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AN EXPLORATORY COMPARISON OF TOOLS FOR REMOTE COLLABORATIVE AND PARTICIPATORY ENTERPRISE MODELING

Research in Progress

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Abstract

Participatory enterprise modeling (PEM) is about gathering domain experts and letting them discuss and jointly create enterprise models, supported by modeling experts. To prepare students for their role as modeling experts, it is useful to practice modeling in comparable situations. Usually, PEM is organized in sessions with co-located participants. During the Covid-19 pandemic, however, personal contact had to be reduced. Searching for alternative ways of simulating PEM sessions, we investigate tools that would allow distributed teams to collaboratively and remotely create models. This paper presents a pilot study examining two online tools concerning usefulness, ease of use, enjoyment, acceptance, and awareness. We let the students create a goal model and a process model to check whether different kinds of models come with different requirements. To enable communication between the participants we used the video conference software Zoom. Interviews give more insight into the students’ perception of the modeling session.

Keywords: training modeling experts, collaborative enterprise modeling, participatory enterprise modeling, online modeling tools, exploratory study.

1 Introduction

Enterprise modeling is used to document the current or a desired future state of a company in a graphical and comprehensible way. Different models represent different perspectives on the company, e.g. goals, structures, responsibilities, or processes (Sandkuhl, 2014). Models can be used for simulation and deployment, but in many cases, their actual use lies in sense-making, communication, and improvements within the organization (Krogstie, 2016). PEM is a fruitful method of eliciting information and creating enterprise models at the same time. Instead of conducting interviews with the relevant managers and employees, these stakeholders actively take part in the modeling sessions by discussing and drawing the model themselves. The main goal of PEM is to increase model quality and commitment to the final models (Sandkuhl, 2014; Stirna, 2018, Rittgen, 2009). Usually, PEM is organized in sessions where the participants meet in one place (Stirna, 2018).

For PEM, modeling experts should not only be trained in modeling languages and tools. They should also be practiced particularly in collaborative and participatory modeling. As students, they should already get the opportunity to experience coordinating and facilitating discussions in PEM sessions. They can take the role of a modeling or a domain expert while jointly working on a modeling task. Sometimes, however, circumstances such as the Covid-19 pandemic make it difficult or even impossible to implement physical meetings. In that case, tools must be available for distributed collaborative modeling, allowing each participant to contribute to the modeling process. Furthermore, communication between the participants must be supported. For an exploratory pilot study, we decided to investigate modeling tools that are suitable for distributed collaboration. We made sure that the tools offered the possibility to draw both goal models and process models. We chose a goal model because this task requires creativity, discussion, and joint decision-making. In contrast to this, we
chose a process modeling task that would require gathering and arranging facts about an as-is state. Furthermore, we concentrated on tools that were freely available because our students usually do not want to or cannot invest money in modeling tools. Draw.io and Google Drawings fulfilled these criteria and served as the first software tools which we examined. In the pilot study, using either Draw.io or Google Drawings, four teams of three students had to create both a goal and a process model. For the communication between the participants, we used the video conference software Zoom.

The major research questions we address in this paper concern three constructs that are considered as the most important influencing factors for the acceptance of a technology: perceived usefulness, ease of use, and enjoyment of both tools (Davis, 1989, Davis, 1992). We also investigate awareness as it is a crucial aspect in collaboration to know what other team members are doing. We state the following questions: 1) Is there a difference between the two tools concerning the above-mentioned constructs? 2) Are there differences in the assessment of the tools depending on the kind of model, i.e. goal model and process model? 3) Which features of the tools might contribute to a possible difference in the participants’ perception?

The next section will present background knowledge on collaborative and participatory modeling, on the technology acceptance model, and on tools for distributed collaborative modeling. We will then describe the exploratory study, its method, and results, and close with a discussion.

2 State of the art

2.1 Collaborative and participatory modeling

In enterprise modeling, a company’s knowledge is usually elicited from different sources, e.g. by scanning documents, observing work procedures, or interviewing the stakeholders (Sandkuhl, 2014). This knowledge may then be put into models by modeling experts who may do this in a collaborative way. The main goal of collaborative modeling is to attain complete models in a fast and accurate way (Barjis, 2011). Participatory modeling is characterized by involving stakeholders as domain experts directly and actively in the modeling process. The stakeholders take part in the actual modeling sessions and contribute to the model creation by discussing and even drawing parts of the models while being supported by modeling experts (Sandkuhl, 2014). It is recommended that the participants meet in person in a special location to ensure complete attention and dedication to the modeling project. The goal of participatory enterprise modeling is to increase model quality by gathering stakeholders and the resulting exchange of information. Moreover, we expect the stakeholders to feel more committed to the models since the stakeholders created them themselves (Stirna, 2018).

