Digital Tool Support for Co-Located Participatory Enterprise Modeling

Anne Gutschmidt[1,*], Til Jeschkowski[1] and Alica Reinke[1]

[1]University of Rostock, Albert-Einstein-Str. 22, 18059 Rostock, Germany

Abstract

In participatory enterprise modeling (PEM), stakeholders actively contribute their domain knowledge while typically lacking modeling expertise. Therefore, method experts support the domain experts during the modeling sessions. PEM is best conducted in co-located settings, where pen, paper, and whiteboard are well-suited tools. However, the resulting models need to be digitized to be stored, shared, and refined more easily. To this end, we developed a prototypical tabletop modeling tool. We now complement previous studies about this tool by investigating how participants perceive the tool's usefulness and ease of use when provided with a predefined structure, particularly through alternating phases of card-writing and discussion. In a small evaluative study with two modeling groups, we found that many usability issues arise from limited workspace. To address this, we propose an extension of the tabletop setup with a complementary mobile phone application. The contribution of this extended prototype is that it addresses space constraints while, at the same time, considering the specific role distribution and social dynamics characteristic of co-located PEM sessions.

Keywords

participatory enterprise modeling, modeling tools, multi-device tool, collaboration

1. Introduction

Enterprise modeling is a way of diagrammatically capturing an as-is or a to-be state of an organization. There exist several kinds of enterprise models depicting different perspectives, such as processes, roles and resources or goals and problems [1]. While conventional methods of knowledge elicitation for enterprise modeling mainly rely on activities of modeling experts, such as interviewing stakeholders, analyzing documents, or observing work processes, participatory enterprise modeling (PEM) aims at actively involving stakeholders in the creation of the models. PEM is a suitable approach when consensus between the stakeholders is crucial. In PEM sessions, different *domain experts* share their specific knowledge and exchange and discuss ideas. The domain experts, however, usually do not have any modeling expertise. Consequently, *method experts*, who master modeling methods and notations, support them [2, 3].

Stirna and Persson [2] emphasize that participatory modeling sessions benefit from co-located settings, as they foster focus and effective communication among participants. Often, traditional tools such as pen, paper, whiteboard, or a plastic wall serve for knowledge elicitation and modeling in modeling workshops [1]. With this, however, a digitization of the models still remains to be done to be able to store, share, and refine models. In the past, we have suggested a tabletop software for creating digital models that has been shown to be equally suitable as a whiteboard for creating small goal models in 4EM notation [4].

In our previous studies with the tabletop software, the participants worked in a self-organized way with only little intervention by the facilitator. We presume that providing more structure to a modeling session, particularly by alternating phases of card-writing and discussion, results in larger models. We wanted to explore how well the tabletop software would work for such a working mode, and especially

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*Corresponding author.
anne.gutschmidt@uni-rostock.de (A. Gutschmidt); til.jeschkowski@uni-rostock.de (T. Jeschkowski); alica.reinke@uni-rostock.de (A. Reinke)
0000-0001-8038-4435 (A. Gutschmidt)

for larger models in order to find out where the tool must be further improved. Therefore, we conducted a further user study where we let two groups consisting of three and four participants, respectively, create models with the tabletop software. We obtained insights through observations, questionnaires, and group interviews.

In this paper, we will concentrate on the following research questions:

1. How do domain experts appraise the usefulness and ease of use of the tabletop software when provided with a structure for the modeling session? Which problems do occur in the tool interaction?
2. How can the software prototype be improved while taking into consideration the specific characteristics of PEM?

Section 2 will give a brief introduction to PEM. As PEM is highly collaborative, we will also give some insight into the psychological aspects of group work in Section 2.2. Moreover, we will present some existing approaches to tool support for co-located PEM in Section 2.3, describing in particular our self-developed tabletop solution. In Section 3, we present the aforementioned user study, which addresses the first research question concerning the appraisal and problems of the tool when providing the participants with a certain work structure. The study underlined a basic issue that we observed in previous studies, which is the limited workspace of the tabletop. Our findings led us to a list of ideas on how to improve the prototype, as formulated in the second research question. We have implemented a part of these ideas, i.e. in Section 4, we suggest a multi-device prototype that combines the use of a tabletop software with an app for mobile devices. Although similar multi-device settings have already been proposed, our approach not only addresses the problem of limited workspace but also considers the specific characteristics of PEM, supporting the different roles with distinctive software features. As this paper describes a work in progress, the prototype cannot meet all requirements, but it represents a first approach. Section 5 concludes our paper.

