BusiMe: A Smart Modular Assistant for Face-to-Face Meetings

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ABSTRACT

This paper examines the problems that arise in face-to-face meetings. The study explores new digital realities by using a design case study approach and investigates in how a business meeting assistance system might look like, behave, respond, and function. *BusiMe* is designed as an embedded modular smart assistant that supports the users in many ways to make meetings more efficient and of higher quality. The system supports especially in the communication between meeting participants and helps with the preparation of minutes and the postprocessing of meetings.

CCS CONCEPTS

• **Human-centered computing → Collaborative and social computing systems and tools**.

KEYWORDS

CSCW, business meeting, artificial intelligence, virtual assistant

1 INTRODUCTION

1.1 The New Digital Realities

Since the transistor was invented in Bell Labs, this fundamental building block of digital electronics brought human beings to the digital age [1, 7]. Nowadays, countless physical items have integrated chips, are increasingly connected to the Internet, which illustrates the growing field of ubiquitous computing and Internet of things. As the technology keeps evolving, virtual and augmented reality, artificial intelligence (AI) are greatly widespread. AI-enabled virtual assistants are facilitating human beings in their everyday life in different areas: At home, a virtual assistant like Alexa remotes the smart home via voice control; on the move, a drivers assistant is helping to keep the car on track; at work, a virtual assistant is helping for instance doctors processing data and diagnosising diseases. Humankind have reached an era of new digital realities surrounded by virtual assistants.

1.2 Technology and Group Work

Technologies are not only supporting each individual, but also facilitating cooperation and collaboration among people. Since humans have a natural tendency to socialize, it is their need to get together exchanging thoughts, generating new ideas, building up knowledge, developing shared understandings, and working collaboratively [27, 31]. A group becomes more than the sum of its parts. As soon as all minds work together, ideas and solutions are emerging faster [31]. Technologies, such as AI, if it is used to assist group work, have much potential, especially in the context of new digital realities, to produce much higher productivity.

1.3 Meetings

As an essential part of the group work, meetings could be advanced in various aspects. Meetings are expensive, unpredictable, and difficult to manage [31].Also, because of different participants, topics, and settings, meetings differ from one another. The challenges of designing systems for meetings are by no means trivial. Many studies concentrate on remote online meeting tools since having people coming together to the same place at the same time can be costly [31]. However, without meeting face-to-face, the richness of information in the meeting will be lost [17]. Nevertheless, the current cooperation in the face-to-face meeting is awkward. For example, participants could easily get distracted by the notifications on their laptop; participants could not decide who should speak next if more than one participant wants to speak; participants could not stop a participant from talking off-topic subjects.

1.4 BusiMe

This paper focuses on face-to-face meetings and demonstrates a new concept of a compact modular system, called *BusiMe*, for facilitating meetings.

The design of *BusiMe* is a response to the needs of users in meetings. It is designed to form a new reality of how a user experiences face-to-face meetings. Since existing solutions do not sufficiently solve the research problems, new or even future digital technologies like artificial intelligence, gesture detection, and a private projection are used to create a highly-skilled virtual assistant. It facilitates cooperation among meeting participants meanwhile promising the information richness of face-to-face meetings. During the meeting, several *BusiMe* modules integrate into a system to play as a moderator for optimizing cooperative behaviours and as an assistant for enhancing productivity. After the meeting, *BusiMe* also takes care of the knowledge management that comes from the meetings.

2 BACKGROUND

This section describes the importance of meetings, explains common issues happening in the meetings, and shows the existing technologies for supporting meetings. Furthermore, the benefits of face-to-face meetings are pointed out.

2.1 The Importance of Meetings

Meetings are a critical part of human activity, and meetings are at the centre of every organization [14, 30]. Almost no one works completely independently and usually, a person is part of at least one group [28]. People gather in groups to communicate; they share information, generate and organize ideas, make decisions,

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coordinate and articulate work, etc. [14, 28]. Productive meetings bring higher morale, faster and better decisions, and inevitably, greater result [30].

