity could be for the crowd to pick the top 10 initiatives that should be considered by the municipal government across these three discussions. Thus, the evaluation activity cannot take place until the three parallel discussion activities have been completed. This cannot be modeled in the current FPM.	**R5:** FPM 2.0 should provide possibilities to model concurrent activities with synchronization of completion status.
CH6: External Input for Activity Some activities can only be executed if a (sub)team is provided with additional information that comes from an external source. For example, during a collaborative writing process, one of the authors may want to bring in snippets of text from a previous related effort. In the current FPM this can not be depicted.	**R6:** FPM 2.0 should indicate when and which outside input is required.
CH7: Interruptions breaks During a collaboration process, stakeholders may be interrupted by activities in other projects. The collaboration process is then timed-out. For example, in an open innovation project, members of a team of judges who are collectively rating a long list of ideas, may be interrupted by other meetings, phone calls, or leave office before the task is complete. Many professionals work on several projects concurrently, so they cannot finish each activity before another project requires their attention. The current FPM can not model these interruptions.	**R7:** FPM 2.0 should be able to capture when interruptions are intended to occur.
CH8: Individual partial actives In collaborative work practices, stakeholders often need more detailed information about an activity, their duration and output. The current FPM cannot model that.	**R8**: FPM 2.0 should be able to make partial activities of every stakeholder transparent.
CH9: Connectivity with other modeling languages When process designers use a new modeling language it is always helpful to recognize already known elements from other modeling standards. The current FPM is not addressing that issue.	**R9:** FPM 2.0 should use elements that most of the process designers already know.

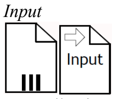
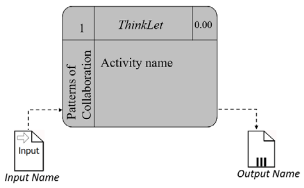
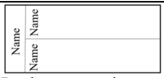
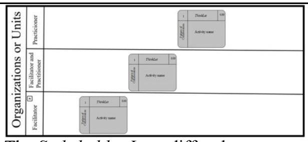
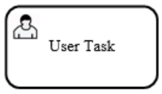
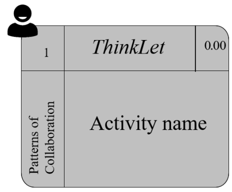
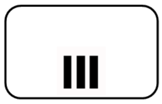
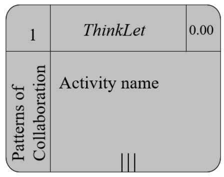
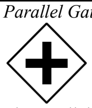
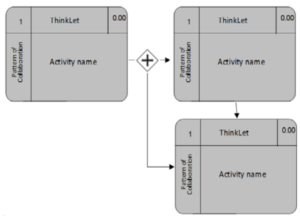
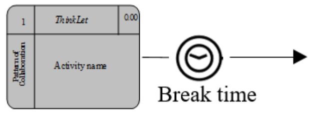
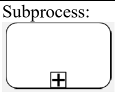
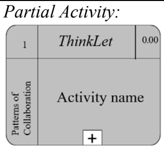
Table 4. Challenges and Requirements.

Table 4 shows the main challenges and emerging requirements for a new FPM modeling technique. Please note that the list may not be complete since it is likely that other challenges exist. However, according to the criteria of modeling languages described in section 2.2, we try to keep the FPM 2.0 modeling technique simple and clear so we will initially focus on the key challenges that have been identified and use them to derive the FPM 2.0 requirements (R).

4.2 Solution

To meet the requirements for FPM 2.0, we enrich the current FPM modeling technique with BPMN 2.0 elements (see Table 5). First, the BPMN 2.0 *Collection Data* and *Data Input* elements are objects that symbolize a collection of information and external data inputs for an entire process. FPM 2.0 includes these symbols to assign activity outputs to inputs and indicate external inputs. The text below to the elements gives them a name. Because of clarity reasons, the output element is only used when it serves as input for later activities (not for following activities). The input symbol indicates an external input source (R1, R6). Second, the BPMN 2.0 element *Pool/Lane* represents different participants or participant types who take part in a process. The pool is a vertical rectangular container that can contain flow objects vertically or horizontally. A lane is a graphical sub-division in a pool that is used to organize and categorize activities within a pool according to a role [17]. FPM 2.0 includes *Stakeholder Lanes* that help to differentiate between different stakeholders. This way, also AI systems can be modeled as separate lanes. Thus, the FPM 2.0 is able to differentiate between stakeholders or subteams along the activity flow (R2).