2. Participatory Enterpise Modeling

2.1. What Characterizes PEM?

Sandkuhl and Seigerroth define PEM as a special form of collaborative modeling [5]. They distinguish PEM from conventional modeling based on whether stakeholders are involved in the modeling and whether more than one modeler is present. The stakeholders provide their domain knowledge and collaboratively create the models, supported by method experts who master modeling methods, notations and tools [1, 3]. According to Sandkuhl and Seigerroth, the goal of such a participatory approach is to *"avoid conceptual deviations (misalignment) between strategic plans and models on different levels"* [5, p. 3]. Consequently, models that were created in a participatory way are expected to be of better quality and to reach broader acceptance among the stakeholders since different perspectives have been considered, and the models are a result of a joint discussion [3].

As mentioned above, in PEM, we distinguish between domain experts and method experts. For method experts, a further distinction of roles can be made. The facilitator leads the discussion but is not to interfere with the content. A tool operator may support the facilitator and the domain experts in handling the modeling tool. A minute-taker may additionally take care of the practicalities and document the process [1].

2.2. PEM as a Form of Group Work

PEM is highly collaborative, i.e., the domain experts interact with the method experts, but above all, they must collaborate with each other. That is why it is important to take into consideration certain phenomena that take place in group work. PEM is a prime example of a task where we expect a performance gain through the collaboration of several people. For example, as more people are involved, we expect more ideas and accurate information to be gathered as a result of the group discussion. In collaboration, there may, however, also occur performance losses, caused by issues related to coordination or motivation [6].

Production blocking is a phenomenon that is said to cause a coordination-based performance loss. It occurs in situations where group members cannot voice their ideas straight away but must wait for their turn [7]. The presence of other people can also inhibit individual performance, e.g., because of the apprehension to be evaluated [8, 9].

For PEM, Stirna and Persson suggest phases of individual card-writing alternating with phases of group discussion and collaborative modeling [3]. This approach is likely to avoid the above-mentioned negative effects of collaborative work. In the card-writing phases, the domain experts have the opportunity to think for themselves in private. Later, in the discussion phases, the participants can present their ideas to the others. This way, not only the louder and more powerful participants have their say.

Performance losses due to motivational issues may also be caused by phenomena like free-riding and social loafing [6]. A countermeasure against this is to make individual contributions identifiable [6, 10] as was suggested in [11] in the context of a PEM software for tabletops. Furthermore, social loafing can be reduced when group members are able to recognize that their contribution is essential for the overall result [10, 12], and when they can compare their performance to that of their teammates [10].

2.3. Tool Support for PEM

According to Stirna and Persson [2], participatory modeling sessions should take place in a co-located way to ensure that everyone focuses their attention on only the given task and that communication functions optimally. During the Covid pandemic, however, we had to move to virtual modeling sessions. In a study about PEM with collaborative online tools in combination with a video conference software, the participants found this way of communication insufficient, saying that *"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"* [13, p. 6]. Consequently, we prioritize modeling tools allowing co-located collaboration.

Usually, for PEM, a plastic wall in combination with cards and pens is recommended [3, 1]. The disadvantage of this tool set is that the model can be modified only to a limited extent and must be digitized before it can be shared.

Tabletops have been studied as a tool for collaborative modeling, e.g., in the context of software design with UML [14] or process modeling [15, 16]. In former studies, we have introduced and used a self-developed tabletop software for participatory goal and problem modeling, e.g., in [13]. The goal and problem model is part the 4EM notation, whereas the 4EM modeling method promotes especially the PEM approach [1]. In [11], we suggested a selection of HCI patterns for PEM on a tabletop and checked our tabletop software for these patterns. We additionally examined the software for shortcomings based on the analysis of videos of participatory modeling sessions. Most problematic were accidental interactions due to the limited workspace, e.g., menus were opened or buttons triggered accidentally. The study also identified the editing of model elements as the most frequently performed task. This included several interactions with the software, e.g., besides the actual editing, opening and closing the editing mode. Thus, we concluded that this task should be supported in particular, as we also consider this to be the most important task performed by the domain experts. For the editing of the element descriptions, the software offers on-screen keyboards where a new instance is attached to each model element as soon as its editing mode is opened. This, however, again takes away space. Moreover, typing on the tabletop has been found to be more cumbersome for some users [14], which we can confirm from our studies.