2.2 Benefits of Face-to-Face Meetings

Current studies focus heavily on the development and impact of virtual meetings. However, face-to-face meetings have their own irreplaceable advantages. Compare to remote meetings, according to Hiltz et al., there are two to three times of communication in face-to-face meetings [16]. Although the group decisions were equally good in two types of meetings, the remote meeting group were less likely to reach agreements [16]. Face-to-face meetings have optimal response time, non-verbal responses, social context, and opportunity for socialization [9]. Remote meetings also reported as could not outperforming the face-to-face meeting under comparable circumstances, and face-to-face meetings had a higher level of satisfaction [34].

The sense of realism and awareness of the presence of an interaction partner is described by the term "presence" [31]. Presence is crucial for getting to know other people — their characteristics, qualities and their inner mental states [33]. The richness of the media and the abilities it affords to the user determine the presence [24]. A person's perception and self-expression enhances with the increased presence [24]. Increased mediation usually decreases the feeling of presence and deducts the ability to agree on the communication process [31]. Face-to-face communication provides a rich interaction that no other communication methods are able to match [17]. Although the technologies for a remote meeting continue evolving with the advent of high-speed networks and advanced processing abilities, technologies for face-to-face meetings are still worthwhile to be explored.

2.3 Related Work

Kim et al. designed a system, called MM, for meeting that detects social interaction and provides real-time feedback to encourage the change of group dynamics that may enhance group collaboration and satisfaction [20]. MM requires meeting participants wear data collection devices to collect the speaking rate, tone of voice and body movement [20]. All the data is analyzed by the system to generate persuasive feedback for higher group performance and satisfaction [20]. The result shows that MM had a strong effect on speaking dynamics in the meeting and reduced the behavior difference between dominant people and non-dominant people. Groups become more polite and collaborative rather than stressful when MM is introduced [20].

To improve efficiency during the meeting, Occhialini et al. designed an ambient display, using dynamic light patterns to support time management without overburdening the participants [29]. However, although the meeting participants were aware of the meeting progress because of the system, some meeting participants felt the lights lack detailed information [29].

The company LogMeIn developed "GoToMeeting", that is an online board to automatically transcribe recorded meetings [26]. Later on, the meeting will be shared online, and the participant can search for information by using keywords as well as go through the whole meeting again [13]. The biggest disadvantage of this solution, is the fact, that a voice recording of the meeting, which is mostly considered as sensitive data, needs to be uploaded to the company's server. As every user has an account and must work online, security issues might appear. Also, the system is not capable to understand contexts. If there is a need to find something in the transcribed meeting, the correct keyword must be used.

Watson by IBM is an AI-enabled virual assistant that understanding context. But by now this technology is mainly used as an agent for customer support [4].

A digital assistant that supports people at work is developed by "zoom.ai". Their agent is an artificially intelligent chatbot, that reminds the user about appointments or gives automated meeting briefings [6]. The artificial intelligence is capable to have natural language dialogue with the user, but it only has knowledge about appointments that are actually in the user's calendar and the briefing for meetings is more or less the already shared agenda, that was generated by a person.

Interactive whiteboards are nowadays very common, especially in schools. The existing solutions have a lot of applications that support collaborative work [19]. The Microsoft Surface Hub 2 runs Microsoft 10 as the operating system, so that any kind of software can be installed and can be configured to the users' needs [5]. However, such a system is not portable and the sharing of saved results needs to be done manually or online.

3 METHODS

To design a system under the consideration of new digital realities, understanding the problem in a special social practice and the needs from users are crucial. The study presented here followed the Design Case Study approach. The strength of the Design Case Study approach lies in the fact that it requires the researcher to understand the relationship between specific social practice and the designed artefact. The design case study approach consists of three phases:

(1) **Pre-Study:** Focusing on understanding the current practice from a technological, organizational and social perspective.
(2) **Design:** Creating the new IT artefact in a participatory approach in which the user-raised requirements are considered and reflected through the prototype.
(3) **Appropriation:** Evaluating the artefact in the field of practice.

All three phases refer to the collaboration between researchers and users. Furthermore, it is important to note that the three phases are not necessarily sequential. It is also possible to work in one phase, for example in the design phase, with iterations [35].

Due to time constraints, the study demonstrated in this paper focuses on the first and second phases. Furthermore, for the third phase, it needs a high-fidelity prototype, this is because of technology restrictions currently not creatable. This is another reason why the long-term testing of the design was not feasible.

