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# Linking Natural Modeling to Techno-centric Modeling for the Active Involvement of Process Participants in Business Process Design

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## ABSTRACT

Actively involving participants in business process modeling enables integration between elicitation and modeling steps of the BPM lifecycle. Such integration may lead to a more efficient design procedure and ultimately to a more accurate representation of the business process. However, active involvement of process participants creates several challenges, as the latter are not expected to have modeling skills. The purpose of this paper is to present a business process design approach, called CoMPArE /WP, which tightly integrates the elicitation and modeling stages of process design, through the active involvement of process participants. To achieve effective involvement of process participants, CoMPArE/WP adopts the principles of natural modeling. However, being a business process design approach aiming at supporting the whole BPM lifecycle, CoMPArE /WP deals also with the transition of natural modeling to formal process representations that can be enacted using a BPMS.

### KEYWORDS

Card-based Design, Collaborative Modeling, Natural Modeling, Participatory Design, Process Design, Process Elicitation, Scenario-based Design, Tangible Modeling

## INTRODUCTION

During the last decades, there is a rapidly growing interest on Business Process Management (BPM), revealed by the plethora of relative emerging technologies. Such technologies include business process modeling languages offering the means to design technically interpretable business process models like BPMN (OMG, 2008), EPCs (Mendling 2008) and S-BPM (Fleischmann and Stary, 2012), tools for business process analysis like Signavio (www.signavio.com), business process management systems (BPMSs) providing the required infrastructure for business process modeling, analysis and enactment like Bonita BPM (www.bonitasoft.com) and AristaFlow (www.aristaflow.com), and sophisticated BAM (Business Activity Monitoring) suites enabling performance tracking of business processes like Oracle BAM (www.oracle.com/technetwork/middleware/bam/overview/index.html).

The central concept behind all these technologies is the business process model, which is designed, analyzed, implemented, enacted, monitored and evaluated continuously in the course of the business process management lifecycle (Weske, 2007). However, in contrast to the wide variety and rapid evolution of such technologies that support the management of a business process model throughout its lifecycle, less progress has been made on how to design a business process model in

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terms of a well-defined methodology (Nurcan & Schmidt, 2012) and even less on how to elicit the model from the real world cases (Mauser et al., 2009).

According to Weske (2007), elicitation and modeling together correspond to the design stage of the BPM lifecycle. The reason they are not depicted as separate phases is that they are not conducted in a sequential manner. Rather, they are performed interchangeably until a process model is reached that sufficiently reflects the real-world process. Typically, a process analyst, i.e. a person qualified to drive the design and analysis procedures, with competence on one or more process modeling languages, interviews a representative group of workers, in order to extract information on how the work is done for a specific business process. Subsequently, the process analyst uses this information to build an initial process model. Afterwards, the analyst proceeds with its calibration, which involves iterations of comparisons between the model and the actual process through further interviews with the involved participants, and exploitation of the discrepancies between the two, to improve the model. This procedure is repeated until model accuracy is judged to be acceptable. The construction of the model is typically based on hierarchical top-down modeling like the approach presented in (Silver, 2009). This approach starts with an abstract model following the strategies and policies set by top management. The abstract model is gradually refined into a more fine-grained representation of work based again on information acquired from managers. However, during the decomposition procedure, process participants may also come into play.

Generally, in the above approach, the process analyst acts as an intermediate between the workers and the model created. Although process analysts specialize in process design, mediation per se may create delays in the process modeling procedure and mismatches between the model and the real world case, as in such an approach elicitation and modeling are tackled as two discrete steps. A possible way to avoid such kind of problems would be to actively involve process participants in process modeling (Front et al., 2015) and to enable them to express themselves directly on the model, tightly interweaving in this manner modeling with elicitation. Modeling that is driven by process participants yields a bottom-up approach that creates models depicting how work is actually done. Moreover, through such an approach the tacit knowledge of workers on how to operate the real organization can be exploited (Dix and Gongera 2011). For tacit knowledge to be even better exploited, collaboration among workers during elicitation should be also promoted (Rolland et al, 1998; Forster et al., 2012). This is in contrast to the classical approach, where each worker is usually interviewed individually.

However, actively involving process participants in process modeling creates a challenge. Process participants are not expected to have modeling skills and usually, as also stated in (Prilla & Nolte 2012), they are not willing to learn a modeling language with a strict syntax and semantics and many different symbols. What they would prefer would be to externalize their knowledge through diagrams that are as simple as possible in terms of both syntax and semantics. Zarwin et al. (2014) stress the importance of *natural modeling*, as they call it. With the term natural modeling, the authors aim at shifting the focus of attention from the technical and formal aspects of modeling to human aspects, since modeling has always been a human-intense activity. For modeling to be widely accepted, Zarwin et al., claim that it should be as natural as possible. To this end, they specified three principles: 1) modeling should be based on intuitive symbols and constructs, 2) modeling should be collaborative, so that models can serve as vehicles of communication facilitating knowledge sharing and promoting negotiation and commonly agreed-upon decisions, and 3) modeling should be flexible in a sense that the symbols do not have a predefined meaning but rather the language used should emerge dynamically based on the situation at hand. They, however, also claim, that – if the ultimate goal of the models produced is their technical processing – modeling support needs enable modelers to work in a continuum between "natural and formal modelling", which "should be fundamentally understood as the two polarities" (Zarwin et al., 2014, p. 29).

The purpose of this paper is to present a business process design approach, which explicitly addresses this gap by enabling natural modeling practices while at the same time maintaining a well-defined bridge towards techno-centric (formal) modeling. Through the adoption of natural modelling principles, the proposed approach, which is called CoMPArE/WP (Collaborative Model Articulation and Elicitation of Work Processes), achieves effective involvement of process participants. Effectiveness in this context refers to the extent the participants are facilitated in externalizing their tacit knowledge and reflecting it on the business process model as well as to the acceptance of the approach by the participants. Being a business process design approach aiming at supporting the whole BPM lifecycle, CoMPArE/WP deals also with the transition of the model developed by process participants to a techno-centric process model, meaning that it can be processed and enacted using a BPMS.

In specific, this paper is structured as follows: First, background information is provided regarding the existing elicitation techniques and it is explained which of them have influenced the proposed approach. Subsequently, the discrete components of the CoMPArE/WP approach are analytically described and then an illustrative case is presented as a proof of concept. Next the related work is discussed and finally our conclusions and future work are presented in the last section.

## BACKGROUND

BPM is regarded to be intimately related to system engineering and thereby the mental approach is the same (Bhaskar et al., 1994). In system engineering, which has been an active field for more than 20 years, a large number of elicitation techniques have been developed, targeting the identification of system requirements. This might be another reason for the fact that, in BPM, process elicitation has not been adequately emphasized. There is indeed a fairly large bibliography on elicitation techniques regarding either requirements in system engineering or knowledge in knowledge engineering, which is also a rather old discipline, dating back to the decade of 80's. In the following, the most common techniques are briefly reviewed.

*Interview-based techniques* are among the most well-known methods for eliciting knowledge (Adel & Nedhal, 2010; Mehdi, 2009). Interviews may be well structured, comprising a very specific sequence of questions that the interviewee is asked to answer. As such, there is an organized form of communication between the interviewer and the interviewee. In contrast, unstructured interviews allow questions based on the interviewee's responses and constitute a looser form of discussion.

Focus groups (Massey and Wallace, 1991) involve extracting information from the discussion among a group of stakeholders about some topic of interest to the researcher, exploiting thus the collective knowledge of the group. For this technique to be successful, it is important to ensure a group composed of well-chosen participants in terms of their relation to the corresponding enquiry, and additional parameters such as their knowledge and expertise and their organizational position.

Another technique for knowledge elicitation is protocol analysis (Goguen & Linde, 1993). In protocol analysis, domain experts report on the process they follow in performing a task or solving a problem. The domain experts can keep notes or think aloud in parallel to their actual work.

*Scenario-based elicitation techniques* (Carroll, 2000, Go et al., 2004) extract knowledge from domain experts by engaging them in specific cases of how to use the system under development or in concrete manifestations of the problem under consideration. Scenarios, which have been extensively employed in software engineering (Weidenhaupt, 1998; Holbrook, 1990; Kavakli et al., 1996), can be used in combination with prototyping. Prototyping (Beaudouin-Lafon and Mackay, 2002; Neumann, 2004) may be an interactive screen (normally consisting of hypertext with no real data behind it), a mock-up (such as a PowerPoint), a navigation flow (such as a Visio diagram), or a storyboard. A technique that can be adopted in conjunction with prototyping is the participatory design (Kensing & Blomberg, 1998; Muller et al., 1993). Participatory design actively involves users in all phases of the design process. Users are not simply consulted at the beginning and asked to evaluate the system at the end or in specific milestones but they are treated as partners throughout.

An alternative category of knowledge elicitation is based on *observation* (Adel and Nedhal, 2010; Mehdi, 2009). Observation is considered a technique eligible for acquiring tacit knowledge. In this technique, experts are visited on site and monitored during their work. Observation is also called contextual inquiry and can be passive, where the analyst merely watches someone working but does not interrupt or engage the worker in any way, or active, where the analyst asks questions throughout the process to be sure he/she understands and even attempts portions of the work.

*Introspective techniques* complement the body of elicitation methods described above. Acquisition of tacit knowledge is the objective of the repertory grid analysis (Hudlicka, 1996). This is a technique borrowed from experimental psychology, designed to access internal mental structures. It is used to indirectly determine the individual's view of the world, for example by asking simple questions about similarities and differences between domain entities or attributes, or by asking the individuals to rate the similarities of two entities on some numerical scale. Repertory grid analysis may be used in combination with laddering (Corbridge et al. 1994). Laddering is a technique for clarifying the relations between the constructs which have been extracted by the repertory grid analysis enabling a hierarchy of concepts to be established. Card sorting (Wang, 2006; Wood & Wood, 2008) is another technique developed by psychologists used also for constructing structuralized piles of concepts. The concepts are first identified and written onto simple index cards or post-it notes. The users then arrange these to represent the groups or structures they are familiar with.