Third, the BPMN 2.0 element *User Task* signals that the task has to be done by a specific group or user. A small little user symbol at the upper left corner indicates a User Task. We include this symbol in FPM 2.0 in order to mark that an activity has an assignment criteria. More details about the assignment criteria can be defined in the agenda. The FPM 2.0 modeling technique therefore defines who is able to conduct an activity (R3). Fourth, the BPMN 2.0 element *Parallel MI marker* marks a task that should be repeated until a defined condition either applies or ceases to apply. We transferred this element in order to indicate activities that has to be executed a multiple times until the output is achieved. FPM 2.0 therefore addresses recurring activitites (R4).

	BPMN 2.0 Element	FPM 2.0 Elements and Rules
R1 R6	*Collection Data Object and Data Input*  A Collection Data Object represents a collection of information, e.g., a list of order items. A Data Input is an external input for a process.	Input/Output:  The *Input/ Output* symbol of an activity is represented by BPMN 2.0 Data Objects. The text below the symbols indicate the input/output name. The input element signals when an input from an external resource is needed to execute the activity.
R2	*Pool/ Lane:*  Pools are containers for whole processes and can contain lanes. Lanes describe who is executing a specific set of tasks.	*Stakeholder Lane:*  The *Stakeholder Lane* differs between practitioner' activities, practitioner and facilitator' activities, and facilitator' activities. Moreover, the small AI sign at the upper left corner of a lane indicates that the Stakeholder of the lane consists of an AI system.
R3	*User Task:*  A User Task models work that needs to be done by a specific group or user.	*Assignment Criteria:*  The *Assignment Criteria* symbol indicates that for executing this activity participants, i.e. practitioners, must own some qualification criteria that are further defined in the agenda.
R4	*Parallel MI marker:*  The parallel MI Marker indicates that the instance has to be executed a number of times until the main task is fulfilled.	*Iteration:*  Similar to the BPMN 2.0 *Parallel MI Marker* element, the three vertical lines within the activity element indicate that the activity should be executed several times within a specific lane until the output is achieved.
R5	*Parallel Gateway:*  The Parallel Gateway Symbol is used to split the sequence flow to activate all outgoing branches simultaneously. It waits for all incoming branches to complete before triggering the outgoing flow.	*Parallel Activity:*  The *Parallel Activity* symbol indicates that two or more activities have to be conducted simultaneously. All parallel activities have to be completed until it triggers the next ativity.
R7	*Time-out Event:*  The time-out event is used when a break is singalized. Below the time-out event, the duration of the break is indicated.	*Break:*  The *Break element* indicates interruptions between activities. Below the element, the break time is indicated.
R8	Subprocess:  Subprocesses represent a collection of activities (and gateways and flows)	*Partial Activity:*  The plus sign indicates that this activity

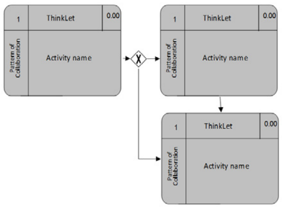
	being represented collectively as a single activity.	can be split up in order to help stakeholders to get more details about their activities.
R9	*Exlusive Gateway:*  When splitting, it routes the sequence flow to exactly one of the outgoing branches. When merging, it awaits one incoming branche to complete before triggering the outgoing flow.	*Decision Criteria:*  The BPMN 2.0 element *Decision Criteria* replaces the current decision criteria symbol.

Table 5. New FPM 2.0 Elements.

Fifth, the BPMN 2.0 element *Parallel Gateway* is represented by a diamond containing a plus sign. It is used to indicate that all outgoing branches are activated. The FPM 2.0 technique picks up this idea including the sign in order to indicate when two different activities have to be conducted concurrently. Each of the activities has to be executed in order to continue to the next activity. This allows modeling parallel activities (R5). Sixth, the *Time-out Event* in BPMN 2.0 is notated by a clock symbol surrounded by a double circle. It is used as one of many events proposed to work for marking interruptions between tasks. FPM 2.0 adopts this symbol to indicate breaks between and during collaboration activities. Thus, the clock symbol interrupts the sequence flow. FPM 2.0 therefore addresses the need to signal activity interruptions (R7). Sixth, the BPMN 2.0 element *Subprocess* is used to indicate that the task can be divided into subtasks. FPM 2.0 transfers this idea and includes the same element for indicating partial activities (R8). Last but not least, the *Exclusive Gateway* symbol is represented by a diamond containing a cross sign. It routes the sequence flow to exactly one of the outgoing branches. This element replaces the existing decision point that might be more familiar to process designers implementing FPM 2.0 (R9).