The purposive expert sampling is used for selecting participants for this research, because of already existing connections to appropriate participants from different companies who have business meetings on a regularly basis.

To get a better understanding of the current technological, organizational, and social practices before, during, and after meetings

in organizations, semi-structured interviews were conducted with four participants. To get a general overview of a cooperative situation, observation is a suitable option, with the advantage that the participant does not have to self-explain themselves, but the observer could interpret the situation on his own [15]. The issues of this method is that it is time-consuming and difficult to have no effect on the participants during the observation. Furthermore, the topics in business meetings could get complicated, so it would not be possible for the observer to get the whole context of the situation and the interpretation would be complicated. Interviews, on the other hand, gave the opportunity to get more detailed information in a shorter period of time. Moreover, the research focus is on new digital realities, which are not in use right now. In order to have a reflection on this topic as well, semi-structured interviews are used instead.

Semi-structured interviews require a guideline with topics and questions before the interview. The advantage of semi-structured interviews is allowing the interviewer to follow the guideline as well as to react freely according to the situation. This helps to get a closer and more defined insight into the thoughts of the users.

Afterwards, the interviews were transcribed verbatim and thematically analyzed with the consideration of technological, organizational, and social aspects. Thematic Analysis is used to systematically identify and organize meaningful patterns across the data set [10]. This method could reveal findings that the interviewees themselves are not even aware of. Thematic analysis is a flexible method that allows researchers both analysing meanings across the entire data set with the inductive approach and examine one particular aspect of a phenomenon in-depth with the deductive approach [35]. In this study, the inductive approach was used for revealing the main issues around the meeting.

To implement and prioritize the requirements into the *BusiMe* concept, a design workshop was conducted. In the design workshop, different projective techniques like collage, mapping or diagramming exercises were used to gain a better understanding of the participants' problems and wishes. Based on the generated and discussed ideas, design implications are established. Moreover, a design workshop helps to discuss the requirements in-depth and to involve the participants in the designing of the system through activity-based research [25]. The performed design workshop was structured in a presentation, brainwalking session and creating a design solution.

Brainwalking is a creativity technique that supports creativity and thinking by physical movement [32]. To carry out this method, several flipcharts are used, and sheets are placed in one or more rooms. Each flipchart sheet is labelled with a heading that represents the topic. The participants add their spontaneous ideas to the already existing ideas of the other participants written down on the flipcharts. Brainwalking is suitable for participants who have to sit for a long time beforehand. Through walking the participant gets more active also in thinking. This method helps to increase creativity and allows the participants to move during the session of the design workshop.

After the analysis and categorization of the findings, during a brainstorming session, a design solution was incorporated into a low fidelity prototype and was tested in a cooperative evaluation. To develop a well-fitting prototype, scenario-based Design was used. The definition of a scenario consists of creating a narrative description of typical activities that a user performs to achieve a goal. By using these scenarios, a solution can be developed that is oriented to the needs of the user and the application area [12]. The scenarios can be used for the design of the prototype as well as for the evaluation. The advantage is that scenarios are concrete and at the same time flexible. This means it is possible to image the impact of the design on the one hand, but also to decide freely on the desired technologies and actions in use, on the other hand.

To evaluate the low-fidelity prototype of *BusiMe* a cooperative evaluation is conducted by using the Wizard-of-Oz method, it was combined with the concurrent thinking aloud method and gathering feedback in an open interview at the end.

Cooperative evaluation is a process, that is used to collect data about problems of a software product and get early user feedback for further improvement. There are four steps: recruit users, prepare task, interact and record, and debrief [8]. For recruiting the same non-probability sampling strategy is used as before.

During the interact and record phase the participants are working with the system and asked to use the concurrent thinking aloud method. In order to get detailed feedback about the tasks, the participants should give a running commentary on their thoughts and feelings. Furthermore, questions help to encourage ongoing talking. After finishing the tasks, an open interview about the session is conducted. During the debriefing, it is possible to ask and talk more specific about certain tasks or the whole system. Besides, to reflect on certain parts of the observed interaction and the debriefing afterwards, the cooperative evaluation has been recorded.