To mitigate these issues, we suggested providing private workspaces such that modelers do not get into spacial conflicts, which may be implemented by embedding further electronic devices [13]. Similarly, Nolte et al. suggested a multi-device approach for process modeling [17]. They suggest the combination of large display walls, tabletops and mobile devices for different collaboration formats. Especially one of their suggested collaboration formats corresponds to the one described above, alternating individual idea generation and joint modeling. For the former, the authors suggest using personal mobile phones;

for the latter, they recommend using a large display wall. The possibility of working in parallel on a personal device is basically seen as a means to save time. Changing or deleting elements is possible only on the shared large display to maintain the collaborative character. The authors also mention the facilitators' importance in terms of coordinating the work, but they do not mention any specific functionalities in the software supporting the facilitator.

3. User Study

3.1. Method

In previous studies, e.g., [4, 18, 11], we used the tabletop software and already identified possibilities of improving it. In these studies, however, we let groups work on our tabletop software in a self-organized way with only a few interventions by the facilitator. To strengthen our knowledge base for refining the software, we wanted to explore in another study how well the tool would work for small groups that followed a strict procedure of alternating phases of individual card-writing and discussion as suggested by [3]. We presumed that the different work mode might help us in uncovering new usability issues or, at least, further underpin previous findings.

We had two groups of students, most of them with a background in business information systems and modeling, collaboratively create a goal and problem model on how to improve students' mental health at the university, in 4EM notation [1]. One group consisted of three members, the other consisted of four members. First, the participants were asked to individually create goals in parallel with the tabletop software, adding a text description to each goal. After this card-writing phase, the goals were discussed and clustered, and possible relations identified. This procedure was repeated for the problems of the 4EM goal and problem model. Due to time limitations, we set time constraints for the card-writing phases of ten minutes. Moreover, we did not explicitly ask the participants to consider further 4EM goal model elements such as cause or opportunity [1].

Each modeling session was facilitated by two of the authors of this paper, who also observed the participants' interactions with the tabletop and documented problems. After the modeling session, the participants were asked to fill out a questionnaire where we assessed the perceived usefulness and perceived ease of use of the table, using translated and adapted scales by [19]. For both constructs, the participants had to rate several items (statements).[1] We calculated the average value of the respective items to obtain a score for perceived usefulness and ease of use for each person, respectively. After the participants had filled out the questionnaire, we asked them for 1) positive and 2) negative perceptions of the tool, and for 3) ideas for improvements. Here, we let the participants write their answers on cards. The cards were subsequently put on a whiteboard and further elaborated in a joint discussion.

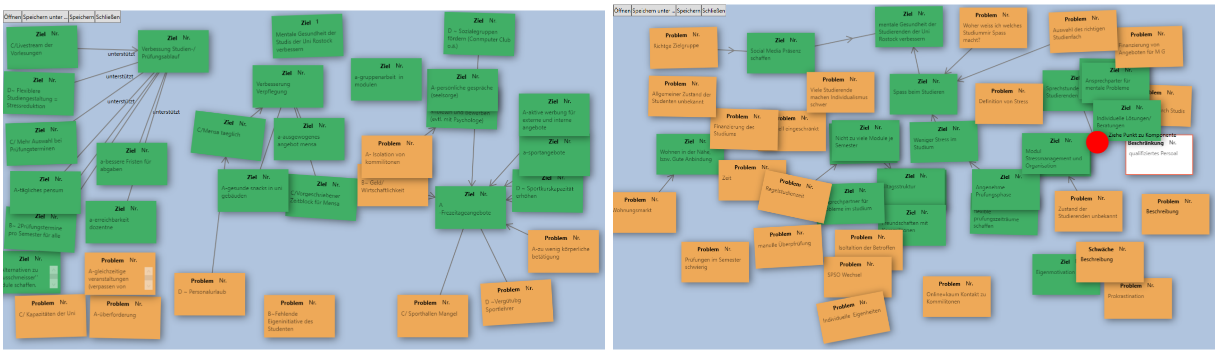
Figure 1 shows the two goal and problem models that the participants created in the respective sessions. In session 1, 33 elements were created; in session 2, 40 elements were created.

3.2. Results

Based on the **questionnaire data**, we calculated mean value, standard deviation, minimum, and maximum value for perceived usefulness and perceived ease of use, given that the individual score for each of the two constructs could take a value from 1 (low rating) to 5 (high rating). For perceived usefulness, the average value in Session 1 was 4.0 (SD = 1.3), while in Session 2 it was slightly lower at 3.8 (SD = 0.9). When both sessions are considered together, the overall mean amounts to 3.9 (SD = 1.1). Reported scores ranged from 2.2 to 5.0 in Session 1 and from 2.8 to 4.7 in Session 2.