All the above techniques have both pros and cons and each of them is applicable for a specific problem category. Therefore, a combination of them might prove more effective for extracting the desired knowledge from domain experts (Hickey & Davis, 2003). For comparisons regarding these techniques, the reader is referred to (Davis et al., 2006; Mehdi Sagheb-Tehrani, 2009; Goguen & Linde, 1993).

Despite the availability of elicitation techniques from the field of systems and requirements engineering described above, in traditional BPM approaches elicitation still is often conducted by a process analyst with workers taking the role of information providers, rather than being actively involved in model creation and alignment of different viewpoints that need to be integrated (Hjalmarsson et al., 2015). In recent years, research in this field has picked up the idea of the active involvement of process participants in modeling and has led to approaches that combine characteristics of some of the aforementioned techniques to promote their collaboration during process design (e.g. (Rittgen, 2009; Front et al., 2015; Türetken & Demirörs, 2011) – cf. section on related work below). The approach proposed in the present article also follows this path and adopts ideas from participatory design, card sorting and scenario-based elicitation. In the following, we introduce our method, show its feasibility in a case study and finally reflect its design against those approaches from related work that pursue similar objectives.

## THE COMPARE/WP APPROACH

CoMPArE/WP is a method based on natural modeling practices which at the same time maintains a well-defined bridge towards techno-centric (formal) modeling. In the following, we use the method notion introduced by Goldkuhl et al. (1998) to describe about the method and its implementation in detail and show how it can be used for business process design. Goldkuhl et al. (1998) suggest to consider the following aspects when providing a structured description of a method following a question-oriented paradigm: A method builds upon a *perspective* it adopts to determine on what it wants to achieve ("What is important?"). It consists of different *method components*, which are characterized by three closely linked aspects: *procedure* ("What questions to ask?"), *concepts* ("What to talk about?"), and *notation* ("How to express answers?"). The method components together form a methodological structure that is referred to as *framework* ("How are the questions related?"), which describes how those aspects are interrelated and also determines how the method components are linked with each other. A method is implemented by *co-operation forms* (Who asks? Who answers?). In the following, the description of CoMPArE/WP is structured along these aspects. We start with an overview of the whole method, and subsequently detail on each component.

## Perspective

CoMPArE/WP adopts the perspective on modeling support argued for by Zarwin et al. (2014) and consequently aims at closing the gap between anthropo-centric (natural) modeling and techno-centric (formal) modeling. To achieve that, it adopts the principles of natural modeling but at the same time it supports the derivation of executable models in a well defined way. The leading question to be answered by the participants implementing the method is: “How is a business process to achieve a given organizational goal (to be) implemented?”

## Framework

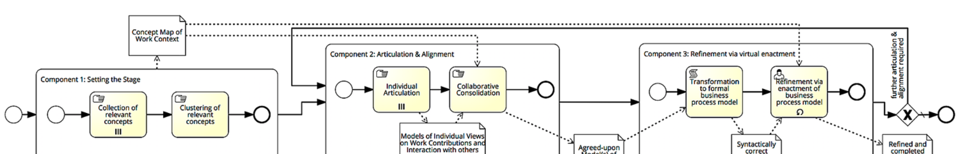
The methodology design is informed by a multi-component framework that enables process participants to gradually develop a comprehensive model of their business process in a cooperative way without requiring them to be familiar with techno-centric modeling languages.

The methodology of CoMPArE/WP comprises three related method components as depicted in Figure 1.

These components aim at enabling modeling practices adhering to the principles of natural modeling in the initial phases of business process elicitation and then gradually developing more sophisticated techno-centric models without confronting users with their complexity. An overview of these components is provided in the following. More detailed descriptions of the component are provided in the following sub-sections, describing them to the level of actual implementation.

- **Component 1:** Setting the Stage
    - **Procedure:** What is important in the context of the business process?
        - **Concept:** When implementing this component, modeling participants try to find a common understanding about the scope of the business process and the notions to use to refer to the relevant concepts. Scope herein refers to where the business process starts, where it ends, and which aspects are to be addressed when implementing it. Groups of modeling participants with heterogeneous backgrounds in particular might have an issue with wording when aligning their different views. The notions used to refer to different aspects of the business process are thus explicitly captured.
        - **Notation:** A semantically unconstrained notation similar to concept mapping is used in this component to allow modeling participants to express their concepts without requiring them to initially adapt to a given modeling language. This addresses the first requirement of natural modeling.
- **Component 2:** Articulation and Alignment
    - **Procedure:** How do we / should we (the modeling participants) collaborate to implement the business process in our organization?
        - **Concept:** Natural modeling requirements 2 and 3 are addressed in the second component, where modeling participants are required to collaboratively agree upon who should be involved in implementing the business process, what contributions the participants are expected to make in the course of the business process, and how they will interact to achieve their goals. Participants are flexible and how they semantically address those

**Figure 1. The CoMPArE approach represented as a BPMN process**



three categories but ultimately need to agree upon a common set construct semantics. The description of the results is restricted to a single case of implementing the business process, thus reducing complexity of its representation in this component.
    - **Notation:** Due to the simplified semantic requirements, component 2 makes use of a simplified, generic notation for describing collaborative business processes, which will be further elucidated in the following paragraphs. This generic notation enables semantic adaptation to the requirements of the modeling participants and therefore meets the first requirement of natural modeling (i.e. "intuitive constructs").
- **Component 3:** Refinement via Virtual Enactment
  - **Procedure:** How should the business process be implemented to appropriately address the potentially different contexts it is executed in?
    - **Concept:** Modeling in component 2 focuses on a single case of the business process to reduce complexity of the modeling and alignment procedure. Component 3 conceptually addresses this shortcoming by elaborating the model in an interactive way towards a comprehensive representation of the business process. This is achieved through refinement during virtual enactment, i.e. engaging modeling participants in identifying problems and gaps of their initially agreed upon model by playing through it and elaborating it concurrently.
    - **Notation:** In component 3, no graphical notation for supporting modeling is used at all for the participants. They use web-based dialogue forms to describe deviations from the business process developed in component 2. Technically, these deviations are incorporated in a BPMN model of the process, which is maintained in the background.

The whole modeling framework is iterative, enabling the flexible combination of design components as the shared understanding about the business process evolves over time and potentially uncovers additional aspects to be addressed. Flexibly combining the three components enables the adaptation of the design procedure to the business process at hand (higher complexity requires more overall iterations), to the amount of divergent views that is present in the group of modeling participants (more divergence requires more iterations of component 2) and to their skills in abstraction and modeling (higher skills enable more complex changes to be made during virtual enactment). Selecting the appropriate steps in an ongoing design process is the task of a modeling facilitator. The selection is made based on the observed situation in the group of the modeling participants and the desired outcome in terms of elaborateness of the resulting model.

## Co-Operation Form

All components are carried out in a workshop setting, where the modeling participants work on creating a shared artifact. However, component 2 comprises an initial step of individual activity without any interaction to capture the different participants' views on the business process, before collaboratively consolidating those views to an agreed upon model.

The methodology enables process participants to gradually develop a comprehensive model of their business process in a cooperative way without requiring them to be familiar with techno-centric modeling languages. As in the participatory design (Kensing & Blomberg, 1998), in CoMPArE/WP process participants are actively involved in process design. They articulate their individual views on a work process to eventually cooperatively develop an agreed-upon business process model. Modeling practices used in this methodology, are not performed sitting in front of a PC screen, using some kind of software for process modeling. Instead, participants use cards with different colors which are assigned specific semantics during the modeling procedure. Like in card sorting (Wood & Wood, 2008), participants create conceptual structures using the cards. Employing tangible means to conduct process modeling has already been proposed in the literature (Luebbe & Weske, 2011; Oppl & Stary, 2014). Using tangible means like cards instead of sophisticated software allows also technologically illiterate workers or, in general, workers that do not feel comfortable with technology to take part in modeling and overall makes modeling more enjoyable and appealing to modeling participants.

In the following, we further detail the description of those components in separate sections by using again the structure of *perspective, framework* and *co-operation form*. *Perspective* elaborates on the conceptual foundations for each component. *Framework* describes internal structure of a component, including *sub-components*, the addressed *procedures* for each (sub-)component, their respective *concepts* and the *notation* elements used for representing them, and puts them into mutual context. *Co-operation form* describes the actual implementation of each component in a CoMPArE/WP workshop.

## Component 1 - Setting the Stage

Process participants do not necessarily share a common understanding of the organizational setting of the business process and which concepts to use for describing it (Sarini & Simone, 2002). Component 1 aims at "setting the stage" to enable co-operatively creating a business process model in the later components. It establishes a common understanding of the scope of the business process and of the concepts used for referring to its relevant aspects.

### *Perspective*

Component 1 is based upon research on collaborative concept mapping as a means to create common ground (van Boxtel et al, 2002; Gao et al, 2007). Concept mapping is a method for externalizing and reflecting knowledge about real world phenomena (van Boxtel et al, 2002), such as business processes, without semantically constraining the participants to use certain language constructs when expressing their concepts. The question guiding concept mapping component 1 is: "What is important in the context of the business process?". This focusses participants on the subject of discourse, while deliberately leaving open, which aspects actually are relevant as well as which constructs are used to describe them.

Semantically open modeling has been shown to be an appropriate approach to address this issue (Faily et al., 2012; Engelmann & Hesse, 2010; Trochim et al. 1994).

