Designing a tangible approach to business process modeling

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Abstract. Business process models are graphical representations of work procedures in organizations. In current practice, process modeling is a special skillset. External consultants interview process stakeholders and subsequently frame their understanding as process models. We designed an approach that empowers the stakeholders to actively participate in process modeling.

This paper starts by deriving principles for process elicitation with stakeholders. Afterwards, our approach, called t.BPM, is described. We report in detail on three case studies and their results. Inspired by these cases, we propose research questions and methods to further scientifically develop this approach. The development of t.BPM is ongoing but the design principles from this paper may be applicable in more settings.

Key words: process modeling, BPMN, process elicitation, media models, cognitive theories, t.BPM, action design research

1 Introduction: The current situation in BPM

Business process management is an approach to structure work in organizations [1]. It implies mapping, measuring and improving the working procedures. In the last decade the phrase was coined to refer to an IT approach to supporting or automating working procedures using software systems [2]. Implementing business processes in software offers great potential to save time, enhance reliability and deliver standardized output [3, 4].

Implementing a process in a heterogenous software environment requires significant software engineering effort. Like for other software projects, misunderstandings in early stages lead to expensive change requests at later stages [5]. Experience shows that the quality of communication between stakeholders is crucial to translate system requirements into software implementation [6]. Software engineering uses languages such as UML to visually model software system design and reduce misunderstanding among stakeholders, especially developers. Likewise process models help to visualize knowledge and facilitate communication amongst the stakeholders of the process.

The stakeholders are the persons involved in managing, monitoring or executing the process. For software development projects, the software engineers are addi-
tional addressees of the model. Typically, business analysts trained in process modeling extract the knowledge from the stakeholders and create a model of their understanding. The model is then passed back to the stakeholders for feedback and subsequently iterated until a consensus is reached about the shared understanding. The resulting model can be used to document, improve or automate the process. Software engineers that have to read, understand and implement the process model. It is crucial that the requirements are correctly documented before the process gets implemented. Only in recent years, business and IT departments start to adopt BPMN [7] as a common process modeling notation [8, 9] discuss opportunities and constraints for process automation.

We interviewed multiple process consultants, experts in process elicitation and modeling, about their job and the path taken from initial contact with the customer to completed process-centered projects. They all work as external BPM consultants in projects that model processes for documentation, improvement, and automation. They reported to conduct individual interviews and group workshops that employ whiteboards, flip charts and post-it notes to capture the process knowledge. The quality of the extracted information relies heavily on the experience and skills of the consultant. She must listen carefully, read between the lines, and extract the knowledge relevant to the process. At the end of a day, stakeholders leave the workshop. The consultant creates a process model, an abstraction and reframing of all notes and impressions she collected during the workshop. The process model now becomes the central artifact that reflects the findings from the workshop and is used in all subsequent discussions. Stakeholders review the model and attempt to provide meaningful feedback. In some cases domain experts reject process models. Because they often don’t have sufficient exposure and training to understand process modeling concepts, they are unable to read the model and conclude that their knowledge is not appropriately represented. Three to five iterations of the model follow until all stakeholders agree that the process is appropriately represented. In Figure 1 we graphically summarize the steps taken in traditional process modeling.

The insight and the starting point for our research was the poor process understanding of the stakeholders and the high number of iteration cycles typically needed to agree on a shared view. From our background in process modeling [10] we strongly believe that it is possible for stakeholders to better express their

![Figure 1](image-url)
process knowledge compared to interviews and current workshops. We think it is possible even for novices to model processes if appropriately guided. The goal is to get better information upfront which means to reveal misunderstandings and provoke direct feedback on the shared process understanding early on. The result is a haptic set for process modeling, the tangible BPM (t.BPM) toolkit. In this paper, we report the principles that guided its design, present the approach, and learnings from case studies.