For perceived ease of use (PEU), Session 1 participants reported an average score of 4.0 (SD = 0.3), while Session 2 reached a slightly higher mean value of 4.1 (SD = 0.5). Across both sessions, the combined average was 4.1 (SD = 0.4). The observed values ranged between 3.7 and 4.3 in Session 1 and between 3.8 and 4.7 in Session 2.

[1]Items used in the study are available in German and English on https://doi.org/10.5281/zenodo.17322054



(a) Session 1 with four persons. (b) Session 2 with three persons.

Figure 1: 4EM goal and problem models created in two modeling sessions.

During the sessions, we **observed** several noteworthy situations in which participants struggled with the tabletop software. We noticed issues with the text input on the virtual keyboards (some participants became less and less "gentle" with the interface while typing). We observed difficulties in drawing relations several times, especially when trying to connect to the right target element. In both groups, we observed situations in which menus or elements were covered by others and therefore not accessible. We also noticed that participants standing at the short sides of the tabletop had to lean forward considerably or rotate elements to properly see and edit them. Eventually, these participants moved to the long side of the table to have a better view.

According to the **group discussion**, using the tabletop tool was perceived as enjoyable. The participants praised the intuitive and well-structured user interface. Some participants particularly acknowledged the possibility of working collaboratively and in parallel.

In both groups, several problems were reported. As the model size increased, the workspace became cluttered, which made it difficult to draw relations accurately, confirming our observations as mentioned above. Elements were positioned so closely that the software sometimes failed to detect the intended target of a relation. The participants also mentioned that menus and elements were sometimes covered by other elements, making it hard to access them, or menus were opened unintentionally. Participants also stated that they could not control the layering of elements (foreground and background), which prevented them from accessing menus covered by other objects. Furthermore, some participants experienced difficulties using the virtual keyboards integrated into the tabletop application.

As a consequence, the participants suggested a feature for controlling the layering of the elements and menus. Moreover, they desired a zoom function or the possibility to extend and scroll the workspace. They also asked for a feature for clustering or grouping elements and made several suggestions to improve the handling of relations. One participant also suggested a feature to integrate the created model with other models.

3.3. Discussion

With this small user study, we addressed our first research question: How do domain experts appraise the usefulness and ease of use of the tabletop software when provided with a structure for the modeling session, and which problems do occur in the tool interaction? The working mode gave more room for individual ideation, resulting in a greater number of model elements and a more cluttered workspace compared to previous studies. The participants' ratings of perceived usefulness and perceived ease of use were quite high with 4.0 and 3.9 of 5 as a maximum, but hinted on room for improvement. Although the participants stated that the tabletop software was generally intuitive and enjoyable to use, they encountered different difficulties. In particular, with the growing number of model elements, these elements were positioned increasingly close to each other, resulting in undesired side-effects such as elements covering other elements or malfunctions when drawing relations, which we had already observed in previous studies [11].

Based on this insight, we gathered several ideas to improve our modeling prototype, addressing the second research question: How can the software prototype be improved while taking into consideration the specific characteristics of PEM? As a consequence of our findings, we see the necessity to come up with a concept for a feature to control the layering of model elements and menus in terms of moving forward or backward. Moreover, the desire for a zoom feature was most prominent. Zooming might appear as a good solution; however, in collaborative settings, especially when the whole workspace should be zoomed, such actions require coordination [20]. Zooming might even disturb or interrupt other participants, in particular, when they are in a mode of individual work [21]. For individual zooming, in a personal workspace or with a personal lens on the table, the available workspace can run out quickly as the number of participants increases. An extension of the workspace by additional (personal) devices, e.g., mobile phones or tablets, seems a plausible solution to this (see e.g. [17] or [22]).

An additional benefit of such devices is that they allow for easier text input compared to typing on the tabletop. Moreover, it is not only the space *on* the tabletop that is limited, but also *around* it, with a growing number of participants. In larger teams, there would not be enough space for everyone around the table, making activities such as individual card-writing even impossible.

That is why we prioritized the development of a workspace extension by additional devices as a first improvement. The personal devices would also provide a private space, potentially alleviating negative phenomena in collaborative settings. In the next sections, we will describe the developed prototype that will not only help in tackling the challenge of limited workspace, but also takes special requirements into consideration that are characteristic in PEM.