### *Framework*

Component 1 consists of two sub-components that support modeling participants in finding a common understanding about the scope of the business process and the notions to use to refer to the relevant concepts. Sub-component 1 is concerned with the collection of relevant concepts, whereas sob-component 2 aims at consolidation and clustering of the concepts collected in the former step:

- **Component 1.1**: Collection of relevant concepts
  - **Procedure 1.1.1:** What are the important elements in the context of the business process?
    - **Concept:** Modeling participants individually, without interaction with each other, collect all elements they consider important or relevant in the context of the business process. Collection deliberately and explicitly is not constrained to any particular types of elements.
    - **Notation:** Each element is noted on a white card. Participants are asked to sort their cards in a stack, starting with the most important one.
- **Component 1.2:** Clustering of relevant concepts
  - **Procedure 1.2.1:** How are the collected elements related to each other?
    - **Concept:** Modeling participants determine clusters of elements that are related with each other according to some criteria. The criteria for clustering are determined by the modeling participants themselves collaboratively.

    - **Notation:** The white cards bearing the named elements are placed on a shared modeling surface. Clusters of elements are represented by spatially arranging the corresponding white cards in a way the participants perceive to appropriately represent the cluster.
  - **Procedure 1.2.2:** Are there elements using the same notion for different concepts or vice versa?
    - **Concept:** Modeling participants might use different notions to refer to the same concept and vice versa during the trial collection of relevant elements. Different notions for referring to the same concept are identified during collaborative clustering and the ambiguity has to be explicitly captured. The same is true for different concepts referred to with the same notion by different participants.
    - **Notation:** Cards, which have been identified to represent the same concept but bear different notions, are stacked, the topmost card bearing the notion the participants agree to use further during the workshop. Cards bearing the same notion but referring to different concepts are placed separately on the modeling surface and are further elaborated with additional textual modifiers, which clarify their different meanings.

### *Co-Operation Form*

The modeling participants perform the following steps as a group to co-operatively build a concept map:

- They individually collect a set of elements (depicted on white cards) they consider relevant in the context of the business process under design. The types of the elements remain unconstrained. All modeling participants assign names to each of their elements individually.
- Each modeling participant presents each of his/her elements separately, one after the other. The element is added to a shared modeling surface accessible to all actors. The other modeling participants are asked to check, if they have also created an element representing the same real-world concept (independently whether they used the same name or not) and resolve such issues according to the described methodology.
- Participants group together elements that are of the same type (e.g. persons, tools, documents, …), making the first step towards conceptual abstraction. Initial clustering and association specification can be performed while adding concepts in step 2. A final round of collaborative clustering and association specification after all elements have been added completes the stetting-the-stage design step.

## Component 2 - Articulation and Alignment

Component 2 contains two sub-components, namely “Individual Articulation” and “Collaborative Consolidation”, which together lead towards semantically more constrained models eligible for business process representation. During this components, the participants use results of component 1 as a reference and implement a multi-perspective articulation approach to process modeling (Mullery, 1979). This separation of individual articulation and collaborative consolidation facilitates knowledge sharing and promotes negotiation and commonly agreed-upon decisions. The consolidation process leads to the documentation of a shared understanding about the business process, in accordance with the second principle of natural modeling.

### *Perspective*

Existing research (Santoro et al., 2010; Fahland & Weidlich, 2010; Kabichler & Rinderle-Ma, 2011; Lai et al., 2014) suggests that starting modeling based upon a concrete work case makes it easier for process participants to develop an understanding of the concepts necessary to describe a business process in an abstract conceptual model. The leading question for this component is: "How do we / should we (the modeling participants) collaborate to implement the business process in our organization?"

### Framework

Component 2 requires modeling participants to collaboratively agree upon who should be involved in implementing the business process, what contributions the participants are expected to make in the course of the business process, and how they will interact to achieve their goals. This component conceptually again is split in two sub-components, where the first one focusses on procedures concerning individual contributions to the business process, and the second one aims at consolidating these contributions to an overall model:

- **Component 2.1:** Individual Articulation The following questions are not necessarily to be answered in the given sequence but should all be represented in the final modeling result. The whole component is carried out individually, without interaction with other modeling participants.
    - **Procedure 2.1.1:** What is my role in the business process?
        - **Concept:** Modeling participants name their own role in the business process
        - **Notation:** A blue card bearing a name for one's role is used by the individual modeling participants to refer to themselves. The card is placed at the top border of the modeling surface.
    - **Procedure 2.1.2:** How do I work in the course of the business process?
        - **Concept:** Modeling participants describe, what they are doing in order to complete their contribution to the business process. They describe their work by means of a sequence of distinct activities.
        - **Notation:** Each activity is represented by a red card, named by the participant to indicate what the activity is about (referred to as WHAT-item in the following). The cards are placed vertically below the blue card representing the participant's own role. Their vertical ordering indicates their sequence, the top-most card consequently representing the first activity of the participant.
    - **Procedure 2.1.3:** Whom do I collaborate with in the business process?
        - **Concept:** Modeling participants determine people or roles they have to collaborate with to finish their work in the course of the business process.
        - **Notation:** For each collaboration partner, a named blue card is placed next to the blue card representing him or herself (referred to as WHO-item in the following). All blue cards are arranged along a horizontal line at the top border of the modeling surface.
    - **Procedure 2.1.4:** How do I interact with others in the course of my work?
        - **Concept:** Modeling participants determine what artifacts (information, material, etc.) they exchange with others in order to complete their work. In particular, they distinguish what they require from others in order to carry out certain activities, and what they can provide to others as a result of their activities.
        - **Notation:** For each exchange, a yellow card is placed vertically below the blue card representing the respective collaboration partner (referred to as EXCHANGE-item in the following). The cards are vertically arranged to match the activities, for which the exchange is required or by which it is provided to others. Yellow cards indicating required exchanges are connected to the red cards representing the dependent activity using a arrow from the yellow to the red card. Provided exchanges consequently are indicated by an arrow from the respective red card to the yellow card.

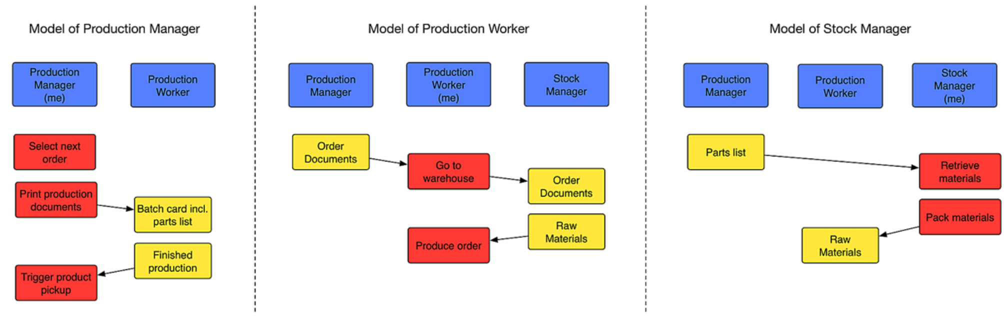
- **Component 2.2:** Collaborative Consolidation The following questions are not independent of each other and should be addressed in a particular sequence, which is described in detail in section "co-operation from" below. The whole component is carried out collaboratively, and is based upon the results of component 1.
    - **Procedure 2.2.1:** Who is involved in the business process?
        - **Concept:** Modeling participants agree upon people or roles, who are or should be involved in the business process.
        - **Notation:** Each process participant is represented by a named blue card. The name is mutually agreed upon. All blue cards are arranged along a horizontal line at the top border of the modeling surface.
    - **Procedure 2.2.2:** Who is responsible for which activities in the business process?
        - **Concept:** Modeling participants articulate, how each of them implements their contribution to the overall business process.
        - **Notation:** All activities are represented by named red cards. The name is determined by the modeling participant responsible for the activity but has to be understandable by the other modeling participants as well. The cards are placed vertically below the blue card representing the person or role responsible for enacting it. Their vertical ordering indicates their sequence in which they are enacted by the person or role. The top-most card consequently represents the first activity.
    - **Procedure 2.2.3:** Who has to collaborate in which way during the business process?
        - **Concept:** Modeling participants agree upon, how to collaborate in the course of the business process and which information, material, etc. is exchanged in the course of this collaboration.
        - **Notation:** All exchanged information, materials, etc. are represented by named yellow cards. The name is agreed upon by the modeling participants involved in the exchange but has to be understandably the other modeling participants as well. Each card is placed between the source lane (i.e. the sequence of red cards headed by the blue card representing the providing person / actor) and receiving lane. If the lanes are not adjacent, the card is placed next to the lane the exchange originates from. The cards are vertically arranged to match the activities, for which the exchange is required and by which it is provided. Arrows are used to connect the red cards representing the providing and requiring activities to the yellow card.