The paper is structured as follows. In Section 2 we present the theories that influenced our research and derive requirements to facilitate the process mapping with novices. In Section 3 we introduce the t.BPM approach and describe how it implements those requirements. Subsequently, Section 4 discusses related approaches. Afterwards, in Section 5, we present three case studies in which we used t.BPM. Based on these new impressions we outline research questions in Section 6 and discuss appropriate scientific methods for investigation. We conclude in Section 7.

2 Theories from Cognitive Science and Design Research

The development of t.BPM was influenced by scientific literature from Cognitive Science and from Design Research. Both areas established theories that guided us when designing our solution. In the following two sections, we describe briefly the prior knowledge relevant to our work. In Section 2.3 we condense this knowledge into principles for process elicitation with novices.

2.1 Cognitive Theories

Research in Cognitive Science investigates the nature of the human mind. It seeks to understand perceiving, thinking, learning, understanding, and other mental phenomena [11]. The goal of this research is to find and describe effects that are consistent in human information processes. The resulting body of knowledge is the groundwork upon which researchers in psychology, linguistics, computer science, philosophy, and neuroscience build.

The cognitive load theory refers to the limitation of the human brains as information processors [12]. In 1956, Miller was one of the first to describe the limitations of the human brain for its ability to process single-dimensional information [13]. He demonstrated that the average person can hold on to “seven, plus or minus two” single dimensional stimuli at a time. Miller also showed that the ability to remember and discriminate information can be expanded by adding dimensional stimuli. Multidimensional stimuli enable humans to hold on to much more information. Dimensions for stimuli can be color, sound, material or space.

Building on this, Sweller and Chandler proposed a cognitive load theory that describes the mental effort of learners [14]. The capacity of the brain available to process new information is described as the working memory which is consumed
by three factors. Namely, (1) intrinsic load, the complexity of the learning topic itself, (2) extrinsic load, e.g. the manner of representation and distracting facts, and (3) the germane load, influenced by the didactic of the learning process. When learning, the working memory is consumed by these factors. Reducing the effort of the learner, e.g. by the reducing extraneous cognitive load, frees working memory available for the other two aspects [15].

The cognitive fit theory postulates that the representation of a problem determines the thinking model applied [16]. In other words, what we see determines, how we think about it. They showed that representation impacts the problem solving performance depending on the task type. This theory has been transported to various areas and e.g. shown to be true in software engineering [17]. In particular, Agarwal et. al measured task performance when process-oriented vs. object-oriented methodologies were applied to process-oriented vs. object-oriented problems. Like others, they found significantly superior task performance when problem and method match, i.e. they emphasize the same information.

The dimensions of notations were introduced by Blackwell and Green et al. [18, 19] as a framework to describe aspects of visual representations. Originally meant as an approach to understanding programming notation systems, it was extended to examine other notation systems as well including music notation and physical prototypes [19]. From the fourteen cognitive dimensions in the framework, three are most noteworthy for us: viscosity, premature commitment, and provisionality.

Viscosity is the “resistance to change”. A highly viscous system requires many actions to change a consistent state of the system into a new consistent state. “Environments containing suitable abstractions can reduce viscosity” (cf. [19]). Premature commitment refers to the constraints imposed on the order in which things can be done. As an example, choosing cutlery before choosing food. Finally, provisionality is the degree of commitment to a state or action. Provisional action can allow sketching ideas or playing “what-if” games.

2.2 Design Research

Design Research is the scientific investigation of the design process through cognitive, qualitative or ethnographic methods [20]. Theories built from this research attempt to explain the design process, the roles involved and the objects used. We focus on the latter ones.