4. A Multi-Device Prototype for PEM

In this section, we will give a brief introduction to the preliminary prototype solution we have developed. The prototype is based on the tabletop software that we have used in several studies for modeling goals and problems according to the 4EM notation, e.g.,[13]. The 4EM goal and problem model comprises only a few element types, such as goals to be achieved and problems that might hinder these goals. Each element must be described with a comprehensive text. Different relation types are used to connect the different elements [1]. A detailed description of the software can be found in [11]. We have now complemented this tabletop solution with an app that can be used on mobile phones, as can be seen in Figure 2 (left). We will describe the new prototype in the following, including the adaptations in the tabletop software to align it with the app. As a basis, we will, however, first summarize general requirements that have to be taken into consideration when designing a modeling tool for co-located PEM. We derived the requirements from the background on PEM, group work, and existing tool support for co-located collaborative modeling as presented in Section 2.

4.1. Requirements For PEM Tool Support

Examining the fundamental characteristics of PEM, we consider it a basic requirement that a modeling tool for PEM should incorporate its typical role concept. Stirna and Persson [3] recommend that in PEM, simple modeling languages should be used, so the *domain experts* can really participate. Simplicity should also be considered when choosing or designing the modeling tool. Thus, domain experts should be provided with a minimum and intuitive set of functionality for creating and editing contributions to the model. They should not be overwhelmed by too many or complex functions, but should still be able to actively participate in the modeling process. We do not want to burden domain experts with editing the overall model on their own, but they should be able to create elements that can be added to the model. From *Method experts*, we can expect an expertise in modeling notations, methods and tools [3, 1]. It is their task to structure and create some workflow in the modeling session. Consequently, they should be provided with more sophisticated functions that support them in this task. Facilitators should have the possibility to coordinate the work, while it should be possible for a tool operator to support both the domain experts and the facilitator.

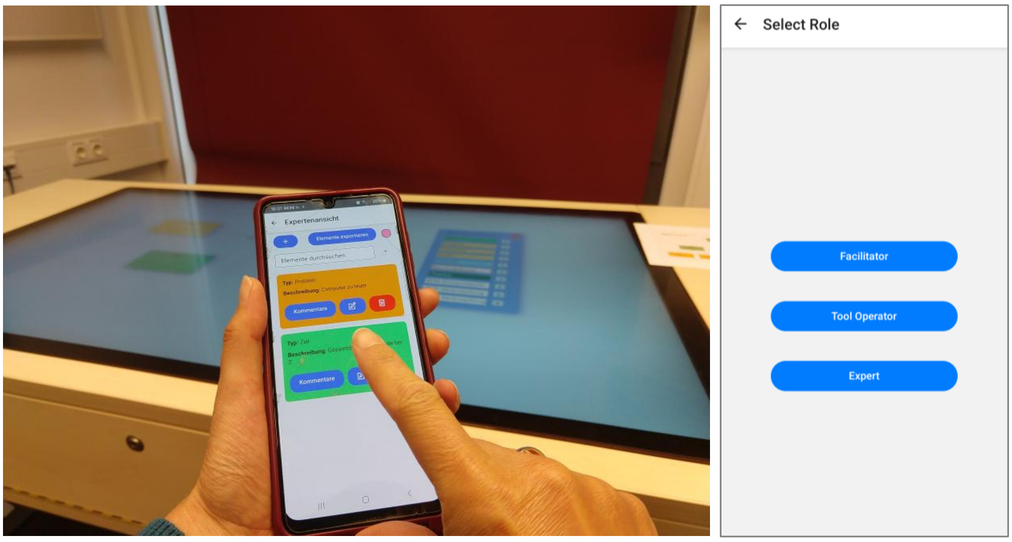


Figure 2: Left: The Multi-device system supporting collaborative modeling on a tabletop and individual contributions from a mobile app. Right: Initial view in the mobile app for choosing the role.

When looking at PEM as group work that might raise negative psychological issues, such as production blocking or evaluation apprehension, the PEM tool should allow individual card-writing in a private workspace, besides collaborative modeling in a joint workspace. Moreover, some groups might benefit from making individual contributions visible to ensure balanced collaboration, e.g., by personal colors or icons. If, however, a modeling project strongly aims for consensus, such markings could be counterproductive. We therefore recommend that the tool should have an additional mode without indications of authorship to underline that the model reflects a common agreement.

Previous studies, complemented by the latest study where we considered a working mode typical of PEM, showed that our current self-developed tabletop software required functions that allow for more space, in particular private space, which can be realized by embedding additional electronic devices such as mobile phones. These could, moreover, enable domain experts to more easily input their contributions. Enabling parallel interactions on a tabletop by multiple users increases the number of steps to accomplish certain goals, e.g., to create a model element. This is partly because single actions on the user interface cannot be reliably traced back to a specific user when relying only on finger touch. On a personal device such as a mobile phone, users could create model elements with fewer steps. Moreover, text input is more convenient than on a tabletop, which is a basic usability issue observed in several studies [14, 11].