2.2 Technology acceptance model

The technology acceptance model (TAM) is based on the well-known Theory of Reasoned Action (Ajzen, 1980). According to the TAM, the acceptance of a technology is crucial to its actual being used. Moreover, acceptance is influenced by several factors. Although the TAM has been refined and extended over the years (Venkatesh, 2000), perceived usefulness and perceived ease of use remain to be the most important factors as stated in the original model. Ease of use itself seems to be an antecedent of usefulness (Davis, 1989). Both constructs may be considered as part of extrinsic motivation because they refer to the product of using a technology. Enjoyment was added to the TAM to represent intrinsic motivation as it refers to the process of using a technology (Davis, 1992). We will use the constructs of perceived usefulness, ease of use, enjoyment, and acceptance to estimate the suitability of selected tools for collaborative and participatory enterprise modeling from the students’ perspective.
2.3 Distributed collaborative modeling tools

Distributed collaborative modeling tools may be divided into those that work asynchronously and those that work synchronously. For asynchronous tools, it is particularly challenging to provide functions such as checkout and merging of model versions, and conflict and consistency management (Sammapun, 2018). Moreover, for large models, it may be more convenient that experts work only on selected parts of the model instead of handling the whole model (Zerrouk, 2017).

Synchronous approaches promise a reduction of inconsistency and versioning issues. They provide a modeling environment where changes can be seen almost in real-time (Nicolaescu, 2013). In the context of collaborative tools, awareness is a crucial feature. It may be defined as “an understanding of the activities of others, which provides a context for your own activity” (Dourish, 1992, p. 107). Thus, awareness means that a user knows what is going on around him or her. Awareness may be differentiated into different types. Mostly, we refer to workspace awareness which is about knowing what the others are doing on the shared workspace (Gutwin, 1996). There already exist different suggestions on how to support awareness, e.g. by marking authorship, identity, or showing an event history (Dirix, 2014).

Besides this, many further challenges have to be managed in this distributed and collaborative setting. Chat functions may not only play the role of a communication means but also a way of documenting design rationale (Xu, 2009). Especially synchronous tools struggle with choosing suitable variants of the undo function (Göhner, 2009).

Many distributed collaborative modeling tools provide support for one purpose, e.g. software design (Barbosa, 2014) or process modeling (Rittgen, 2009; Rittgen, 2008). We, however, intend to consider different types of modeling tasks, involving creative tasks on the one hand and gathering and structuring information about an as-is state on the other hand. We combine this with the special requirements of participatory enterprise modeling sessions where synchronous communication and social interaction are crucial.

3 Method

3.1 Experimental setting and procedure

For the study, we decided to let student teams create both a goal model that requires more creative work, and an as-is process model that requires gathering and structuring knowledge. We believe that these different types of modeling tasks trigger a different way of working resulting in different requirements. We chose the goal model of the 4EM notation (Sandkuhl, 2014) because it is very simple and intuitive. The goal model mainly captures the goals and problems of a company. In our setting, it served as a basis for a subsequent process modeling task. For that, we chose the BPM notation as we expected most of our students to know this notation.

We had to choose modeling tools that would fit the requirements of collaborative and participatory enterprise modeling sessions. For simulating a PEM session, the tools should allow synchronous communication. Every user should be able to interact with the software, ideally at the same time. Additionally, it should be possible to create predefined shapes with the tools. A goal model following the 4EM notation consists of rectangles with predefined colors, logic connectors, and arrows, while BPMN comprises a richer collection of shapes plus the concept of pools and swim lanes to assign tasks to different roles. Besides these functional requirements, we restricted our tool selection to freely available software. Most of our students do not want to pay money for a modeling tool. Ideally, an installation on a local computer should not be needed as we expected our participants to use their own computer. We chose Google Drawings and Draw.io as tools for they both fulfill these requirements.

Besides the modeling tool, we had to think about how to support discussion and coming to a joint agreement among team members as this is especially important in participatory modeling sessions.
PEM creates a situation where social aspects play an important role. As a consequence, we decided to additionally provide the participants with a video conference system to allow synchronous voice communication and visual contact. Based on our experience at our university, we chose Zoom as the most reliable tool.