Media describes the external embodiment of information, e.g. in language, software or hardware. The embodiment determines the affordances. By affordance we refer to the work of the perceptual psychologist J.J. Gibson, who coined the term as a way of discussing perceptual cues of an environment or object that indicate possibilities for action [21, 22]. Blanco found that externalized representations serve as intermediary objects [23, 24], which afford distributed cognition, act and are acted upon. Shared models may be considered as enlistment devices, either allowing or baring access to collaborative participation. Media that allows collaboration is open and media which restrict collaboration is closed.
Media Models Framework is built on top of these theories by Edelman [25]. The main idea is that media steers the conversation in design. A conversation is communication between multiple people involved in the design process. A media model is an artifact that represents the design. His theory proposes that the media influences the communication between people. He identifies the dimensions resolution and abstraction to impact the conversation. Abstraction is defined as the highlighting and isolation of specific qualities and properties of an object, such as color, size or functions. Fewer represented properties indicate a greater abstraction. Resolution refers to the fidelity with which an object is defined with respect to its final form. For example if a final product is a car, a Lego model of a car would be considered low resolution. However, if the deliverable is made of Lego and the Lego model shares the same dimensions then the Lego model must be considered fully resolved.

Similar to the cognitive fit theory, resolution and abstraction impact the way designers think about the model. However, Edelman describes the framing and steering effect that the media choice has on design conversations. As an example, discussions about CAD models are different to those provoked by a plasticine model. In general, less abstract and highly resolved media models focus the discussion on parametric changes while highly abstract and less resolved media models afford paradigm changes. The interplay of both dimensions leads to the "ease of change" [25] which is the effort required to make consistent changes analogue to Blackwell’s viscosity dimension [19].

Tangibility as a quality for interaction is studied in multiple disciplines such as HCI [26] or industrial design [27]. Tangibility is typically referred to as the physical experience of information. In the words of Miller [13] it is information with multi-dimensional stimuli. In design research, tangible prototyping is used to get extensive feedback fast. It is therefore seen as a key enabler to collect feedback and iterate in early design stages [28, 29]. Similarly, Clark [30] suggests that thinking doesn’t happen only in our heads but that “certain forms of human cognizing include inextricable tangles of feedback, feed-forward and feed-around loops: loops that promiscuously criss-cross the boundaries of brain, body and world” (cf. [30] p. 129f).
2.3 Principles for process elicitation with stakeholders

Stakeholders of a process are the subject matter experts that process consultants talk to in order to elicit the information related to the work done, the data used and the responsibilities. From reviewing related theories from Cognitive Science and Design Research we derive the following principles to facilitate this elicitation:

- **Map out the information**
  People have limited information processing capacity [13]. Mapping information can help to reduce the cognitive load and extend capacity to hold on to details by adding new stimuli to the information.

- **Make it intuitive to use**
  The available working memory is consumed with different types of load [14]. Reducing distracting noise (external load) frees capacity for other concerns [15].

- **Make it a process representation**
  For each problem, there are more and less suitable representations depending on the nature of the problem [16]. The representation impacts the task performance, e.g. processes should best be discussed using a fitting representation [17].

- **Choose easily changeable media**
  Low viscosity, high provisionality, and low premature commitment all reduce the overhead associated with change [19]. From a different perspective, the media chosen implies the ease of change, characterized by the abstraction and resolution of the representation [25].

- **Make it tangible**
  A physical embodiment makes the idea accessible for others and provokes feedback [28, 29]. Physicality also stimulates different thinking styles [30].

3 t.BPM: Tangible Business Process Modeling

The t.BPM approach is the result of many iterations [31, 32] in which we prototyped ideas and continued to read literature to inform our work. Some learning cycles are documented in Section 5 but the development is ongoing. In Section 6, we outline research questions that guide further evolution of tool and application method.