With the additional devices, we, however, do not intend to enable distributed model creation. The overall model should be created on a joint workspace, encouraging the collaborative character of a modeling session as suggested by [17].

Based on these general requirements, we have come up with an extended prototype version whose features we will describe in the following.

4.2. Basic Features

4.2.1. Private versus Shared Workspace

The mobile app represents a private workspace where the domain experts can capture their ideas in the form of model elements and comments. The elements can be exported to the shared workspace on the tabletop, where the participants can discuss each contribution. They can edit the model and add relations between the suggested elements. To link the input of the domain experts to the model they are working on on the tabletop, we needed to add a project administration function to the system. We use passwords for the method experts and access codes to establish and maintain this link, for all participants who want to join the project with their mobile phone.

4.2.2. The Role Concept

The software system provides for three different roles, i.e., the domain expert, the facilitator, and the tool operator. In the tabletop software, there is no explicit distinction of the roles, i.e., all functions are available to all users. Changing views for different roles on the tabletop would not make sense, as it is a joint workspace. Furthermore, we expect the facilitator and the tool operator to be mainly in charge of the tabletop software. Compared to the former version of the tabletop software, we have added functions for project administration and coordination. In the mobile app, the user has to initially choose a role, as can be seen in Figure 2 (right), which will give access to the corresponding functions. Both the tool operator and the facilitator have to enter a password to get this access.

4.2.3. The Domain Expert's Functions

On the tabletop, domain experts are able to create, delete, and edit elements of a goal model as well as relations between the elements. The creation of elements can, however, also be done on a personal mobile phone. The domain experts can add a new element, choose the element type, and add a description (see Figure 3). Compared to the tabletop, the users no longer need to open a menu to create an element, and they do not need to open and close an editing mode for each element. Moreover, they can input text on their personal phone in a manner they are used to.

We decided not to provide a function for creating relations due to the small display of the mobile phone. Moreover, we wanted to provide a digital analogy to the typical colored paper cards that are traditionally used in PEM workshops. Nevertheless, the domain experts can add comments to their element to document ideas about possible relations to other elements. Domain experts can export their own elements only if the facilitator has enabled this function. While the elements have not yet been sent to the tabletop, they can only be seen by the respective author and by the method experts. Thus, each domain expert has their private workspace that can be used e.g. for individual idea generation. Due to the limited display, we also provide a text search and search filter for the different element types.

4.2.4. The Facilitator's Functions

The facilitator is provided with a special set of functions in the mobile app as shown in Figure 4. The facilitator can generate a time-based access code with which participants can join a project. The access code can also be generated from the tabletop software as the facilitator will need an access token for joining the project on the app him-/herself. Furthermore, the app provides the facilitator with some functions for coordination: the administration of participants, the export of elements, and project settings. The project settings comprise the enabling or disabling of user identification and element exports by domain experts.

4.2.5. The Tool Operator's Functions

In the mobile app, the tool operator has access to the complete list of elements that have already been exported to the joint workspace on the tabletop. If the group decides that an exported element should be refined, the tool operator is able to "send" the element back to the app to be edited there. While domain experts can concentrate on content modeling, the tool operator takes on coordinating tasks such as the targeted distribution of work content. On the other hand, the centralized redistribution avoids potential conflicts and ensures the consistency of the process. In addition, communication via the tool operator enables a structured feedback loop, which underlines the iterative nature of participatory modeling.

The tool operator also has access to the domain experts' comments that have been exported to the tabletop. Domain experts may document hints on the possible relations between specific elements and other additional information in the comments that the tool operator can use and add to the overall model.