The study was set up as an experiment with the modeling tool and the kind of model being the independent variables. Each team had to create both a goal and a process model (within-subjects-design). We, however, decided that each team used only one tool, either Google Drawings or Draw.io (between-subjects-design), resulting in a mixed design. We did not want to make the setting too difficult for the participants by changing the tool during the experiment. In participatory modeling, we would also avoid using different tools. Moreover, testing all tools with all kinds of models would have taken too much time. In our setting, every trial took two hours.

As all our participants were students, modeling tasks should relate to student life, and the participants should be able to contribute their personal experiences. The first task was to draw a model describing goals and problems when applying to a new university. The second task was based on the first one and was about modeling the process of the application. All the participants were first introduced to the modeling tool. Furthermore, before each task, a facilitator gave an introduction to the modeling notation using an example. After each task, a questionnaire had to be filled out to assess the dependent variables perceived usefulness, ease of use, enjoyment, acceptance, and awareness. Each trial was closed with a brief interview exploring further critical incidents during the session concerning the tool, and their communication via Zoom.

3.2 Measurement and data evaluation methods

We measured perceived usefulness (PU, 7 items), ease of use (PEU, 7 items), and acceptance (2 items) using scales from Davis (1989) and Venkatesh (2000). The assessment of enjoyment (3 items) was based on a scale by Davis (1992). The two items measuring awareness were provided by Norbert Semmer (University of Bern) and translated to English. The items were represented as statements that had to be rated on a 7-point scale. We formulated items for goal and process modeling separately, e.g. one item to measure PU in two versions was 1) Using the modeling software improves our performance during goal modeling, and 2) Using the modeling software improves our performance during process modeling.

Due to the small sample size, we did not do a factor analysis to check the scales’ validity. We calculated scores for each of the scales based on the average values of the respective ratings leading to one overall score value for each construct and for each model type. We also did not perform significance tests for the comparison of the mean values for each tool because of the restricted sample size. However, the descriptive statistics already provide a good impression of the tools’ suitability for the considered purpose. Lastly, we evaluated the interviews by extracting statements that contain hints on positive and negative aspects of the modeling tool and the video conference software and sorted them into categories. Moreover, we asked the participants about the differences they perceive between goal and process modeling. We intended to get more hints on the different tool requirements of different model types.

3.3 Sample

We gathered four teams of three persons (3 women, 9 men) to be able to investigate online collaborative modeling. The average age of the participants was 24 years (min = 20, max = 34). In two of the teams, all participants knew each other before, in the other two teams, one member was new. Modeling experience was not mandatory, however, we intended to collect opinions and assessments of participants with different levels of modeling experience which led to a heterogeneous sample. Based on the participants’ rating of their experience in 4EM notation and BPMN on a scale from 1 (no experience) to 5 (a lot of experience), the average values we calculated were 3 (σ = 1.1) and 2.9 (σ = 1.3), respectively. All the participants were either Master or Bachelor students in Business Informatics.
or Computer Science. Since the participants came from different countries (Germany, Russia, Syria, Iran, Albania), everyone spoke English during the study. English skills were rated at 3.6 on average ($\sigma = 1$).

## 4 Results

### 4.1 Quantitative Results from the Questionnaires

The following diagrams show the average values for perceived usefulness (PU), perceived ease of use (PEU), enjoyment, awareness, and acceptance for both tools. The lines between the data points serve only for better visualization of the tool profiles. We depicted separate profiles for goal and process modeling. Tab. 1 presents the average values for all constructs with additional standard deviations.

![Fig1. Average values for perceived usefulness (PU), perceived ease of use (PEU), enjoyment, awareness, and acceptance for both tools, separated by goal and process modeling](image)

<table>
<thead>
<tr>
<th>Goal Modeling</th>
<th>Process Modeling</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Draw.io</strong></td>
<td><strong>Google Drawings</strong></td>
</tr>
<tr>
<td>PU</td>
<td>5.4 ± 1.2</td>
</tr>
<tr>
<td>PEU</td>
<td>5.6 ± 1.1</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>5.7 ± 0.8</td>
</tr>
<tr>
<td>Awareness</td>
<td>4.7 ± 1.0</td>
</tr>
<tr>
<td>Acceptance</td>
<td>4.2 ± 1.2</td>
</tr>
</tbody>
</table>

*Table 1. Average values and standard deviations for all constructs separated by tool and model type.*

### 4.2 Qualitative Results from the Interviews

The participants reported both positive and negative aspects of both tools which we sorted into categories. Two persons using Draw.io and three persons using Google Drawings liked that you could work together in one model and see what the others were doing in real-time. One person who used Google Drawings explicitly commended that he could see exactly who did what. Four persons (three using Draw.io) stated that the tool was not originally meant to be used for enterprise modeling, i.e. there were no predefined shapes and detection of notation errors. In contrast to this, in five statements (three concerning Draw.io), the flexibility of the tools was praised, the provided shapes being sufficient.