### *Co-Operation Form*

For implementing the components described above, the participants are provided with cards of different colors for modeling. The spatial arrangement of the cards based on their colors acts as a structural scaffold, guiding the consolidation process in a structured manner via dedicated areas for describing different aspects of the process (cf. Figure 2). Scaffolding is a concept widely used in education to describe structures or methodologies that support learners in self-directed efforts to understand something new (van de Pol et al., 2010). The scaffold used in component 2.1 supports modeling participants in describing independently of each other their own activities, the actors or organizational entities they are interacting with, as well as how this interaction manifests itself in terms of information or artifact exchange and enables them to use the same elements for consolidation in component 2.2. Consolidation is performed according to the following scheme (modeling steps described to in brackets refer to the example depicted in the next section):

- One of the modeling participants starts by placing the WHO-item representing him/herself on the shared modeling surface. If known a-priori, the actor responsible for starting the real-world business process starts modeling (cf. step 1 in Figure 3). The process start is indicated by an individual model, which contains WHAT-items that are not dependent on any EXCHANGE-items

Figure 2. Result of component 2.1: Individual Articulation

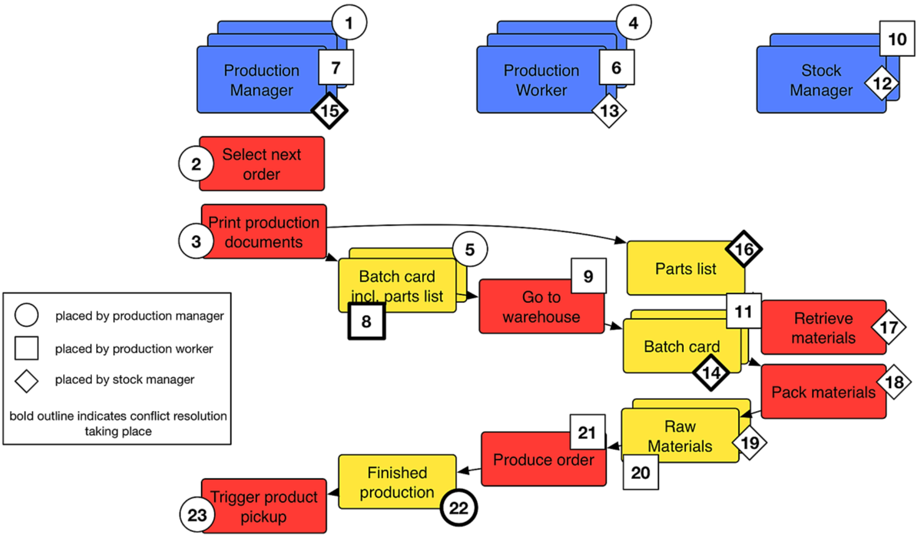



to be received. If more than one such individual models exist, this indicates a business process with multiple parallel starting activities, which are only synchronized at a later point in time. In such cases, any of the affected modeling participants can start modeling.

- The same participant describes his/her own contribution to the business process by placing WHAT-items below his/her own WHO-item. Others do not intervene during this stage (cf. steps 2-3 in Figure 3).
- As soon as the participant places the first EXCHANGE-item (step 5 in Figure 3), the targeted communication partner steps in and matches his/her own perception of the business process (steps 6-8). Matching can take the following forms:
    - The communication partner has a matching EXCHANGE-item (i.e. an EXCHANGE-item that matches the already placed item). In this case, the matching elements are merged (cf. steps 19-20 in Figure 3).
    - The communication partner has no matching WHO-item (i.e. he/she has not perceived any collaboration with the original modeling participant at all). This is a fundamental difference in the perception of the business process. Participants need to agree, how to resolve this issue (cf. steps 15-16 in Figure 3, where the stock manager expected to receive a parts list from the production manager directly, whereas the production manager passed it on via the production worker).
    - The communication partner has no matching EXCHANGE-item (i.e. he/she did not share the perception of collaboration or did not consider it relevant). Such a difference again needs to be resolved by the affected participants (cf. step 22 in Figure 3, where the production worker considered to be finished after the order was produced, whereas the production manager expected an explicit notification that the production was finished).
    - The communication partner considers one of the his/her own EXCHANGE-items to match. The involved participants, however, have a different understanding of the content or form of the exchanged information or artifact. Such differences need to be addressed by the participants (cf. steps 5 and 8 as well as steps 11 and 14 in Figure 3, where in the first case the production manager provided a more detailed description of the EXCHANGE than the production worker, and in the second case the EXCHANGE between stock manager and production worker was modified due to upfront communication of the parts list).
- Consolidation continues in this way until all points of collaboration are agreed upon. When one actor has completed his or her contribution, others with remaining elements not yet incorporated in the common model take over and provide further input to the consolidation process (cf. step 22-23 in Figure 3).

The limited set of modeling elements used in component 3 prevents the occurrence of co-operation and externalization problems due to lack of participants' experience in modeling (Genon

**Figure 3. Result of component 2.2: Collaborative Consolidation**




et al., 2010; Britton & Jones, 2008). When actively involving process participants, it seems to be appropriate to limit the number of available modeling elements a priori to those appropriate for the intended modeling perspective and targeted outcome (zur Muehlen & Recker, 2008), i.e. case-based models of business processes, as in scenario-based elicitation techniques. In this way, models are kept simple and comprise the most fundamental constructs used for the description of work and therefore the first requirement of natural modeling is met (i.e., intuitive constructs).

### *Example*

Figure 2 shows three sample models created individually in component 2.1, which together form a foundation for later consolidation. The labels in the models refer to a (exemplary) production process, in which a production manager, a production worker and a stock manager are involved. The models indicate several fundamentally different understandings of how the production process should be implemented. While those differences might not occur in such a drastic way in reality, the scenario has been chosen to illustrate different aspects of consolidation below.

The resulting models of component 2.1 are consolidated into a common model in component 2.2. Figure 3 shows the merging process for the sample models depicted in Figure 2. The numbering indicates the sequence of consolidation steps, the outlines of the numbers indicate the different modelers, and the stroke of the outline indicates whether conflicting viewpoints needed to be resolved.

### *Transition from Component 1*

The presented arguments for semantically open modeling in an initial phase of business process elicitation leave open the question of how the results of components 1 can be used in component 2 beyond the indirect effects caused by the upfront alignment of the participants' mental models. Although the modeling constructs are semantically not constrained in component 1, clusters of concepts that are instances of the same semantic construct can be expected to emerge during modeling (Trochim et al., 1994). Following the assumption that a business process can be described by naming the active entities, the actions performed by these entities and the exchange of tangible or intangible resources between these entities (Trochim et al., 1994), it is likely that concepts using these semantic constructs will emerge already in component 1.

Component 2.2 can be augmented by asking the participants to identify concepts from component 1, which are instances of the language constructs introduced in component 2 after consolidation. This triggers reflection on the outcome of components 1 and 2 at the same time and might lead to further modifications. Still, there might be concepts that bear semantics, which is not used in component 2. They have to be considered in the description of the process context in order to provide further information about how the model has to be interpreted and/or can be put to practice. This additional information is beneficial for model understanding of process participants (Herrmann & Nolte, 2014; Santoro et al.,2010), which can be useful for refinement via virtual enactment in component 3.

## Component 3 - Refinement via Virtual Enactment

Completing the modeling components described above leads to models that are semantically incomplete representations of business processes. Most notably, these models do not account for different variants of a business process. Refinement through virtual enactment is a means to complete a process description without the need to create comprehensive process models as in the case of traditional conceptual modeling. This is enabled by transforming the results of component 2 to BPMN (cf. section on transition from component 2 below) and using the BPMS described in (Kannengiesser et al, 2014) and (Schiffner et al, 2014) to play through complex decision processes via workflow enactment. By incrementally adding process variants, the model evolves as virtual enactment continues. Complex models of business processes are documented in this way without the need to ever translate one's perceptions of a business process to abstract process descriptions in a single step. The model permanently maintains a syntactically valid state during refinement, which allows for further processing, such as live validation of dead- or live-locks or mathematical simulation of capacities. These aspects, however, have not yet been investigated and are subject to future research.

### *Perspective*

The method components described above deliberately follow a case-based approach to reduce model complexity and keep modeling simple and intuitive in accordance with the first principle of natural modeling. A comprehensive model of the business process, however, still is required for further processing. Component 3 therefore takes a refinement perspective on the modeling process, aiming at elaborating the model to comprehensively represent the business process. The case-based models are co-operatively refined guided by the leading question of "How should the business process be implemented to appropriately address the potentially different contexts it is executed in?"

### *Framework*

Component 3 widens the focus of articulation from a single case, which is elaborated in component 2, towards a comprehensive representation of the business process by elaborating the model in an interactive way. The procedures here focus on validating the model, identifying gaps and filling them with appropriate model information, if necessary:

- **Component 3:** Refinement via Virtual Enactment
  - **Procedure 3.1:** Are there any errors in how the activities and exchanges have been described?
    - **Concept:** Modeling participants identify any steps in the business process that are described in a way they consider erroneous or cannot agree upon content-wise. Such steps are modified in a way that all affected participants can agree to.
    - **Notation:** Refinement is implemented via a web-based dialogue-form, which allows to modify the descriptions of the current step.
  - **Procedure 3.2:** Are there any alternative ways to act than currently described?
    - **Concept:** For each tasks the participants assess whether there are any alternative ways of acting, and, if so, under which conditions these alternatives are to be executed. Both, the additional activities and the conditions need to be specified by the affected participant

and have to be understandable to all other participants, as such changes might trigger cascaded changes that need to be addressed by them.
    - **Notation:** Refinement is implemented via a web-based dialogue-form, which guides the description of deviations from the existing model, starting with deviation conditions and continuing to describe the next step.
  - **Procedure 3.3:** Are there missing activities, exchanges or roles in the original description of the process?
    - **Concept:** As a result of modifications made based on question 3.2, but also due to incomplete representation in component 2, gaps might by identified in the business process. These gaps need to be addressed by agreeing on and adding further activities, exchanges or even new roles. Fundamental changes might trigger the need to go back to component 2 and explicitly address the newly identified part of the business process.
    - **Notation:** Refinement is implemented via a web-based dialogue-form, which enables the description of extensions of the existing model by adding further steps, communication acts or even new communication partners.

### *Co-Operation Form*

For refinement during virtual enactment, an instance of the process is started. As stated earlier, this model initially only reflects one single variant of the process, omitting more sophisticated control flow constructs such as decisions or loops. It also does not contain the content and format of the exchanged information or resources. The aim of refinement through virtual enactment is to create a semantically correct and complete representation of the business process in all its variations as perceived by the involved actors. During the process of virtual enactment, the modeling participants enact the process step by step. For each step the responsible modeling participant assess the questions described above.

If any of these assessments lead to the need for changes in the process, these changes are made directly during execution. It should be stressed at this point that participants during the virtual enactment do not perform modeling. The BPMS rather presents web-based dialogue forms to the participants, allowing them to describe the deviations from the currently enacted process. Potential changes include adding, altering or removing activities of a process participant, shifting activities between participants, adding or removing messages required from or provided to another participant, etc. The forms support the description of the new or altered process steps by providing the current process context (i.e. what was done, before the deviation was started), as well as information about potential interaction partners.