With these new FPM 2.0 elements, we provide suggestions to expand the current FPM 1.0 modeling technique in order to address the described requirements (see section 4.1) of collaborative work practices. Figure 3 summarizes the new FPM 2.0 modeling technique.

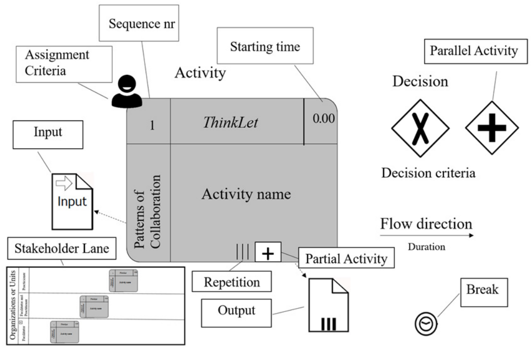


Figure 3. FPM 2.0 Technique

4.3 Criteria-based Evaluation

As the focus of our research is to develop an updated version of the FPM technique and, thus, has a more conceptual focus, a criteria-based evaluation constitutes the first logical type of evaluation. Therefore, we verify our solution in the light of the ML quality criteria. However, before we do so, we substantiate our way of thinking in light of Socrates' three sieves to provide a first justification of our solution: i.) truth; ii.) goodness; iii.) necessity. We argue that our FPM 2.0 technique is
i.) *truthful,* since we understand truth as the extent to which an artificial statement (e.g., a model) relates to the world and accurately describes reality [2];
ii.) *good*, since we refer to the ML quality criteria and verify our solution against them;
iii.) *necessary*, since we derived the demand for revising the FPM 2.0 notation from scenarios of new arising forms of collaboration. In addition, we examined whether other modeling languages could satisfy our demands. For example, BPMN 2.0 lacks some important features that are necessary for designing new collaborative work practices. As BPMN 2.0 partially satisfy our demans, we developed the FPM 2.0 elements by adapting elements from the widely-used BPMN 2.0 standard.
Compared to the current FPM technique, we argue that the FPM 2.0 technique better meets the quality criteria of a modeling language (ML). To this end, we refer to the formal, user-specific and use-specific criteria proposed by Frank [6] (see Table 6). The current FPM technique fulfils some of the proposed criteria. However, since FPM 2.0 is better able to capture the richness of modern and emerging forms of collaborarive work practices, it better covers the ML criteria proposed by Frank [6].

Quality criteria of modeling languages fulfilled (yes/no)	FPM 1.0	FPM 2.0
Formal:		
Correctness and completeness	X	X
Uniformity and redundancy	X	X
Reusability and maintainability	X	X
User-specific:		

Simplicity	**X**	X
Comprehensibility and clarity		**X**
Use-specific:		
Powerfulness and appropriateness		**X**
Operationalizability		**X**

Table 6. Criteria-based Evaluation.

Next to the *formal criteria* that are already met by the FPM 1.0, we based the development of the FPM 2.0 elements on the successful way of modeling from FPM 1.0. With regard to the new forms of collaboration, the FPM 2.0 specifically addresses *user-specific criteria* such as comprehensibility and clarity as well as *use-specific criteria* such as powerfulness and appropriateness, and operationalizability.

Regarding user-specific criteria, the FPM 2.0 helps the collaboration engineer, i.e. the designer / modeler, to visualize a process flow of a collaborative work practice in a richer and more comprehensible way using a managerable amount of meaningful symbols and concepts. To do so, we started with an analysis of new forms of collaboration (see section 4.1), then inter alia identified typical characteristics of collaborative work practices and then derived the main representative challenges. This procedure allowed us to focus on critical requirements and not to become too detailed. Representative examples where our solution covers user-specific criteria are e.g.: The *Stakeholder Lane* differentiates between collaborators and offers the possibility to mark if a lane is occupied by an AI system. Moreover, the *Parallel Activities* offer the possibility to show different activities that takes place concurrently. Regarding the use-specific criteria, our procedure to develop the new FPM 2.0 helped us to meet the criteria as well. The criteria powerfulness and appropriateness of a ML require that every relevant property of a situation can be modeled. To ensure this, we analyzed and discussed challenges of new forms of collaboration and derived solutions for new FPM 2.0 elements. Since collaborative work practices have changed over the past decade, we included elements that are required to model these new situations. Representative examples that our solution covers use-specific criteria are e.g.: The *Stakeholder Lanes, Parallel Activities, and Breaks* support modelers to capture the complexity of a collaborative work practice. To include information on which preparations a facilitator needs to complete to run an activity, the FPM 2.0 offers an *Output/Input element* that helps team facilitators to capture what they need to prepare in advance or which outputs from an earlier activity are needed. With regard to the criteria operationalizability, our solution offers descriptions with specifications on how to use the new FPM 2.0 elements. Thus, we can argue that this criteria is met as well. Yet, future research should focus on a deeper assessment of FPM 2.0's operationalizability by having the technique be applied by other collaborative work practice designers.