In the Wizard-of-Oz method, the main part is playing the wizard, who is creating the system response behind the scene, while the participant interacts with a system that appears to him as already implemented. The advantage of this method is that the user's reflection on the concept of the product is visible before the costly implementation starting. Mistakes and problems could be figured out at an early stage of the development [25]. Through the Wizard-of-Oz method the AI and gestures interaction of the system is simulated by the action of the wizard. The wizard (the researcher) should be hidden during the session but should also be able to react with less response time to the user's input.

For combining the feedback with the first low-fidelity prototype a video-prototype was created. This kind of prototype provides a good opportunity to show the concrete solutions and how users interact with the technology due to its media-richness [21]. It also allows to show the product in use with different actors and to show the concept additionally with the new Realities.

4 THE CONCEPT OF BUSIME

The concept of *BusiMe* is the result of our empirical research and was manifested in a context scenario. The details of the findings about the device components and the system functionalities are described as follows.

4.1 Main Concept

BusiMe is an assistance system embedded in a physical device, to enhance the productivity and efficiency of meetings. It focuses on the facilitation of collaborative communication, knowledge sharing,

and storage during and after the meeting. Therefore, the experience of the meetings that *BusiMe* offers goes beyond traditional face-to-face meetings. The *BusiMe* device is modular, lightweight, and is designed for all kind of meeting participants. Each user owns a module and brings it to the meeting to form an integrated system.

4.2 Device Components

This section gives an overview of the technological system requirements.

Artificial intelligence. The core of the system is an artificial intelligence that can transcribe directly and process contexts in a reliable way. In addition, the system is able to recognize different voices.

Microphone. Voice commands are entered via a directional microphone mounted on a moving rail in the system, which automatically aligns itself with the user at the beginning of the meeting.

Projection. The module integrates a projector that projects a screen onto the table surface. Due to privacy issues and to avoid distractions the projection will be only visible by the user him or herself. Also, *BusiMe* is capable to project an image on a surface up to a 180°angle.

Such a fully developed system is not available by now, but the "Sony Xperia Touch" is capable to project an interactive surface directly in front of the user [3].



Figure 1: Sony Xperia Projector [2]

Sound. A loudspeaker and a Bluetooth chip are installed for voice output of the system. Bluetooth provides extended functionalities like using wireless headphones.

Near Field Communication. A near field communication chip is installed for direct communication with the modules, that are on the top or the bottom of the device.

Gestures recognition. The system can recognize gestures. Since participants of the design workshop consider cameras in a meeting to be critical and they would feel observed, *BusiMe* uses an alternative technology for gesture recognition. Jaime Lien et al developed a system, that is capable to interpret gestures with millimetre-wave radar [23].

Device Display. There are moments when the participants in a meeting do not pay attention to the private projection. To visualize in such cases important things, the modules themselves are equipped with a bright display on top of them.

Fingerprint sensor. To unlock the device, the user's fingerprint must be scanned.

Battery. *BusiMe* is equipped with a strong battery for mobile use and can be charged wirelessly via a charging pad.

General. In meetings, things are often discussed that are not allowed to leak to the outside. That's why *BusiMe* is designed as a local system that does not require an Internet connection, which leads to more security regarding unauthorized access. If the device gets lost, it is protected by the fingerprint sensor and a required voice match.

4.3 System Functionalities

Application wise, seven functions have emerged from empirical and methodical work. These are described as follows:

Word Prediction. *BusiMe* utilizes artificial intelligence to understand the conversation context and to analyze speech in real-time, to predict the next word the presenter could say. Once the presenter stumbles, word recommendations will be shown in the private projected area. The words suggested by the system are sorted by the confidence of the prediction.

Off-Topic Voting. Every meeting participant can vote whether the presenter is talking off-topic subjects. When the user configures the system, he will be asked to define a secret gesture for off-topic voting, so that it will be later possible to vote anonymously. As soon as one meeting participant starts the off-topic voting process, the other meeting participants will be asked to vote, too. If more than 50 persent of the users have voted for off-topic, a conspicuous notification will appear on the projected screen of the presenter. It is now his decision if he wants to react. Besides, there is a possibility to decide for yourself whether you want to receive this anonymously generated hint or not.