### *Transition from Component 2*

Component 2 has been designed to lead to models that are transformable to models created with role-aware, communication-oriented business process modeling languages such as BPMN (White & Miers, 2008). If the source models adhere to the described syntax, syntactically correct models adhering to the BPMN-*notation* can be derived:

- WHO–elements representing actors, roles, or organizational entities (exact semantics depending on the level of abstraction individually chosen according to natural modeling principle 3) map to “pools” in BPMN.
- WHAT–elements representing activities map to “tasks” in BPMN.
- EXCHANGE-elements describing exchange of information or artifacts among WHO-elements (exact semantics depending on designator for element according to natural modeling principle 3) map to “message flow” in BPMN.

The relationships between the BPMN-elements can be derived from the spatial arrangement of the models resulting from component 2:

- Each WHAT-element is assigned to a WHO-element by placing it on an imaginative straight line originating from the WHO-element (this corresponds to assignment of “tasks” to “pools”).
- Causality between WHAT-elements is expressed by their order on the line starting with the one that is placed nearest to the WHO-element (this corresponds to “sequence flow,” “start event,” “end event”).
- EXCHANGE-elements are placed between the lines of the communicating WHO-elements and are causally related in the stream of WHAT-elements by spatial arrangement, explicitly adding connecting arrows from the activity in which or after which the exchange is triggered to the activity that receives or is triggered by the exchange (this corresponds to “message flow”).

As shown above, the proposed language can be mapped to BPMN enabling therefore virtual enactment through a BPMS.

Components 1 and 2 from a representational aspect are implemented using physical cards. In order to enable execution of the models in component 3, the card-based models need to be converted into digital model representations. To this end, the card-based model initially is captured as a pixel-based image via taking a picture, for example using a mobile phone. The modeling cards bear visual markers that can be recognized and uniquely identified in the picture. The optical marker recognition engine used for this purpose is based upon the ReacTIVision system (Kaltenbrunner & Bencina, 2007). Based upon the coordinates of each marker, the cards contained in the image can be identified and extracted. The extracted information is also used for identification of potential connections that are drawn between cards. The model layout is subsequently analyzed in the next step regarding its adherence to the CoMPArE/WP notation. If modeling rules are violated, missing, or ambiguous, then the information needed for the transformation can be added interactively. IT-based guidance through the interactive parts of the transformation process is currently implemented prototypically and described in (Oppl, 2015). Once the transformation process is finished, the resulting model can be used for refinement through virtual enactment.

## CONCEPT VALIDATION

As already mentioned, the design of the CoMPArE/WP method is based on conceptual considerations derived from the aims of natural modeling (Zarwin et al., 2014). Its components are informed by procedures and concepts identified to be supportive in reaching those aims in existing research. The novelty of CoMPArE/WP lies in the combination of those procedures and concepts in order to reach the aims of natural modeling while providing a well-defined bridge towards techno-centric modeling. The goal of validation in this article therefore is to show that the method facilitates natural modeling and at the same time enables participants to produce a techno-centric model of the business process. Consequently, the validation questions can be derived from the design goals as formulated in the introduction: Q1) Are the modeling participants able to semantically interpret the used notation(s) intuitively in the way specified by the method?; Q2) How do the created models facilitate knowledge sharing and promote negotiation?; Q3) To which extent does the approach enable the modeling language to emerge dynamically based on the situation at hand?; and Q4) Do the final modeling results provide the syntactic and semantic quality of techno-centric models and allow for further processing in IT-systems?

These questions imply the existence of an organizational context in which actors can develop different views on a business process, calling for case study research. We thus present in the following an illustrative case study that demonstrates the implementation of the CoMPArE/WP approach in a real-worlds setting. Methodologically, the validation requires to qualitatively document and analyze both, process and result of modeling in the different method components with respect to the formulated questions. Consequently, the modeling process of the case study was videotaped and analyzed with respect to the validation questions asynchronously. The modeling results of component 1 and 2 were photographed and transcribed to digital versions for easier assessment. The results of component 3 were exported from the used BPMS. The documented results and observations made in the case are used to discuss how the requirements of natural modeling are met while maintaining the bridge towards a technically interpretable business process model.

## Illustrative Case Study: The Project Set-up Process

The case presented in the following is situated in an organization that undertakes software development projects. At the beginning of every project, the project set-up process is conducted aiming at agreeing upon the project's scope, the relevant stakeholders, the timeframe, etc. The project teams always consist of a set of developers, who are led by a team leader. Ongoing communication with the client is ensured by a dedicated contact person (who, might also be a developer). In addition, there are mentors who formally do not belong to the team, but are experienced project managers supporting the project teams and acting as backups, if interventions become necessary.

The aim of the CoMPArE/WP workshop was to investigate the effectiveness of the CoMPArE/WP approach regarding a) the active involvement of process participants in business process design and b) the transition to a comprehensive process model. Representatives of the following roles took part in the workshop: a team leader, a mentor, the contact person, and a client. In addition, a facilitator was involved to guide the process methodologically. One observer was present to document the results and the process of the workshop for later evaluation. The workshop was carried out in two parts. The first 3-hour block was dedicated to the first two components of CoMPArE/WP. Based on the outcomes of this first part, a model was built using the CoMPArE/WP language (based on the *who*, *what*, *exchange* constructs). This was used for virtual enactment in the second part of the workshop, which lasted 2 hours.

### *Component 1: Setting the Stage*

The four modeling participants implemented the first component of CoMPArE/WP by creating a model that described the relevant concepts in the context of clarifying the scope of a new project. They followed the procedure described above, i.e., individually collected concepts each of them considered important and subsequently consolidated them in a shared model.

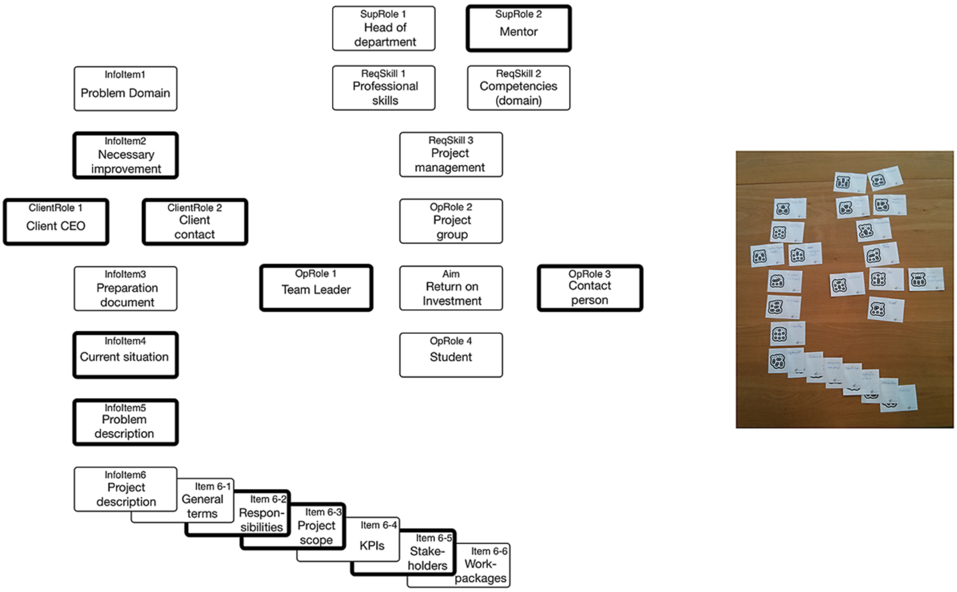
The identified concepts were complementary, as the modeling participants focused on different aspects of the business process. Consolidation consequently required effort in making mutually transparent the individually selected foci and explaining their meaning. However, no discussions on the relevancy of any of the concepts arose, and all concepts were finally incorporated in the model.

Figure 4 shows a conceptualized transcript of the model. On the right, a photo of the workshop's real card setting is presented. As shown in this photo, the cards bear the visual markers for digital recognition mentioned earlier. Also, a big table constituted the sharing modeling surface and thus connecting arrows were drawn directly on the cards.

The identified concept classes largely centered around the different involved roles (operative in the project team - *OpRole* -, as well as roles that support the process within the organization -*SupRole* -, and client-side roles - *ClientRole*) and relevant information items (*InfoItem*) that were backed with sub-items in the case of the project description (visualized at the bottom of Figure 4). In addition, skills required within the project team (*ReqSkill*) as well as the aim of the process (*Aim*) were identified.

The concepts were clustered along two dimensions: the sequence of elements running from top left to the bottom right of the model indicating the fundamental procedure of clarifying the project scope with the customer. It thus can be considered to represent an "external perspective" on the project setup process. The ostensible sequence in the first cluster, however, does not describe a process, as it does not rely on activity-describing concepts, but mixes other, structurally motivated concept

**Figure 4. Result of Component 1 - “Setting the stage”**




classes. The second cluster of concepts can be considered to cover the “internal perspective” on the project setup process and has identified the necessary skills and involved operative and support roles.

The open semantics used in this component enabled both – the agreement on relevant conceptual classes (like aims, skills, roles and information items) and their clustering in terms of perspectives to be considered when thinking about the business process for project setup (internal needs vs. externally visible collaboration and artifacts). The elements marked with bold outlines were directly re-used in individual articulation and subsequently were incorporated in the consolidated model version. The remaining elements (drawn with narrow stroke outline) were not incorporated in the following steps but left as contextual information, describing the context of the process.

The outcome of the first modeling step thus clarified the scope of the business process to be reflected upon and outlined its fundamental building blocks. It furthermore validated the selection of the involved roles. Consequently, concepts specified in the first component were re-used in later modeling steps indirectly by the modeling participants, who picked them up again during individual articulation.