*The t.BPM toolkit* is a set of four basic shapes reflecting the iconography of the Business Process Modeling Notation (BPMN) [7]. The concepts represented are work items (tasks), events, routing notes (gateways) and the information used in the process (data objects). The thick acrylic tiles can be transcribed with whiteboard markers and are laid out on a table. The responsibilities for work items and the actual flow of the process steps are marked on the table with the same whiteboard markers. Whiteboard markers can easily be removed with a wipe of the hand. Figure 2 depicts the three samples of the t.BPM toolkit at use. With markups the meaning of the four shapes can be further refined. E.g. a gateway can be used to exclusively branch the flow or trigger parallel execution paths.
The *t.BPM method* describes the application of the toolkit. At its heart all participants gather around the table and map out their knowledge using the t.BPM toolkit. The method expert acts as a facilitator. At first, the minimum amount of concepts is introduced to the participants. Namely, the concepts of tasks (work items) and the start and the end event as the scope of the process. If more concepts are needed they are introduced by the facilitator during the modeling session. The goal is to create an initial overview fast and iteratively refine the model. When more detailed information is required, e.g. about the information flowing in the process, the required concept, e.g. the data object, is introduced and the model is iterated. At each stage, the participants must understand the model, because they have to create and refine it. The facilitator ensures that concepts are not misused and helps the participants to frame their knowledge into a process model. It can be helpful to exercise with a sample process first before creating the actual process model.

*Revisiting the principles* suggested in Section 2.3, we can state that,

- t.BPM maps out information.
  The knowledge is instantly brought to the table, reducing the amount of information to be kept in the working memory of the brain.
- t.BPM is intuitive to use
  Pointing at issues, creating, rearranging or removing knowledge can be done without any education beyond kindergarten.
- t.BPM is a process representation
  The BPMN standard, a professional process modeling language, inspired t.BPM iconography and is used from the start.
- t.BPM is easily changeable
  The t.BPM model does not impose complex change actions. Thus, changes are made easy by the tool.
- t.BPM is tangible
  The physicality affords a different layer of accessibility to the concepts of process modeling. Different types of thinking and feedback are provoked.
4 Related Modeling Approaches

Process modeling practice in the field has developed ideas similar to t.BPM. Model building in conjunction with end users typically happens in moderated groups \[33, 34, 35\] in which a modeling expert translates the input into a model that is discussed with the audience. This can be done by using a dedicated software tool operator who translates the input from the audience into a process model which is simultaneously projected to a wall \[35\]. It is suggested to use two distinct persons to model and run the workshop because the software tool imposes a high cognitive load.

A popular low-tech version for workshops is brown paper modeling \[4, 36, 37\]. The process is taped to the wall using post-its or differently shaped paper. There is no commonly agreed operationalization of this idea. Joint creation of models might be hampered by the moderator standing at the wall while the participants are sitting. Typically, the moderator then asks questions, filters and frames the answers. Participants may become passive. Depending on the operationalization, the representation on at the wall may not frame the problem as a process model.

Unfortunately, process elicitation techniques practiced in the field are barely published as they are intellectual property of the consulting company that runs it. One exception is Unity\(^1\). The company uses the proprietary OMEGA process modeling method \[38, 39\] embedded in a “strategic production management” approach. Their best practice suggests to use paper cards that reflect the iconography of the modeling elements in workshops and interviews. Cards are available in different sizes and the use is said to be depending on the consultants “gusto” and “experience” \[40\]. This method is said to have in general a “stimulating effect” on the participants, however a more comprehensible investigation is not available.

In summary, some techniques point into similar directions, such as instant mapping or enhanced user involvement. To our best knowledge, there is no tangible approach to enable process modeling done by stakeholders as we propose it. Details about workshop facilitation are barely published. Finally, nobody has scientifically investigated the effect that such a mapping approach has on the information elicitation process.

5 Case Studies with t.BPM

During the development of t.BPM we continuously assessed and refined our ideas by prototyping elicitation situations. In total, we have conducted more than thirty interviews using t.BPM, structured interviews and other techniques to learn about differences and develop methods for guidance. Most case studies were captured on video for analysis and reflection. In this section, we report on three case studies. They are representative for different stages of the t.BPM

\(^{1}\) http://www.unity.de/
development, show the discovery of unintended effects, and raise further research questions to be investigated.