Raising Finger Function. The raising finger function allows the user to express the request to speak. Therefore, he just raises his index finger. As soon as the system has noticed it, the request of speaking is communicated to the other people via the display on the modules and the projected screen of each participant. The user also has the chance to cancel the request at any time. If several people request to speak next, the speaking sequence will be displayed on each projected screen to guarantee that no one is getting ignored. Unlike the traditional hand raising, the presenter will not be immediately disturbed or interrupted but can continue to express his thought.

Writing messages. The system of *BusiMe* allows the user to write messages to other meeting participants during the meeting. To do this, the user taps on the person in the seating plan (shown in the projection) who he or she wants to write to. A virtual keyboard then appears. If the recipient of the message likes to reply, the system provides predefined response options, that fit the context. This is for speeding up communication and reducing distractions for everyone involved. However, if the user wants to answer something different, he can also use the virtual keyboard.

Personal Notes. Each meeting participant can use a gesture to record what is discussed at a certain moment. As soon as the user makes the gesture in a meeting, the last spoken sentences are noted down and displayed as feedback in the private projection. Also, the user has the option of using a virtual keyboard for memos. All personal notes are saved later on the automatically generated minutes. There it is also possible to read or recite the notes in the referencing context.

Holistic Record. *BusiMe* transcribes the meeting in real-time and saves it as a text file. Since *BusiMe* also understands contexts, the system is later able to answer any question about the meeting. If necessary, it also searches in old recordings that are stored on your module. After each meeting, the system automatically creates personal holistic minutes.

Whiteboard. All the *BusiMe* modules can complement each other to project an interactive whiteboard on the whole table surface. Afterwards, the results drawn on the board are stored in each module and can be retrieved at any time.

Privacy. As shown in the application overview, the system is very privacy concerned. Through the secret projection and private gestures, no participant can directly see the actions of others.

5 DESIGN AND DEVELOPMENT

This section explains the detailed process of the design and the development of *BusiMe*.

5.1 Pre-Study: Interviews

To understand the existing practice a pre-study was performed by conducting semi-structured interviews. Literature research supported regenerating interview guidelines, which contained the following subjects:

The guideline of interview contains 9 topics:

- Frequency of having a meeting
- Supporting technologies
- Relationships among meeting participants
- Meeting structures
- Self-expression durning the meeting
- Experiences of cultural differences
- Other issues in the meeting
- Follow-up of the meeting
- Workaround of missing a meeting

By using purposive expert sampling four interviewees (28-31) emerged, who have experience with meetings on a regular basis. Two research assistants from different universities as well as two people from industry partook and delivered four hours of interview material. The thematic analysis was key bringing for identifying problems, needs and opportunities of meetings.

5.2 Pre-Study: Thematic Analysis

In the following, the results of the thematic analysis will be portrayed. Three main themes transpired from the relationships among nine codes via the thematic analysis: Insufficient preparation, reduction of productivity and follow-up of meetings.

The issue of having an insufficient preparation is having a negative impact on a meeting and originates of three different aspects: Not knowing the right behaviour, having a wrong attitude towards the meetings and needing a substitute for the meeting.

Not knowing the right behavior. If a meeting-member doesn't know who else is going to be in the meeting, it is difficult to know how to behave and how to address the others correctly according to their job titles.

"As soon as you have these cards [...] you can address them accordingly. And you also know the position of the people. Yeah, that's very useful." (I1, M, 29)

Wrong attitude towards the meetings. Some meeting participants seem to be not prepared well enough and to talk about trivial topics during the meeting.

"[...] one could have talked about for two hours to put much detail into the planning, but he didn't put much detail into the planning. So, in the end many people are not that badly paid, it's a cheap meeting, [...] meeting actually cost you [...] People are being paid for sitting there" (I1, M, 29)

Substitute for the meeting. If a meeting cannot be attended, a substitute is needed. But usually, the substitute is not able to be prepared enough to represent the other fully in the meeting.

"In some case of emergency the person might not show up, some other person from other team come in as a replacement, just to provide some information. He's not so much ready. Uh yeah. He came, but we didn't get all the information." (I3, M, 29)

The productivity gets reduced because the concentration is limited, there is a lack of a common language and because of hierarchy effects.