5. Example Application

Following, we exemplarily illustrate the application of our new FPM 2.0 technique using the example of an open innovation setting that consists of four phases: 1) ideation; 2) convergence; 3) evaluation; and 4) selection (see Figure 3). The collaboration goal is to select the best idea concepts for a new lifestyle traveling brand in an AI-supported collaboration (among decision-makers and employees from the innovation department and potential customers inherent in crowdworkers). In *phase 1* the decision-makers generate evaluation-criteria and an assignment to select suitable crowdworkers. The assignment specifies the categories for which they want to collect new idea concepts. In the subsequent activity, employees and external crowdworkers generate ideas independently from each other. While the employees

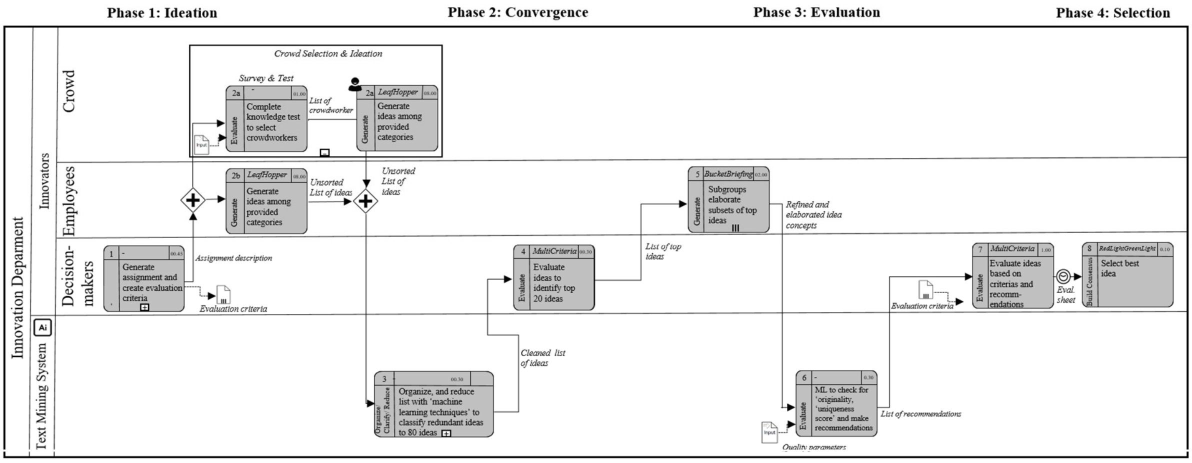


Figure 4. FPM 2.0 Example - Open Innovation Process.

can start directly, the crowdworkers need to complete a survey and test. Only suitable crowdworkers receive access to the idea generation activity. After both stakeholder groups completed their activities, an unsorted list of idea results as collaborative work product. In *phase 2* convergence activities start. The unsorted list of ideas is delivered to an AI (i.e. text mining system) that uses machine learning techniques to identify and classify redundant ideas to a list of 80 ideas. After that, the AI delivers the cleaned list of ideas to the group of decision makers. Those evaluate the ideas and build a list of the top 20 ideas. Next, the top 20 ideas are splitted into subsets and assigned to smaller breakout-groups of employees. Those breakout-groups work in parallel and elaborate the assigned ideas to a meaningful idea concept. The idea concepts constitute the input for the next phase and activity. *Phase 3* is characterized by an evaluation from an AI that analyzes the idea concepts in the light of the pre-defined criteria of 'originality' and 'uniqueness'. The AI uses machine learning techniques to combine results of the subsets into a single large set and uses this large set and makes recommendations based on originality and uniqueness scores. Finally, the selection phase 4 starts by which the decision makers evaluate the recommended idea concepts based on pre-defined criteria. After a break of two weeks the decision makers finally select the best idea.