The first study was done by the authors with university assistants. It illustrates the variety of output created by using different media for elicitation. The second study was done by students with students. It illustrates the influence of the t.BPM toolkit on individuals. The third study was done by a professional consultant with hospital doctors in a clinical process modeling project. It illustrates a possible application method for the toolkit in the field.

5.1 University Assistants with t.BPM, Post-its, and classic Interviews

We asked six administrative assistants at Stanford University and Potsdam University to report on their processes such as making travel arrangements for the professors that they work for. The goal was to investigate how t.BPM can be introduced to interviews and how it is different to other interview situations. Three types of interviews were conducted with the six interviewees. We used (1) conventional structured interviews to elicit the process knowledge in five situations, we used (2) t.BPM in five situations and we used (3) post-its to conduct two more interviews. Thus, we did twelve interviews with six interviewees in total. Some of the interviewees were interviewed using only one technique, while other interviews employed all three techniques. No particular criteria were applied in pairing subjects with techniques or selecting the order in which they were exposed to one or the other technique.

For each interview, interviewers followed the same protocol. Interviews started with questions to get an overview of the process. Afterwards, interviewees were asked to elaborate on each step of the process and subsequently asked what they like or dislike about the current process. Finally, each interview was concluded by asking the interviewees whether there is anything else that they would like to share about the process.

We found that in structured (conventional) interviews, the interviewees started by telling a compact narrative, i.e. a quick run through the process. Subjects with more experience spoke more quickly and more structured about the process with more generalization. When asked to dive deeper into the process steps subjects often referred to individual cases. For conventional interviews, subjects were not provided with any memory aid. In one instance the interviewee used her fingers to count and hold on to the abstract steps to be done.

Responses to the question concerning likes and dislikes about the elicited process varied. However, when asked the final question, whether there is anything else they would like to share, none of the interviewees added information. “No, just as I said”, was a common answer to the last question. The average conventional interview took about ten minutes.

We conducted two interviews with post-its, to investigate the effect of this commonly used mapping tool. We encouraged the interviewee to use the post-its as they saw fit. The result was a stream of post-its marking points in the narrative that the interviewee told. We observed that mapping process knowledge to post-its
was quite fast because every thought was seemingly mapped without reflection. In the two interviews conducted with post-its the resulting stream included events, activities, hand-overs, artifacts and notes. When asked to elaborate about the details the interviewees reproduced the narrative adding very little new information to the initially mapped story.

When asked the final question, "Is there anything else you would like to share?" both subjects read the narrative from the post-its again but added no further information. Both interviewees reported that they found it quite helpful to use post-its as a memory aid. One reported that any piece of paper would have done the same. In any case, the result of such an interview was not framed as a process. The interviews took twelve and fifteen minutes.

Fig. 3. One subject in three different interview situations: In plain interviews only hands were available to hold on to information (left); Post-its in interviews provided a mapping tool for the narrative told (middle); t.BPM (right) provided a tool to frame the implicit knowledge as a process model.

We found mapping knowledge to be very different in interviews where the t.BPM toolkit was used. As described in Section 3 the toolkit embodies concepts from process modeling and helps to structure the participants thoughts. During interviews, proper use of the t.BPM toolkit was enforced by the interviewer.

From previous prototypes we knew that subjects intuitively accepted a logical order if steps were laid out from left to right. Thus, the interviewer only introduced start and end event of the process and explained the concept of tasks as work items. Swimlanes for task responsibilities were introduced where appropriate. While we chose not to explicitly introduce concepts of control flow, in four of five t.BPM sessions, interviewees captured alternatives and parallelism by putting activities one over another. Only in one situation, both concepts occurred together and the interviewer introduced gateways (exclusive and parallel routing constructs). In general, we found that very few concepts already added a lot of clarity to the discussion.