Lack of common language. Meeting participants from other cultural backgrounds may not be able to communicate freely with a second language. Also, different organizations may have different terms for the same thing. Furthermore, entering business language can be hard in general for everyone. If the communication doesn't flow, the productivity can be reduced.

"And I also think that sometimes it's hard for me to get across the thing I want to explain in German, and it's the same thing, but these time delays sometimes lead to the feeling that I have less speaking time in the whole discussion." (I2, F, 28)

"People that come from larger firms are used to certain kind of vocabulary, they're used to certain kind of structure in a meeting." (2, F, 28)

Hierarchy effects. During the meeting, there are also hierarchy effects in terms of the speaking amount. Lower hierarchy levels seem to have a smaller amount of speaking time, than participants from higher hierarchy levels, even though the key bringing information comes from the lower hierarchy speakers.

"There is a certain hierarchy and people that are superior in the hierarchy will lead the meeting automatically, but will not necessarily provide content, that is not relevant to the meeting. But as long as they're talking, you're not talking and your colleagues, who might provide useful content, are not talking." (I4, M, 29)

The main topic according to the follow-up of meetings consists of the inconvenience of accessing the information, the lack of a holistic record as well as the lack of personal notes.

Inconvenience of accessing the information. During a meeting, there are topics which address one person more than another.

Some information can be very important and should be remembered. Meeting minutes do exist but are most times not useful for finding certain information.

"But in the end based on the information provided in the minutes, I just don't read it, because there is not much content for anyone who hasn't attended the meeting, and it's much more efficient to ask someone who has attended the meeting, what key topics were discussed and what decisions were made. Yeah, I uh don't really care or actually I learned to not care, because it's just too much work otherwise." (I1, M, 29)

Lack of personal notes. The meeting minutes nowadays usually cannot cover all of the meeting information in detail. Therefore, personal notes need to be taken additionally.

"Well, I take notes a lot. Simply because I like to take little more detailed notes, before I miss something in the end." (I2, F, 28)

Holistic record. The meeting minute is not including all the information and there is no time while writing personal notes to include the whole context. Therefore, not the meeting minute nor the personal notes can illustrate the context or holistic record, which can be decisive.

"Because experience has shown that questions always arise afterwards or at latest at the next meeting, you no longer know who said what or who was assigned which tasks." (I2, F, 28)

The thematic analysis gives a brought view on the requirements before, during and after meetings. Having collected all the requirements of a meeting, detailed drafts need to be developed.

5.3 Design Workshop

The design workshop was used in a cooperative way. Two participants from the previous interviews partook: one research assistant from university (28) and one from the industry (29). Additionally, three participants from the research group (25-29) took an active part in the workshop. After a brief introduction, the design workshop started with the presentation of the pre-study results. As a result, every participant had the same knowledge level to continue with a brainstorming session for the potential design ideas. Additionally, a short introduction to new realities was given to get the participants into an innovative thinking mode.

The brainwalking session was realized through mind mapping. To come up with design ideas the nine issues evolving from the thematic analysis were paraphrased into nine questions:

- How to know the right behavior?
- How can the substitute be well prepared for the meeting?
- How to get the right attitude towards the meeting?
- How to ensure/improve the concentration in the meeting?
- How to eliminate business/foreign language barrier?
- How to communicate freely in a hierarchical structure?
- How to provide personalized notes?
- How to access the meeting information more convenient?
- How to achieve a holistic record?

Each question was written on a flipchart as the center of a mindmap. Each participant was asked to quietly walk around to write down their personal ideas and additional ones, which are inspired by the already written ideas of the others. After 40 minutes, all workshop participants discussed and reflected on all the ideas on the mind maps one by one together. After a break and a short recap, all participants were encouraged to showcase their own design solutions for assisting meeting on paper. The participants were asked to focus their design on the solutions they found the most important according to their personal experiences in meetings or liked the most. Furthermore, the participants could ask for some existing technology, which was printed out and could be used for their drafts. They did not know, which technology was available in the printed-out form and had to ask for a specific one before getting it. The participants focus while drawing the design solution was inspired by the questions, how they would imagine the design of their system (appearance, applications and technical aspects) and how they could imagine the interaction with the system.

When everyone was finished each designer presented their concept and the advantages, as well as the disadvantages, got discussed. During the discussion, two further topics turned out to be relevant as well: The need for a quick messaging function and a whiteboard.