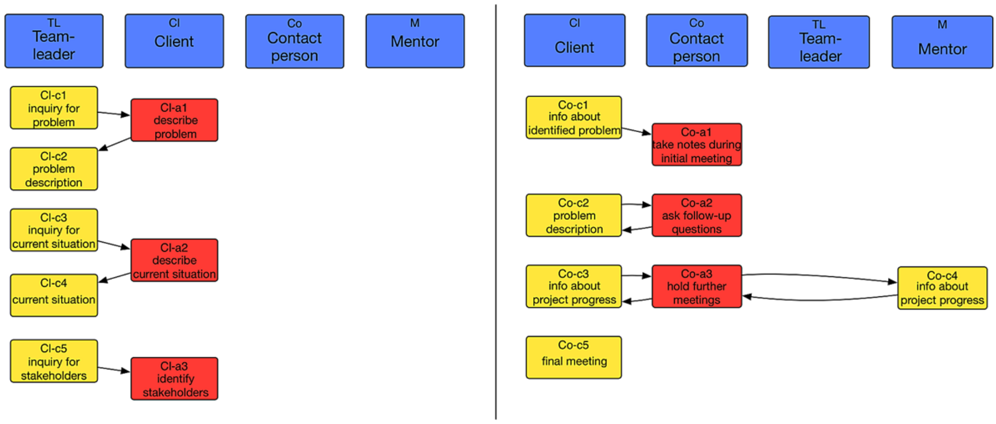
### *Component 2.1: Individual Articulation*

In the second component, the modeling participants individually described their own perceived involvement in the business process and their interaction with others. The individual modeling results are shown in the following. As the connecting arrows were drawn directly on the cards, explicit representations of sources and targets in communication acts have been added in the conceptual transcriptions for easier understandability.

Figure 5 (left) shows the model created by a modeling participant representing the client. Content-wise, one notable modeling choice here is the strong involvement of the team leader in communication, while at the same time communication with the formally responsible contact person is completely omitted.

The perceived involvement of the contact person is shown in Figure 5 (right). The modeling participant representing the contact person basically described the formally prescribed procedure of

Figure 5. Result of Component 2.1 - “Individual Articulation” for participants representing “Client” (left) and “Contact Person” (right)



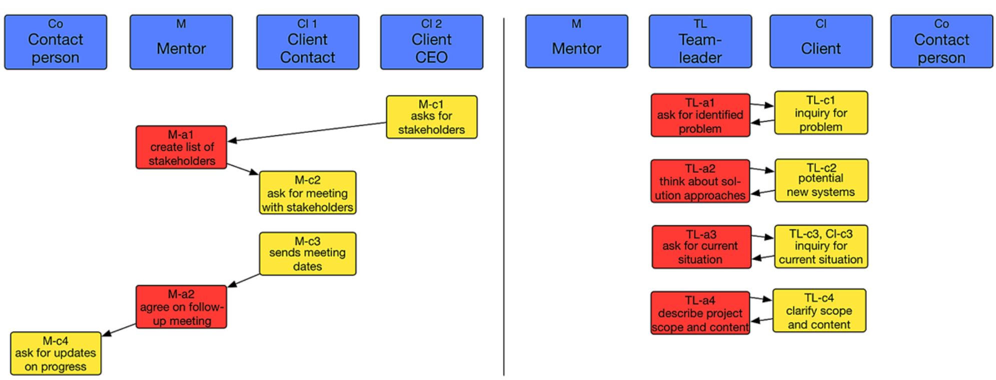

acting as the primary contact for the client and involving the mentor during project implementation, after the problem description has been settled upon.

The model incorporates a syntactic deviation from the proposed modeling language as EXCHANGE elements were used to describe mutual communication processes. The proposed syntax defines EXCHANGE elements to always have exactly one source activity and one target activity, representing a uni-directional flow. In terms of natural modeling, however, this is a valid use of the element as it takes a coarser approach to describing exchange of information, which can be refined in later steps when developing towards a model that is useable for workflow execution.

The model shown in Figure 6 (left) represents the mentor’s view on the business process. It describes an intervention in the late stage of the scope clarification, where the mentor communicates with a management representative of the client and the operative contact regarding relevant stakeholders in the client company and then agrees on a follow-up meeting during the project with the customer contact person in the project team. The mentor was the only modeling participant, who distinguished between different client roles.

The forth individual model shown in Figure 6 (right) represents the team leader’s view on the business process. It largely matches the view of the client, in which the main tasks of project setup are shared by the two of them – in contrast to the company-wide guideline, which stated that the contact person should be the sole face to the client. Structurally, the model contains bi-directional

Figure 6. Result of Component 2.1 - “Individual Articulation” for participants representing “Mentor” (left) and “Team Leader” (right)



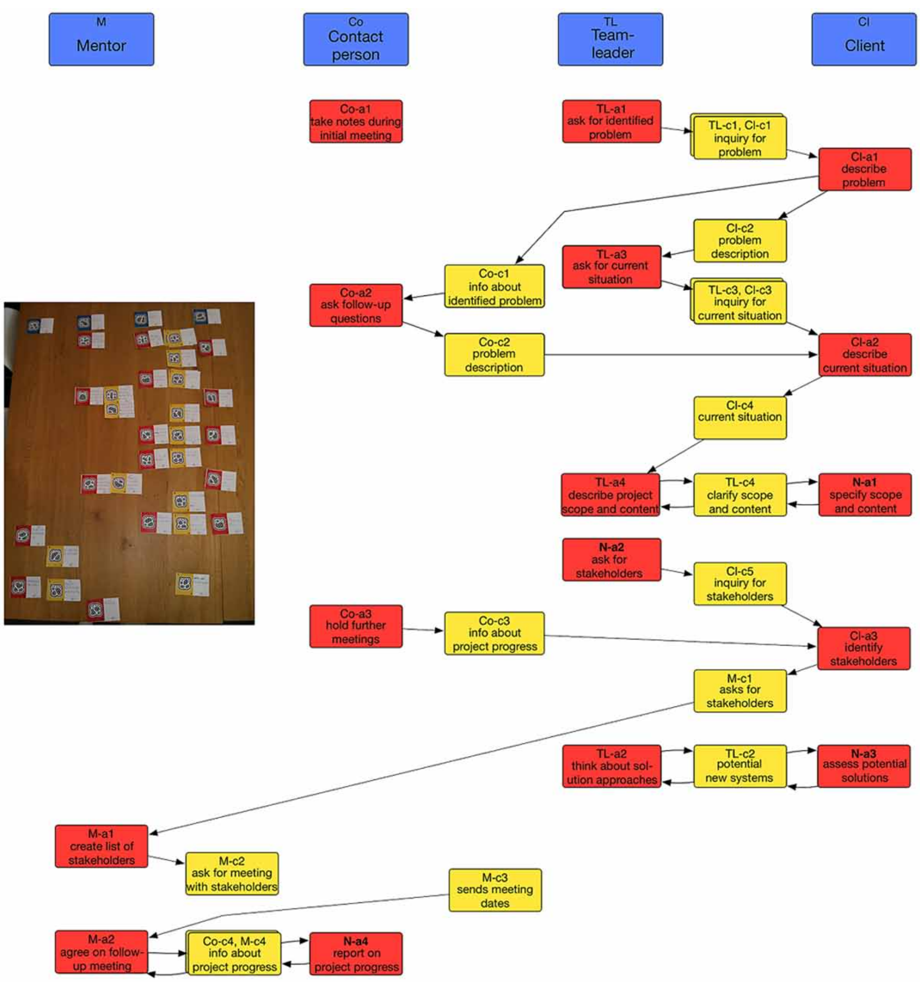
exchange attached to single activities, like in the model of the "contact person". As above, the participant was not able to describe a more detailed interaction process for his perceived tasks and thus – as proposed in principle 3 of natural modeling – dynamically adapted the modeling language to be able to represent his perceptions.

Overall, individual articulation lasted around 30 minutes and was carried out without any communication between the modeling participants. The facilitator intervened methodologically once in clarifying the meaning of EXCHANGE elements for the person representing the customer contact. The other modeling participants did not have any issues with understanding and using the modeling elements according to their description.

### *Component 2.2: Collaborative Consolidation*

Figure 7 shows the agreed upon card-based model of the business process of the collaborative consolidation. Figure 7 uses the same unique identifiers for elements as specified in the individual articulation models. The only element that has not been incorporated in the shared model was "Co-c5" (final meeting). This EXCHANGE-element was agreed during collaborative modeling to be superficial, as it was beyond the scope of the business process. Some elements have been added, mainly

**Figure 7. Result of Component 2.2 - "Collaborative Consolidation"**



to reflect the activities of the originally underestimated role of the team leader. Added elements bear labels starting with "N". In the following, we describe the changes made during consolidation and outline their rationale as given by the modeling participants (extracted from workshop recordings).

The consolidated model shows the business process from an overall perspective. In a collaborative effort (cf. natural modeling principle 2), the modeling participants reached common ground on the issue of who should be the primary contact to the customer during project setup. The modeling participants followed the argumentation of the client representative, who claimed that it was crucial to involve the team leader in the early phases of a project to create a clear and unbiased image of the client's needs. Consequently, the role of the customer contact was reduced to acting as a supporter for the team leader during the project setup phase and only taking over operative communication after the successful kick-off of the project. The modeling participants also recognized the need for phases of intense communication between the team leader and the client, which is indicated by the double-linked EXCHANGE-elements "TL-c4" and "TL-c2". Following the argumentation of the team leader, the other modeling participants also refrained from detailing the communication any further and identifying distinct acts of information exchange in those phases. The same holds true for the communication between the mentor and the customer contact at the very bottom at the model (indicated by the matched and merged EXCHANGE-elements "Co-c4"/"M-c4"). Additions to the model (all elements with Prefix "N") were added by the modeling participants representing the affected roles. In all four cases this was triggered when they were confronted with EXCHANGE expectations of communication partners they could not meet with existing WHAT-elements.