At a blank table, interviewees were unsure about what is expected and how to start. We found that elicitation works best when the interviewer listens to a high-level process summary and then models the first two tasks of the process. This example was then used to explain the concepts behind the objects and
their arrangement. That sample also set the level of granularity and labeling conventions for activities. Subsequently, subjects accepted the tool as the thinking model and started using it themselves.

The initial process creation with t.BPM was relatively slow because subjects had to find appropriate activity names and write them down on the t.BPM elements. Once the process was modeled, it functioned as a map through which interviewees navigated confidently. We observed subjects jumping around the process narrative in contrast to the linear narratives that were told in other interview types. Subjects themselves decided to add details, rearrange objects or create additional ones. Pointing at activity elements made it easy for the interviewer to follow subjects’ explanations.

The response to the final question, “Is there anything else you would like to share?” yielded more detailed information from participants. In three out of five cases, subjects started rearranging the process to highlight alternatives. In general, subjects in t.BPM interviews were observed to explicitly point out exceptions to the mapped standard process. On average the t.BPM interviews took twenty-eight minutes.

We learned from this case study series that introducing only very little concepts already yields big effects. From an expert point of view, the process models were not very sophisticated. However, framing into tasks, responsibilities and order-dependencies already added a lot of clarity not only for the interviewees but also the interviewer about the situation. While post-its are easier to handle, they do not frame thoughts into concepts and miss to realize this benefit. At that time, interviewees were sitting at the table.

5.2 IT students modeling PC setup using t.BPM

We invited freshmen at the start of the semester to participate in a new experiment. In compensation for participation, students were offered cinema vouchers. Ten students responded and were randomly assigned to do a conventional structured interview or a t.BPM interview. The goal was to test a possible laboratory experiment setup.

All students were given a brief introduction to BPMN as a modeling technique by means of a printed example and subsequently asked to do a pretest. All participants scored well on the pretest, indicating that they understood the fundamentals of BPMN as a modeling notation. The topic concerned setting up a windows PC for their grandparents. After the interview, a post-test on process modeling was performed similar to the pre-test. Both tests were based on a preliminary framework by Melcher et. al. [41] to test process model understanding. We intended to investigate whether a difference in learning effect could be measured between the two groups. In short, the test results did not indicate a difference in process model understanding due to t.BPM. The ability to solve such as test is more related to abstract thinking and mathematical understanding. The students did well in both tests. There was no additional learning effect in that respect by applying t.BPM.
Yet, we noted several important differences between the groups using the conventional structured interviews, and those using t.BPM. Consistent with Case Study 1 findings, the t.BPM subjects took thirty minutes on average for process modeling and the interview questions, while the group using the conventional interview took ten minutes. In a thirty minute t.BPM mediated interview session, an average of five minutes were spent without a word or an action. The subjects were observed to look at the represented process and presumably think about the process and its details. While it is uncomfortable to be quite in an interview situation, pauses from talking were acceptable in t.BPM sessions.

We used a big table to give maximum space. That made students stand up and walk. In contrast to the standard interviews, this created a more vivid atmosphere. After the initial mapping students were asked to name documents in the process, identify problems and phases. In t.BPM sessions each question triggered a refinement of the laid out process. Subjects using t.BPM constantly reviewed their model, applied changes and added information to it. In contrary, conventional interviews made students quickly answer each question and move on. As in Case Study 1, mapping information with t.BPM allowed participants to point to individual elements and to navigate through the process with confidence. In contrast, subjects in conventional interviews told inconsistent narratives. That means they raised issues that were not followed-up on or forgot to elaborate on steps mentioned earlier. This effect might be reduced if the process was more mature (more frequently done). However, it is less likely if the information is laid out on the table.

After the process mapping, including adding documents and phases, participants were asked about independent activities, which means they could be done in parallel with other activities. All five students using t.BPM related this question to optimization, and rearranged the process dramatically. On the other hand, subjects in conventional interviews typically responded by enumerating tasks with loose interdependencies to the original process.