Quick messaging function: During the meetings, there is the need to communicate with someone within the meeting without disturbing the others.

Whiteboard: In meeting situations, a whiteboard or something similar is often needed to visualize problems. The technology had already been mentioned in the semi-structured interviews as a utility during meetings.

The most important issues filtered out through the design workshop and its possible solutions got visualized through context scenario and addressed in the prototype.

5.4 Context Scenario

The evolved solutions and notes from the participant of the design workshop were analysed regarding their similarities and which were considered to be most important. By merging the ideas in a brainstorming session, the following context scenario was written to describe how *BusiMe* would assist in a working environment.

Lisa is 29 years old. She grew up in Germany and has just started as a user experience designer in a large international company. During the personal briefing on her first day, the meeting assistant *BusiMe* is introduced to her. She, therefore, receives her own module. As she has some questions about the system, the recruiter replies that the system is intelligent, and she can directly ask *BusiMe*.

In the evening, she has time to get to know the device. After pressing the fingerprint sensor for 5 seconds, the system boots up and helps her with the setup. Afterwards, all functions are explained to her in detail and her questions are answered just right. Lisa is amazed by the promises of the system and is looking forward to the first meeting.

The next morning, she has a meeting with three team members, where she needs to introduce herself. What she was not told, however, is that one of the original participants is sick and now his colleague who only speaks English is stepping in. When she comes into the meeting room, her colleagues are already there. Lisa notices that three *BusiMe* modules are stacked and placed in the middle of the table. She unlocks her module with the fingerprint of her index finger and places it on top of the *BusiMe* stack. When she takes her seat, she says: *BusiMe*, I'm here" and her module aligns itself to her

and projects the user interface into her field of vision on the table. But she is not able to see the projections of the others.

Looking at her screen, she now sees the seating plan with the names and job titles of the others. She notices that the colleague who temperately stepped in is the leader of the project she is scheduled for next month. Due to this and because English is only her second language, Lisa is nervous about introducing herself in English, but she has to do it now. After she spoke about five sentences, she stumbles because she cannot think of a word to describe the thing she is talking about now. Quickly she looks at the projected screen and notices that *BusiMe* has already given her three-word predictions about what she is perhaps trying to say next. The first word is exactly the one she was searching for. She soon gets used to the system and looks down as long as she cannot think of a word. Lisa is amazed by how well *BusiMe* works and is almost not nervous anymore. She finally managed to introduce herself in English. Next, her first task is going to be discussed. One of the colleagues loads the whiteboard record from the last meeting. The whole table surface is now used as a projected whiteboard. Lisa gets everything important explained to her with the help of the whiteboard projection, things are added to it and the recordings from the last meeting are copied to her module via voice command.

As Lisa later goes to her workplace, she tries to retrace her tasks in her mind. However, she realizes that she lacks some information. She then asks *BusiMe* the context related question and immediately receives an appropriate answer. She now would like to call the project manager who was also in the meeting to discuss the tasks in detail. She asks *BusiMe* for the contact. The contact of the manager gets transmitted when she holds her smartphone to her *BusiMe* module. Lisa manages to work on the tasks without any further problems and is visibly happy about the work assistance.

One week later there is a plenary meeting of the department with eight participants. Every team should present their project status. The meeting had already lasted half an hour when one of the participants was very much off his topic. Suddenly Lisa sees in her projection that someone voted for "off-topic". She decides to do the same and makes an inconspicuous gesture, which she has chosen during the setup of the system. After about 30 seconds, the presenter apologizes for speaking "off-topic" and returns to the original subject.

During the presentation by the head of the department, Lisa receives a message from one of her colleagues, who is telling her, that the things, that have now been said are also relevant for her. Lisa quickly makes her gesture for a personal note and is thanking her colleague with a reply option predefined by *BusiMe*. Because it's so quick to take notes and to answer, she can follow the presentation without much distraction. Shortly afterwards Lisa wants to ask a question but does not want to interrupt her boss unnecessarily. Therefore, she does not raise her hand, but uses the raising finger function of *BusiMe*. She lifts her right index finger and the top one of the stacked modules shows a green arrow on its display, that points in Lisa's direction. The head of the department seems to notice it but continues with his speech. Shortly afterwards, an orange arrow appears pointing in the direction of one of Lisa's colleagues. Lisa can see in her projection the spoken context as she raised her finger and that a colleague also wants to request something. When the boss has finished his thought process, he looks at his projection, which is not visible to the others, and calls Lisa by name. For a short time, she forgot what she wanted to ask. But with reading the context information again, she remembers it. As she formulates her question, the orange arrow disappears. Lisa concludes that her colleague wanted to ask the same question and has now annulled his request with a gesture.