To briefly explain our use of the FPM 2.0 elements we exemplarily refer to the phase 1 ideation: The FPM 2.0 element *Stakeholder Lane* indicates that there are subgroups (e.g. decision makers, employees and crowdworkers). The FPM 2.0 element < + > indicates that activity 1 is a meta process that has several sub-activities. The FPM 2.0 element *Parallel Activities* indicates that two stakeholder groups are working in parallel and independently. The FPM 2.0 element *Input/Output* indicates that there is an external input required to run the activity. The FPM 2.0 element *Assignment Criteria* signals that only certain types of participants are allowed to execute the activity.

6. Discussion & Conclusions

In this paper, we report on the development of an updated version of the Facilitation Process Model (FPM), which is widely used by Collaboration Engineering (CE) researchers and practitioners. The current FPM technique suffers from a number of shortcoming that make it hard to impossible to capture modern collaboration processes such as AI-based colls and crowdsourcing efforts. In our research, we identified nine distinct challenges with the current FPM technique and derived requirements for an updated version of the technique. We selected elements from the BPMN 2.0 standard that were incorporated into the FPM technique to meet these requirements, resulting in FPM 2.0. In itself, FPM 2.0 is different from the BPMN 2.0 process model technique in that it only includes the elements that are required for a CE modeling effort and expand on some elements to include aspects that are specific to CE, such as a designation for an activity's resulting pattern of collaboration and the thinkLet used to execute the activity. We further argue that FPM 2.0 meets the requirements of a ML language more comprehensively than the original FPM.

In the remainder of this section we describe our contributions to research and practice, as well as our study's limitations and directions for future research.

6.1 Contributions to research

Our work makes several contributions to research. First, compared to the original FPM, the FPM 2.0 technique is arguably a superior modeling technique for CE researchers to design and report their repeatable processes. FPM 2.0 allows CE researchers to be more precise in their designs and tackle a broader variety of collaborative situations than previously possible. In fact, FPM 2.0 is opening up possibilities for CE researchers to address process design issues in contexts that traditionally have not been covered by CE, such as crowdsourcing. Second, FPM 2.0 further provides a stronger basis for researchers to report on alternative designs and compare and contrast them. A structured and comprehensive modeling technique is a necessity to allow for a detailed and meaningful evaluation of alternative design. Finally, researchers that use experimental methods to study interventions in collaboration processes can use FPM 2.0 to more precisely report on the experimentation process that they followed in each condition. This will facilitate the review of their study's execution as well as strengthen its replicability by other researchers.

6.2 Implications for Practice

Our work also has several implications for practice. First, we argue that FPM 2.0 represents a richer, yet still easy to use modeling technique. FPM 2.0 models are expected to be easy to communicate to any stakeholder involved in a collaboration process. The extent to which this is indeed the case should be the aim of future research, both in the context of explaning and validating a process design as well as using FPM 2.0 models to support training practitioners in the execution of a process. Second, the FPM 2.0 technique sets a clear set of requirements for automated tool support. A CE design studio should support collaboration engineers to click together FPM 2.0-based process design that could then be transformed into Process Support Applications [4]. A

PSA is a template collaborative application for a repeatable process that can be instantiated each time a team needs to run it.

6.3 Limitations & Future Research

A number of limitations have to be considered with respect to our study. First, the list of challenges with the current FPM is based on an assessment of a selection of scenarios. While these scenarios address the most prevalent challenges that CE researchers have encountered in recent years, they may not be comprehensive. Future research is recommended to develop a structured overview of the plethora of collaborative situations that FPM 2.0 has to be able to model. Based on such an overview, additional challenges may be uncovered. Second, the quality of FPM 2.0 has yet to be determined in practice. To this end, we recommend a portfolio of assessment studies. For example, designers could be trained in the use of FPM 2.0 and given a number of collaborative situations for which they have to produce a process design. These designs could be evaluated on quality and the designers' perceptions on the ease of use and completeness of the FPM 2.0 technique. Also, existing collaboration processes in use in organizations could be modeled using FPM 2.0 to determine whether a complete and correct representation of these processes can be created. Finally, the FPM 2.0 technique could be assessed by a panel of business process modeling experts to determine its quality against each of the ML requirements as proposed by Frank [6].

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