The final question, "Is there anything else you would like to share?" resulted in similar findings as in Case Study 1. Participants using standard interview
technique had nothing to add, while those using t.BPM added new information and made adjustments to their models.

We learned from this case study series that standing and working with t.BPM made people much more active than the interview situation. That directly impacted the evolvement of the process, which was iterated more often. t.BPM allows fast rearrangements and students heavily used this to evolve the model with their story. At the same time, with t.BPM it is acceptable to be quiet and think about model. Although students had no BPM education, they told us in post-interviews that they could relate the concepts to known concepts from math and circuit diagrams. That explains the good test results to us. It also raises the question, whether people with a less formal background would perform alike with t.BPM.

5.3 Hospital doctors modeling clinical pathways with t.BPM

A German university hospital decided to use a BPM approach to map their clinical pathways. These are the processes that patients go through in hospital treatments. An experienced BPM consultant was hired for a two-week full-time workshop to model and optimize processes with medical doctors. Upon invitation by the consultant, we sent a student to bring in the t.BPM toolkit and document the use of it. The goal was to explore how t.BPM can be adopted in real projects.

On the very first day, a general introduction to Business Process Management and BPMN as a modeling language was given. On the second day, the consultant started mapping the processes with the input from two student doctors and the medical superintendent. Within the first hour, the doctors started to engage to the same extent in the discussion and the process of modeling. A rich set of process modeling concepts was used right away, including exclusive and parallel routing, responsibilities and passed information (data objects). Nevertheless, doctors who occasionally dropped in also commented, ordered and changed process steps although they had not participated in the first day introduction to BPMN. There was a strong notion of shared model ownership that allowed everybody to interact with the model and contribute to the result. Discussions led to clarifications, changes, and refinements while the model was created. As the model grew, more tables were moved together to extend the modeling space. The result of the first day with t.BPM was a detailed model depicting the two predefined core processes. Because they had much more in common than originally anticipated, they were captured in a single model at first. Divergences between the processes were captured using differently colored markers.

Overnight, the model was digitalized by the consultant and printed for discussion. This is common practice but usually involves the translation of workshop results, such as post-its and notes, to process models. Instead, the pre-modeled process was photographed and reproduced using a software tool. The next day was spent on a review of the initial process. Changes were applied to the model on the table using the t.BPM toolkit. The consultant digitalized the results immediately. The forth day was spent on exploring and mapping some
subprocesses using t.BPM. By day five, more than twenty process models depicted clinical pathways, including overview pictures, processes and subprocesses. The doctors introduced to the software tool and used it to navigate the captured process knowledge and enrich the models with more information. Discussions about process models were usually done with printouts or at the computer. One more model was developed using t.BPM. After the fifth day, the t.BPM case study ended, but the project went on for another five days to refine models and define more optimal clinical pathways.

In interviews after day five, the doctors reported that it was fun to work with the t.BPM toolkit. They indicated that the playful introduction of the modeling concepts was well suited to integrate all participants and that the use was interdisciplinary. Physicians said they preferred paper print-outs for model reviews. The modeling software was perceived as a tool to store and navigate models. t.BPM was perceived as the optimal tool to jointly develop new models.

The BPM consultant reported that t.BPM served to shorten the introduction time to BPM and BPMN. He did not anticipate that it would allow jump-starting initial process mapping as it did. He estimated an increase in productivity of thirty percent for the first three to four days. For future workshops he would like to stay at the table for all process mappings and reviews, and try to avoid “fiddling with the [software] tool” during the workshop hours. In his opinion, the most important difference between t.BPM and standard process elicitation is that t.BPM forces the participants to work out their processes themselves, instead of leaving the participants in the backseat of process modeling sessions. He would only recommend t.BPM for highly complex processes that require a lot of discussion.
We learned that t.BPM is applicable for BPM projects and group modeling sessions. It fits into the niche of joint model creation in complex environments. It has to interplay with other tools such as software and print-outs which are more suited for knowledge navigation. Playful introduction shortens the starting time with a detailed initial overview mapped within one day. The intuitive handling enables all participants to contribute, even people dropping in occasionally. This created a strong notion of shared ownership.