The CoMPArE/WP-methodology should lead to pair-wise matching EXCHANGE-elements, one element representing provided EXCHANGE created by the sender and one representing expected EXCHANGE created by the recipient. This matching, however, was only done three times (for EXCHANGE-elements "TL-c1"/"Cl-c1", "TL-c3"/"Cl-c3", and "Co-c4"/"M-c4"). The lack of further matches can be attributed to the role shift in interaction with the customer, which was not reflected in the individually articulated models of the customer contact person and the mentor. In addition, the EXCHANGE-elements M-c2 and M-c3, originally targeted at the client in the individually articulated model of the mentor were not matched by the client in the consolidation phase. The representative of the client was not able to describe a WHAT-element that would have been triggered by M-c2 and would have led to issue M-c3, and thus left those two EXCHANGE-elements dangling. This leads to temporary under-specification of the model, which causes issues that need to be resolved during virtual enactment.

In a final step, the results of component 1 ("Setting the stage") were reflected against the outcome of collaborative consolidation. Regarding constructs, the participants were not able to match the concepts describing skills and the aim of the process. These concepts were left aside for later consideration.

As far as content is concerned, the participants discussed the concepts representing roles and information items. They were able to confirm semantic equivalence to WHO and EXCHANGE items, respectively: "Team Leader", "Contact Person" and "Mentor" were directly matched. "Client CEO" and "Client contact" were only used as separate items in the mentor's individual articulation, whereas all other participants only worked with a single "Client" element. During reflection of collaborative consolidation, this issue was addressed again. The participants used a single client element in the consolidated version, as they agreed that distinguishing between the Client CEO and Client contact was not necessary and relevant for the depicted scenario. "InfoItem5 - Problem description" was directly reused in component 2 as "Co-c2", "Infoitem4 – Current situation" was reused as "Cl-c4". Other InfoItems were identified during reflection to be semantically equivalent: "InfoItem2 - Necessary Improvement" was matched to "Co-c1", "InfoItem6-2 – Responsibilities" and "Infoitem6-3 – Project Scope" were covered by "TL-c4", and "Infoitem6-5 – Stakeholders" were subject of modeling in the sequence stating at "N-a2" to "M-a1". The remaining concepts that were considered to be potentially relevant during component 1 have not been incorporated in the result of component 2. They were still considered relevant for understanding the business process and consequently remained as context information.

### *Component 3: Virtual Enactment*

For virtual enactment, the model was transformed to a syntactically correct BPMN model (cf. Figure 8). The source model has some semantic ambiguities that hamper direct enactment, as the BPMN model is semantically underspecified.

The affected elements are "TL-c4", "TL-c2", and "Co-c4"/"M-c4", where the exact point in time of EXCHANGE is not specified. In addition, "M-c2 and "M-c3" are not explicitly considered by the client for receiving and sending, respectively, at all. Consequently, the first group of ambiguities was transformed to mutual message flows connected to the respective activities, whereas the second group of messages was transformed to message flows that are connected to the targeted pool representing the client. All other exchange elements were mapped to message flows with corresponding throwing and catching message events.

This model was used for virtual enactment to identify necessary refinements and extensions of the process model. This was done in a second workshop, in which also a representative of the team leader role was involved. As an example for refinements through virtual enactment, Figure 9 shows the initial refinement step made in the workshop, visualizing the original version of the team leader's behavior on the left and the refined description of the behavior on right. The elements bearing a name starting with "R" have been added during refinement. The refinements in this step do not affect any other pools, thus no cascading changes were necessary.

**Figure 8. Result of transformation to BPMN**

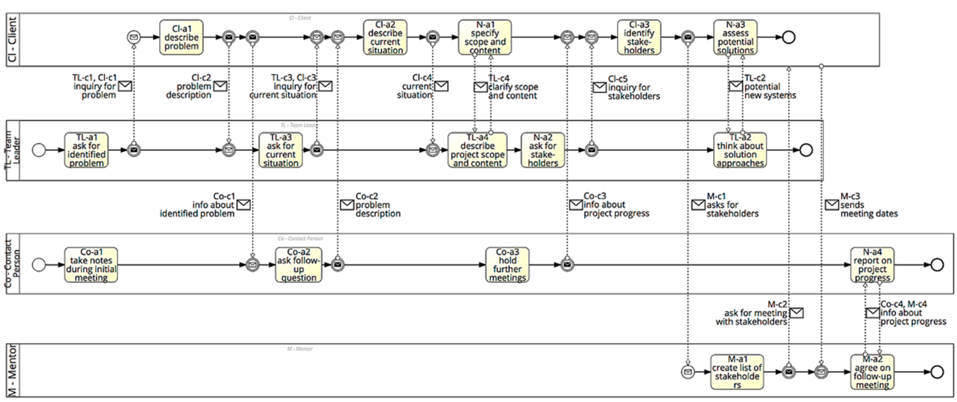
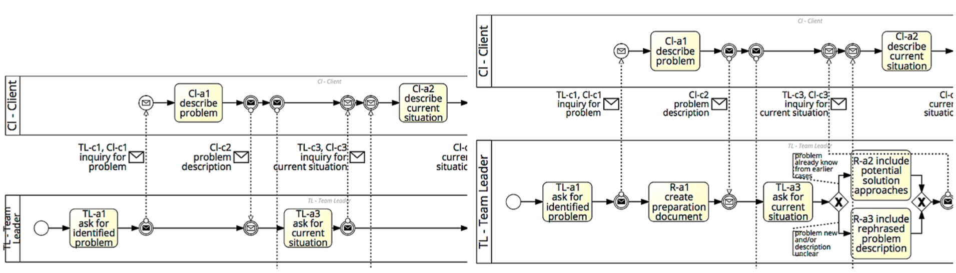



**Figure 9. Example of refinement (left: original process, right: refined process)**



In the later phases of virtual enactment, the semantic ambiguities still contained in the model were resolved. For “TL-c4”, “TL-c2”, and “Co-c4”/“M-c4”, a more detailed description of the communication procedure (to be implemented in future) was created, whereas “M-c2 and “M-c3” were removed, reducing the mentor’s role to an internal one, only interacting with the client contact person and the team leader. In making these changes, the model gradually evolved from depicting the as-is-process to depicting a to-be-process, envisioning improvements to the collaboration setup via playing through the process model. The case study was concluded after this first iteration through the modeling and virtual enactment process.

## Discussion

The following discussion of the evaluation results is structured along the validation questions formulated above. The section closes with a summary.

**Q1 – Intuitiveness of Modeling:** Ex-post feedback of the workshop’s modeling participants revealed that they enjoyed their engagement in process modeling. They felt that they had generated added value for their understanding of the business process itself and how it is embedded in the process landscape of the organization. In the case study, the incremental rise in the modeling language complexity throughout the phases in particular helped the inexperienced modelers become familiar with reading and understanding models, and using them as a form of expression for their own viewpoint, facilitating in this respect the externalization of tacit knowledge. Tangibility of the modeling elements (i.e. their physical presence in the form of cards and the chance to directly manipulate them) seemed to have positive impact on the “intuitiveness” of the modeling process itself. One participant in the case study, agreed by the others, stated that “not having to master a computer tool before being able to contribute” provided added value over more traditional computer-screen-based means of modeling support.

**Q2 – Facilitation of Knowledge Sharing and Negotiation:** The process of modeling and refining the model through virtual enactment is inherently cooperative in all its components, which have been successfully implemented to this respect in the case. Alignment of concepts and constructs in particular has been facilitated in the second component, which by design focuses on uncovering ambiguities and different perceptions and facilitates the development of a shared understanding. The fundamental content-wise revisions of the business process during collaborative consolidation in contrast to the individually created model parts is an indicator that knowledge was not only successfully shared among the modeling participants but also has been actively co-constructed via negotiation processes. This observation is confirmed by results of further studies of a variant of this component reported on in (Oppl, 2016).

**Q3 – Emergence of Modeling Language Semantics:** During concept mapping applied in component 1, the used language constructs emerged fully dynamically during modeling. In component 2, the set of language constructs was more restricted, but still left room to adapt to the situation at hand due to their abstract nature. The modeling elements used in component 2 (WHO, WHAT, EXCHANGE) were intuitively used correctly (i.e., according to their prescribed semantics). A drawback of the reduced set of modeling elements, however, became apparent during collaborative consolidation. The lack of a structured approach to specify the content of EXCHANGE elements led to “vague” definitions (Herrmann, 2000) that neither reflected nor facilitated the achievement of agreement on the transferred information or artifacts. This, however, could be compensated for during virtual enactment, when the resulting “vague” message flows were refined with scaffolds provided by the facilitator. As it can be seen in the case description, nearly half of the concepts identified in component 1 were reused in component 2 as a foundation for individual articulation and for collaboratively reflecting on the outcome of consolidation. The benefit of open semantics as used in component 1 is that it makes visible how to reconcile fundamentally diverging viewpoints on the scope of the process and the vocabulary used to describe it. Both issues were hardly present in the case study, so that the added value of component 1 was to confirm the already shared understanding of what the project setup process was about and to produce an artifact that later could be used for reflection of the process modeling results.

**Q4 – Evolution of Techno-Centric Models:** The model resulting from component 2 semantically depicted a single scenario of the complete process and was syntactically compatible to BPMN. The transformation process led to a model that already met the aim of producing a syntactically correct business process model. This model was then used for semantic refinement through virtual enactment in component 3. Only at this point, a semantically fully refined modeling language (BPMN) was used for representing the process. During virtual enactment, the participants, however, were not directly confronted with the BPMN model representation, but performed refinement by describing their additional or altered process steps in the BPMS. The process of refinement, however, was perceived to be cumbersome due to the lack of appropriate tool support in the prototype. Participants had difficulties to appropriately describe their additional process steps appropriately, in particular when additional message exchange was required. Picking up sent messages on the receiving side was confusing for the participants, as the user interface did not appropriately guide them to resolve such temporary process inconsistencies. These situations were resolved by the facilitator but require further research and development.