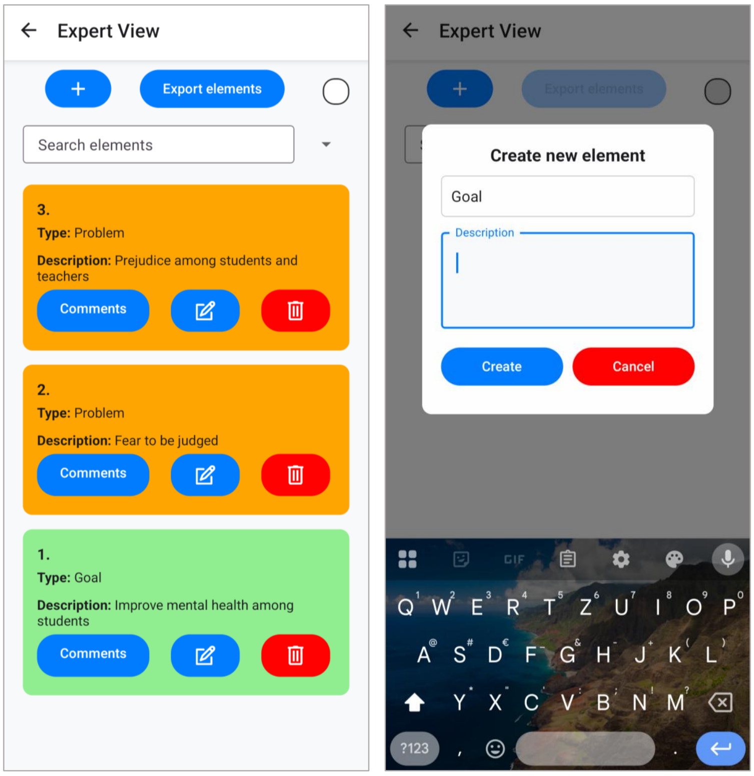


Figure 3: Left: The domain expert's view showing the list of created elements. Elements can be exported, and the list can be searched with a filter. Comments can be added to each element. Right: Elements can be added by choosing the type and adding a description.

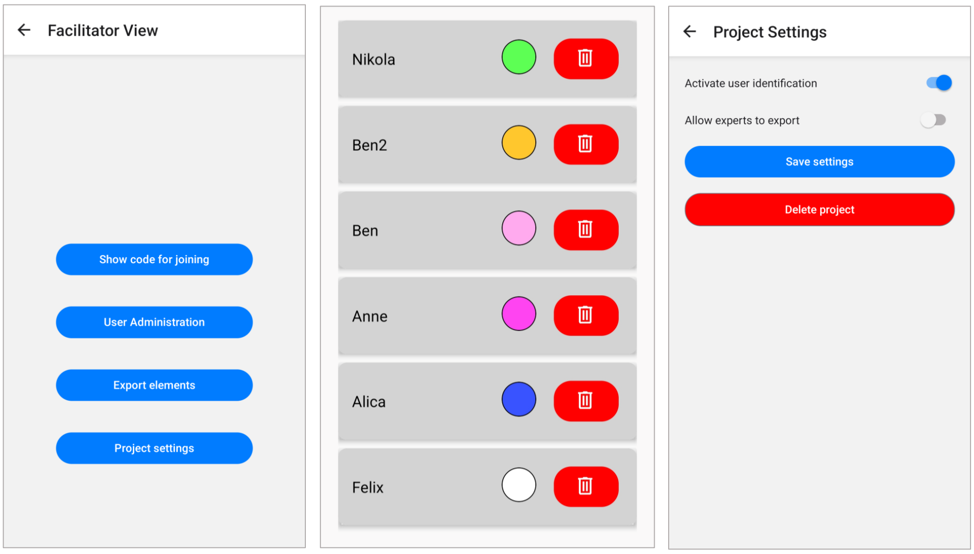


Figure 4: Left: The functions provided to the facilitator in the app. Center: User Administration. Right: Project settings.

4.2.6. User Identification

Depending on the character of the modeling project, e.g., whether there is a strong demand for agreement, the facilitator can enable or disable a mode where each domain expert's contribution will be identifiable. If the mode is enabled, the facilitator will have to assign a color to each participant. When an element is exported to the tabletop, it is annotated with a colored mark indicating the specific authorship, as can be seen in Figure 5.