The participants described different usability issues where most of the statements referred to Draw.io. Four participants (two for each tool), complained that it was hard to handle big models, especially
process models, in the editor, e.g. text was too small, the model became too crowded and incomprehensive. Two participants who had used Draw.io concretely described that it was hard to enlarge the workspace so that the model could be conveniently extended. Arrows or connectors, respectively, represent crucial elements in modeling. Consequently, the participants perceived usability problems concerning the handling of arrows as severe, as stated by four participants using Draw.io and one participant using Google Drawings. Two persons using Draw.io and one person using Google Drawings complained about difficulties in selecting elements and easily making mistakes while modeling. For both tools, one participant was unsatisfied with the undo functionality. Again, for both tools, there was one participant reporting that team members were interfering with each other, probably due to a time delay in their interactions with the model. Two persons explicitly said that Draw.io had an interface that was easy to understand whereas one participant who had used Google Drawings said he found the interface unintuitive after being familiar with other modeling tools. Single statements describe general advantages of online tools, i.e. you can share models with others, you do not need to install it, and you can use it on every platform.

Concerning the communication via Zoom, two persons explicitly stated that just seeing faces and hearing voices is not enough, that more nonverbal communication is needed, or that doing the session in person would have been nicer. One participant said it took some time to get to know each other. Another person said the interaction between the team members was slower than in person. Nevertheless, five persons were generally satisfied with the functionality Zoom provided. Two persons said it was better to communicate via Zoom than not to talk to each other at all. Two participants mentioned that they would have preferred a second monitor as they had to switch between the modeling application and Zoom. Single positive statements referred to Zoom having a normal theme, being very convenient, and offering the possibility to use a camera.

When asking the participants about the differences between goal and process modeling, five of them found that in contrast to goal modeling, in process modeling, it was clear what to do. Two persons said that in goal modeling, you needed more thinking and brainstorming. Another person said goal modeling was more abstract when thinking about what you want to achieve. Moreover, two persons stated that goal modeling required some effort in finding an agreement among the team members. One person found goal modeling easier, it needed only a conversation. This is underlined by another statement that the notation of goal models was easier. One person mentioned that process modeling was more difficult. Lastly, one participant stated that during process modeling, a team could split up and distribute subtasks whereas this was not possible during goal modeling.

5 Discussion

5.1 Summary and Interpretation

We conducted an exploratory study to investigate the suitability of two selected tools for remote collaborative and participatory enterprise modeling. We mainly addressed students as target group who must be made familiar with creating enterprise models in collaborative and participatory settings. What makes this study different from others is that we focused on the special requirements of participatory enterprise modeling while also taking into consideration that these requirements might differ depending on the model type, i.e. modeling creative ideas (goals) versus an as-is state (process). In participatory modeling, discussion and finding an agreement among participants with different modeling expertise are core elements. Moreover, we wanted to identify tools where all participants could actively contribute to the creation of the models. The study gives a first insight into the subject by investigating the tools Draw.io and Google Drawings. Our quantitative results consist of the assessments of perceived usefulness, ease of use, enjoyment, awareness, and acceptance, separated by tool (Draw.io vs. Google Drawings) and model type (goal model vs. process model). With the help of qualitative interviews, we tried to add some explanation to the quantitative results.

Our first research question referred to differences between the tools regarding the above-mentioned constructs relevant for technology acceptance (PU, PEU, enjoyment) and awareness. We found
differences between the tools regarding these constructs with Draw.io being rated better in most cases. Only for awareness, Google Drawings was rated better.

Our second research question addressed the differences in the tool ratings that might be caused by the type of model to be created. We found that for goal modeling, Draw.io was rated better than Google Drawings concerning perceived usefulness, and even more clearly for enjoyment, while ease of use was only slightly better. For awareness and acceptance, the ratings were similar. After process modeling, the rating of enjoyment for Draw.io decreased which might also be caused by the difficulty of the BPMN. The rating of awareness for Google Drawings rose and clearly exceeded the rating of Draw.io. An explanation for this is that in contrast to Draw.io, Google Drawings shows the author’s name when a user has edited the model close to the location of change. Nevertheless, acceptance is rated lower for Google Drawings than for Draw.io. With the help of interviews, we wanted to find further explanations of this assessment. Goal modeling requires more creativity and thinking which is why some participants perceived this task as more difficult. Other participants found the task easier than process modeling which is probably caused by the simple 4EM notation. A division into subtasks is not common as the participants have to constantly agree on the goals they are modeling. That is probably why awareness is not rated much lower for Draw.io than for Google Drawings concerning goal modeling. For modeling an as-is process, the working steps seem to be clear, like working through a list. The participants usually seemed to know what to do. The notation is, however, more difficult. Thus, more modeling support would have been helpful. In contrast to goal modeling, a division into subtasks seems to be possible.