6 Further Research

Our case studies indicate that the theory works in practice but to evaluate the tool and a methodology with scientific confidence, more research is required. In this section, we raise two main research questions and discuss suitable research methods to answer them. While many more questions may exist, we concentrate on the two most pressing ones for us.

• What are positive effects of t.BPM on individuals when compared to interviews?
  In this paper, we indicated many positive effects that we observed when comparing t.BPM with conventional techniques, such as structured interviews. Yet, these are qualitative findings derived from observations. If it is possible to quantify those effects, we can derive hypotheses, testable statements. The observations from this paper combined with further literature studies are the starting point to derive hypotheses about the effect of t.BPM on individuals. The hypothesis can be tested by controlled experiments in which a group doing t.BPM is compared to an interview group. The measured effects can be analyzed with statistical methods to assess significance and support or falsify our hypotheses about t.BPM. Method guidance for this type of research is available from social science [42], psychology [43] but also software engineering [44].

• How can professionals facilitate groups modeling with t.BPM?
  Facilitation during the application of t.BPM is of particular importance for the success of the approach. As discussed in Section 4, related approaches do not publish how to operationalize workshops for process mapping. Ultimately, things depend on the experience of the moderator. In Case Study 3, a t.BPM workshop run by a professional consultant, we observed a successful application of t.BPM and gained many new insights. We opt to continue working with experienced experts to develop the facilitation method in the field. Thus, we can ensure that t.BPM improves real situations.

Action Research as a scientific method addresses situations in which researchers evolve a situation within a real world environment instead of a laboratory. The method was proposed by Lewin in 1946 anticipating social scientists "building productive hard-hitting teams of practitioners" ([45] p.221). The method evolved and diversified since originally proposed [46]. At its heart, it implements a learning cycle. In each iteration a problem is identified, action is planned then taken, and the effect is measured.
While we choose the most suitable research methods for our research questions at hand, we recognize that researchers in Information Systems have faced similar problems and defined a more general framework to guide this type of research. As the nearest approximation, the design science framework [47] for Informations Systems research (DSR) can be used to describe our work. It proposes to find a relevant problem in current practice, build an artifact to solve the problem by using a rigor scientific knowledge base and then evaluate it. Design science also proposes that evaluation leads to new insights and evolvement of the artifact.

Recently, an extension to the design science research (DSR) framework was proposed, called action design research (ADR). It builds on DSR but aims to stress that "the artifact emerges from interaction with the organizational context even when its initial design is guided by the researchers intent."([48] p.10). ADR enriches the original DSR framework with the learning cycle as proposed by Action Research [46]. In other words, the problem in the field is theorized and the researcher proposes a solution. Afterwards, the solution is evaluated and iterated in the field. This part is done using Action Research principles.

Our research theme fits the setting for ADR as a research framework. It is thus seen as a suitable approximation of our work.

7 Conclusion

We started with the observation that process elicitation is typically not done using process model representations. Instead, consultants model processes after interviews/workshops and iterate the result until all stakeholders accept it. We derived principles to better facilitate process elicitation with novices from the literature and reviewed related approaches.

Our solution is a tangible approach to process mapping that spans a toolkit and a method for application. We presented case studies in that paper which illustrate the evolvement of t.BPM. To scientifically measure the effect of t.BPM, we propose to develop hypotheses and assess them in a controlled experiment. To develop an application method for groups, we propose to work with professionals in the field and implement an action research cycle. The development of t.BPM is ongoing. The design principles described in this paper may be applicable in further research settings.

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