**Summary:** According to our overall experience acquired through the case study, the method has succeeded in implementing the principles of natural modeling and has achieved to actively involve process participants in modeling leading at the same time to the production of a BPMN-model, which can act as the basis for further techno-centric processing. The case study, however, also illustrated challenges in the design process, in particular at the gateways between the methodological components. The role of a facilitator still appears to be of high importance for guiding through the articulation and consolidation process. The major challenge here seems to be prompting participants in a way that facilitates description of their work so that the semantics of BPMN elements the model is transformed to later on is accommodated. This has not been fully successful in the described case, which caused higher effort during transformation to BPMN. Facilitator's guidance appears also to be required for applying correctly the modeling guidelines. It is notable that participants failed to correctly refine the labels of the EXCHANGE elements, after their transformation to BPMN message flows for use in component 3. In component 2, they partially used verbs instead of nouns that are normally used to indicate exchanged messages in BPMN and were not aware of the need to change this until an intervention of the facilitator.

## RELATED WORK

CoMPArE/WP is based on the idea of participatory design. This is also the foundation of the work of Türetken & Demirörs (2011), who propose a decentralized process elicitation approach ("Plural") in which individuals describe their own work. Plural is based on a multi-perspective modeling paradigm (Mullery, 1979), which focuses on representation of individual work contributions in models and subsequently merges them into a common model by agreeing on the interfaces among the individual models. It uses eEPC (Nüttgens & Rump, 2002) as a modeling language and assumes that actors are familiar with this (techno-centric) language. Plural uses tool support built upon a commercial modeling environment, which identifies inconsistencies between individual models. The authors mention tool support for resolution of inconsistencies between models but do not elaborate further on how scaffolding for inexperienced modelers could be implemented.

Multi-perspective modeling is also proposed by Front et al. (2015) in their ISEA approach to involve process participants in business process elicitation. Perspectives here are with respect to different constructs used to describe organizational reality (which is different to PLURAL and CoMPArE/WP, where multiple users conceptually describe their perspective on organizational reality using the same constructs). Similar to CoMPArE/WP It emphasizes the needs of process participants for a "simplified domain-specific language", which, at the same time is kept executable to allow for interactive validation through roleplays. While the intended outcome of the method is similar to that of CoMPArE/WP, the methodological focus of the two methods is different. ISEA focusses on eliciting business process models by reviewing them from different semantic perspectives, while CoMPArE/WP focuses on methodologically supporting the identification and resolution of different viewpoints in terms of construct semantics and collaboration when implementing a business process.

Herrmann et al. (2000) have also adopted the idea of participatory design for process elicitation proposing a methodology ("Socio-technical walkthrough" – STWT) that allows the creation of semi-structured and incomplete models. Workshops following the STWT methodology (Herrmann et al., 2007) target domain experts who do not necessarily need to have modeling experience. The STWT uses SeeMe (Herrmann et al., 2000) as a modeling language, which comprises three core-modeling elements with context sensitive semantics and is designed to represent models of socio-technical systems. It represents vague information, which explicitly captures disputed or unclear parts of a business process and thus is very close to the principles of natural modeling. No explicit scaffolds for model creation or alignment, however, are embedded in the methodology or the modeling language. The resulting models are intended for use in information system design but are not executable in BPMS. A similar approach is proposed in CPI modeling (Barjis, 2011). Modeling is performed in a workshop setting similar to the STWT and focuses on validation of the process during modeling by revisiting the model concepts in moderated discourse. The approach claims to use an intuitive modeling language, which appears to be a simplified version of activity diagrams, to let process participants collaboratively create a "trustworthy and complete" model of an enterprise. Again, the focus is on process elicitation and no bridge towards execution of the created models is discussed. In an attempt to make BPMN (as a techno-centric language) more accessible for participatory design by process participants, T-BPM (Luebbe & Weske, 2011) use tangible modeling elements in a collaborative workshop setting. The modeling methodology focuses on articulation using BPMN notation elements, which, the authors claim, are intuitively understandable by participants after a brief introduction using examples. The result of modeling can be manually transcribed to a digital representation for further processing.

CoMPArE/WP in its final component provides tool support for guiding collaborative model creation among participants. This approach is also promoted by COMA (Rittgen, 2009) and CEPE (Santoro et al., 2000). COMA focuses on providing support for articulating and consolidating models during collaborative modeling with a language-agnostic negotiation approach. The COMA tool provides support for UML (Unified Modeling Language) and enables actors to communicate via the software in a structured way specified by the COMA methodology. It provides scaffolds for model consolidation (i.e., the negotiation process), but presupposes that the involved participants are technology-proficient. As a result, participants, who have an important input to a process but do not feel comfortable with such software tools might express unwillingness to be involved in a software-based collaborative elicitation-modeling procedure. CEPE also supports collaboration during modeling with a particular focus on BPM. The modeling language proposed uses a limited set of elements to describe tasks, responsibilities, and decisions in a process. Further technical processing of the resulting models, however, is not addressed. The associated tool provides awareness features that support collaborative modeling. Aside of these features, no dedicated methodological or conceptual support for collaboration of process participants is provided. In more recent research, Santoro et al. (2010) propose to use storytelling techniques in the early phases of process elicitation and further develop these stories to BPMN models of the described process. They describe a method to support the abstraction process necessary to derive models from stories and to finally create formal representations in BPMN. As such, it takes a complementary approach to CoMPArE/WP, where the need for explicitly creating formal representations is avoided by refinement via virtual enactment.

Table 1 summarizes the characteristics of the described approaches with respect to the validation questions specified above. As can be seen, CoMPArE/WP is not the first approach to tackle collaborative modeling by process participants for eliciting business process knowledge. Existing approaches supporting collaborative articulation and modeling, however, either target inexperienced modelers or aim at producing a model that can be directly executed. This is a reasonable approach given the conflicting requirements in those areas (Zarwin et al., 2014). From a BPM perspective, however, it remains desirable to satisfy requirements in both areas with a single methodological approach. The present work goes beyond the state-of-the-art by proposing a methodology that involves transitioning from natural modeling toward refinement of technically interpretable models. To enable this transition, the representation used for articulation and alignment support is syntactically and semantically compatible with techno-centric modeling languages like BPMN.

## CONCLUSION

The approach presented in this article aims at actively involving participants in business process modeling to enable real integration between elicitation and modeling steps of the BPM lifecycle. Active involvement of process participants creates several challenges, as the latter are not expected to have modeling skills, and thus require facilitation for elicitation and formulation of the models in a way that allows for technical processing of the results. The CoMPArE/WP approach meets successfully this goal by operationalizing the principles of natural modeling while at the same time providing a transition to a representation of a business process that can be enacted by a BPMS. As also revealed by the case study, the gateways between the methodological components constitute the major challenge in the application of the approach. CoMPArE/WP has tackled this issue by introducing a simple intuitive modeling language (consisting of the fundamental process concepts *who*, *what* and *exchange*) that bridges the gap between the human-oriented card-based model of the first components, which uses open semantics and the techno-centric process model created in the last component. The approach enables participants to gradually develop structured business process models and does not confront them with the complexity of fully elaborated process models. While the transparency of the complexity of the developed model has been a design goal, it can be at the same time considered the most fundamental disadvantage of the approach, as it prevents to develop an in-depth understanding of the resulting process model by the modeling participants. Furthermore, the elicitation strategy of the methodology is focused on the individual perceptions of the business process contributed by the participants and does not consider potentially divergent process views of other stakeholders, which are not directly involved in the modeling process.

The present work has several methodological limitations. First, the validation is limited to a single case, and consequently is restricted in scope, application domain and complexity. Still, the feasibility of the proposed method is demonstrated and the identified shortcomings hint at areas of further improvement. Second, the method component "refinement via virtual enactment" has not yet been examined in full consequence. The case did not provide the opportunity to assess the viability of the approach in case of fundamental changes such as the introduction of an additional actor. While the

**Table 1. Review of Related Work**

| | Q1 - Intuitiveness of modeling | Q2 - Facilitation of knowledge sharing and negotiation | Q3 - Emergence of modeling language semantics | Q4 - Evolution of techno-centric models |
|---|---|---|---|---|
| Plural | | multi-perspective modeling | | uses processable eEPCs |
| ISEA | via simple domain-specific languages | multi-perspective modeling | | |
| STWT | via simple notation and vagueness | collaborative workshop | through combination of elements and vagueness | |
| CPI | via simple notation | collaborative workshop | | |
| T-BPM | via tangible elements | collaborative workshop | | uses processable BPMN |
| COMA | | tool support for negotiation | | uses processable UML |
| CEPE | | tool support for awareness | | |
| Storytelling for BPM | | collaborative workshop | non-restricted semantics during storytelling | |

conceptual and technical means to implement such changes are available, their usability in terms of the methodology remains to be examined. Third, results from research conducted in parallel with the present work in the field of multi-perspective end-user modeling (e.g., (Front et al., 2015; Simões et al., 2016)) could provide relevant input for further improving the method with respect to supporting natural modeling. These results, however, have not yet been incorporated in the work reported on in the present article.

Our future work consequently will mainly focus on the methodological and technical implications of a (semi-)automatic transition from natural modeling settings to processing-oriented business process modeling. This requires further empirical evidence in particular on the participants' expectations and requirements at the gateways between the different methodological components. Evaluation setups that go beyond participatory observation are necessary to enable a structured review of the transformation steps of the models between the different components and how they affect the resulting business process models. The findings from these evaluations will further refine both the methodology and the supporting tools. Future iterations will focus on improving technical support for refinement through virtual enactment (e.g., providing interactive scaffolds for modifications of the model) and for the model transformation process (e.g., merging of multiple models produced during iterative consolidation).

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