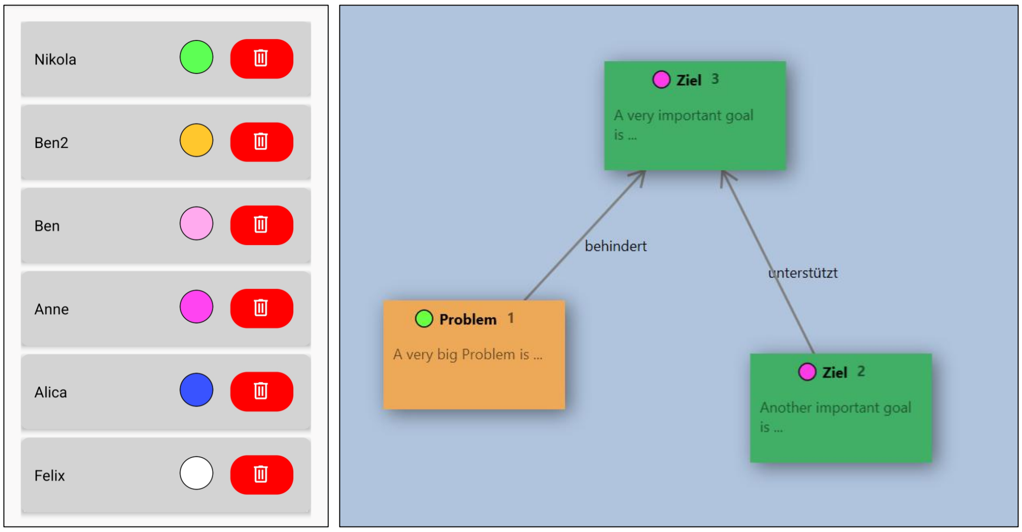


Figure 5: Left: The list of users with their identifying colors, as shown in the app to the facilitator. Right: colored marks indicating the authors are shown in the elements in the model on the tabletop.

5. Conclusion

PEM is a strong approach in the context of enterprise modeling, promising gains in the acceptance and the quality of the resulting models. As digital tools make saving and sharing models a lot easier, it is worth exploring the possibilities of such tool support for PEM. In this paper, we presented a prototypical extension of a tabletop software we had developed for collaboratively creating 4EM goal and problem models in a co-located setting. The concept of the prototype is based on general requirements we derived from literature on PEM, group work, and existing tool support for PEM on the one hand. On the other hand, we relied on our previous investigations, complemented and underpinned by an additional user study of our own tabletop software, presented in this paper. In this study, we followed a recommended work scenario of alternating phases of individual card-writing and joint discussion, causing the models to grow quickly in a short period of time. The results helped us answer our first research question: How do domain experts appraise the use and ease of use of the tabletop software when provided with a structure for the modeling session, and which problems do occur in the tool interaction? Although the participants' appraisal was good, it left room for improvement. Moreover, the structured work mode seemed to exacerbate issues that we were already partially aware of, e.g., the limited workspace, and also brought up new ones, e.g., the need of a function for grouping elements. Thus, these insights led us to a collection of ideas on how to improve the tool, as expressed in the second research question.

In particular, we found that the limited workspace caused several usability issues. We decided to extend the workspace by using additional mobile devices. Using mobile phones seemed most reasonable, as most people are usually equipped with one. Moreover, mobile phones appeared sufficient for providing users with basic functionalities like creating elements. They could be used especially in phases when individual work seems appropriate. We did not intend to let users work on the entire model (which would have required larger displays) in a distributed way, so as not to undermine the collaborative and co-located character of the modeling session. Thus, the purpose of our tool is not to enable distributed collaborative modeling, which would have involved several further requirements, such as managing model consistency and conflicts.

The tool extension should, however, not only alleviate the above-mentioned issue of limited workspace but also consider the special requirements in the context of PEM. The fundamental characteristics of PEM and possible pitfalls of group work led us to a list of requirements. Based on the corresponding background and former elaboration and developments of tools for co-located and collaborative modeling, including our own prototypical tabletop software, we have gathered a collection of general requirements that we partly implemented in a multi-device modeling tool. On the whole, we combined the use of a tabletop for a shared workspace with the use of mobile devices as private workspaces. With this, we follow the example of existing approaches such as [16, 17], but we want to set an even stronger focus on supporting method experts, i.e. the facilitator and tool operator. The suggested system already offers a set of distinctive functions for the different roles of domain experts, the facilitator, and the tool operator. Functions such as user administration, element export, and element re-distribution are available only to the facilitator and the tool operator, supporting them in their coordinating role. In the future, we want to elaborate further on the features that should be provided exclusively for method experts. With our concept and prototype we suggested only a collection of potential improvements which is why we cannot fully and reliably answer the second research question. Whether these improvements bring the expected benefits, such as greater model quality or stakeholder alignment, and how the revised tool is perceived by the users concerning usefulness and ease of use has to be evaluated in future studies.

We believe that our concept can be applied to other kinds of models (e.g., BPMN process models), with the complex model remaining on the joint workspace of the tabletop and simple model elements (e.g, a BPMN task) being created and edited on the private workspace on a mobile phone.

Still, the prototype is only a starting point for implementing a multi-device concept. There are still many issues to be solved, such as the question of how to accommodate large models on a tabletop with its limited space or the question of how refined versions of elements should be handled and administered. We still need to elaborate on which phases of a modeling project such a tool support is of particular benefit, e.g., in the starting phase or in later phases of model refinement. Depending on this, we might have to introduce new functions or extend present functions, while other features might be less important in other phases.

Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT and Grammarly for grammar and spell checking, rewording, and linguistic improvements. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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