Our third research question dealt with software features that might cause differences in how the students perceived the tools. The interviews revealed that the participants appreciated the synchronous collaboration. Although usability problems were reported for Draw.io more often in the interviews, the above-presented quantitative results show a generally better rating for this tool compared to Google Drawings. It seemed to be a problem that both tools are not originally meant for enterprise modeling tasks. They do not provide default shapes, although Draw.io provides at least a set of shapes for process modeling. However, for goal modeling, the participants had to know the colors of the different elements. Moreover, the tools do not provide any syntactical or semantic check. Furthermore, students who had worked with tools that were originally developed for modeling might have problems in handling such a general drawing tool as one of our participants reported.

With regard to using Zoom, it seems that using such video conference software is better than not having voice communication at all. Nevertheless, the interviews give hint that it cannot fully replace physical presence. Nonverbal signals are missing and getting to know each other takes longer according to our participants. Two participants mentioned that they would have liked a second monitor to avoid switching between Zoom and the modeling tool. One solution would be to use a tool that unites modeling functionalities and voice and video communication. The disadvantage of integrating videos would be that space is taken away which is often needed for large models, though voice communication would already support the process. A second solution would be to let a facilitator share the screen in the video conference software showing the modeling workspace to the participants. That way, only the facilitator would be able to edit the model. Rittgen (2009) criticizes this way of working and calls the facilitator a bottleneck. Channeling all ideas through the facilitator slows down the process and turns the domain experts into passive spectators. In contrast to this, Gutschmidt (2019) found that identification with the model was higher when only the facilitator was modeling than when the domain experts modeled themselves. However, while Rittgen (2009) studied process modeling, Gutschmidt (2019) investigated goal modeling with the 4EM notation. As stated before, we assume that the kind of model plays a role in this.

On the whole, both tools seem to be suitable for collaborative and participatory enterprise modeling only to a limited extent. Modeling experts are used to specialized software whereas modeling beginners might not find enough support from the tools. If a notation is more difficult, such as BPMN, language support and syntax checking will be needed more. Moreover, if modeling tasks can be split, such as process modeling, more awareness support is needed. If remote collaboration is really
necessary, voice and, if possible, video communication are particularly valuable. Especially for creative tasks requiring agreement again and again, such as goal modeling, they will be indispensable.

5.2 Limitations and implications for future research

Our pilot study comprised only a small sample which was, however, enough for a first exploration of tools that students can use to remotely practice collaborative and participatory enterprise modeling. For our students, synchronous collaboration, language support including syntax checking, voice communication, and handling large models on a limited workspace were particularly important. We plan to examine further tools that should, in contrast to the tools examined here, be tailored to enterprise modeling. Besides goal modeling and process modeling we would like to consider more model types in the realm of enterprise modeling. With the pilot study, we tested one possible design to examine suitable tools. We also consider an alternative setting where the same participants test different tools for one type of modeling task. Furthermore, we did not examine the hardware our participants used. In future studies, we will have to consider input (mouse, touch, etc.) and output devices (e.g. screen size) as control variables. These studies should also investigate the importance of voice communication in synchronous sessions and compare its effectiveness to chat communication and comments, especially in creative discussions as it is typical of PEM.

Based on the collected materials, we still have to analyze the models and their quality. We also intend to further investigate the modeling process based on the recordings we made of the modeling session. In future studies, we would like to assess the participants’ perception of model quality and their feeling of ownership towards the model. The latter is especially interesting when the modeling tool can be handled only by a facilitator. Furthermore, we would like to investigate the possibilities of dividing modeling tasks, especially in larger teams. This will extend the requirements for the communication software as contributions have to be orchestrated by a facilitator, e.g. a teacher.

The list of ideas on possible future research is long and the study presented in this paper is a first step. Nevertheless, we have identified important features of tool support for remote collaborative and participatory modeling which are useful for the context of remotely training students in PEM, but also, to a limited extent, for remote PEM sessions in companies.

References