When the meeting is over, Lisa goes back to her desk and asks the system for the minutes. Now her module projects an automatically generated report with the most important points, including the questions she asked during the meeting and the given answers, additionally to her notes. When her colleague wrote her the personal message, she was a little late with the gesture. That's why she now clicks on the note again and reads through the previously said information, marks the important passages and saves the changes to the report.

Lisa quickly got used to the ease of use of the system and is amazed about how much it simplifies communication and makes meetings more efficient. Also, the annoying large notebooks, taking notes and writing minutes are no longer an issue. She also doesn't have to worry about losing her data, because if she uses the charging station on her desk, a backup is made there regularly. Next week she will be in France on a business trip. So, she is glad that they also use *BusiMe* and that she gets minutes in German at the end. The meetings she is going to miss in Germany will be simply transmitted to her module by her colleagues and then will be replayed with the help of the artificial intelligence of *BusiMe*.

5.5 Prototyping

Based on the context scenario a low-fidelity prototype was created to evaluate the main functions of *BusiMe*. It consists out of four 3D printed module cases equipped with remote-controlled LEDs and a simulation of the private projected area. Therefore, an iPad was integrated into a fake table, that blends itself in the whole setting by showing on its screen the same surface structure as the table. The tablet is connected to a notebook and works with the help of the app "Duet" like an external monitor. The User Interface is a clickable prototype, that was generated and gets controlled via Microsoft PowerPoint. Seven of the eight main functions (Word Prediction, Off-Topic Voting, Raising Finger Function, Writing Messages, Personal Notes, Holistic Record) mentioned in the concept section were included to get tested by users.

The interactive whiteboard function is not a part of it. As such boards are already very common, it would be only possible to gain new findings by the use of a high-fidelity prototype.

5.6 Cooperative Evaluation

The cooperative evaluation was conducted in a usability laboratory. The low-fidelity prototype was placed in the middle of the room. The fake table was surrounded by comfortable seats and the whole scenario was captured via cameras. The wizard was hiding behind a curtain and could see everything since a camera was transmitting the information in real-time on a screen. Therefore, the wizard could react immediately to the given situations. The PowerPoint slides were controlled by the wizard, so that the private projection was reacting simultaneously to its user during the testing.

The low-fidelity prototype of *BusiMe* got tested by four participants: An UX designer, an aspiring teacher (already working partly at school), a conceptual designer in user research and a web-designer. After an introduction to the project and the system, the participants had to fulfill certain tasks to test the functions of *BusiMe*:

The cooperative evaluation has shown the following findings and solutions for implementation into the refined concept:

On the one hand, every function was evaluated to be practical. One participant took the chance to get in touch afterwards to give further feedback on a situation she had, where she wished for the system and its off-topic function. Nevertheless, some participants thought, that the off-topic function could be rude, to tell the speaker, not in a direct way to be off-topic. Therefore, the functions should be customizable. There should be the option to hide functions. For example, everyone should have the option to choose for themselves, if they want the feedback of the others, to be voted off-topic or not.

On the other hand, the usability testing showed, that chosen gestures to interact with the system can be offensive for other meeting members. Furthermore, there is the risk to do a gesture by accident. Therefore, the gestures should be chosen wisely and to support that, the users shall get tips from the system while choosing it. Additionally, there needs to be the possibility to undo commands with a wisely chosen gesture.

Furthermore, there were some issues in the design of the user interface, for example, that the people wanted to tab the word prediction because they thought the word was a button. Therefrom, there needs to be an enhancement of the design of the user interface.

Additionally, the context of personal notes was missing and that is why it needs to be linked to the holistic record. The notation will not be just about the main sentence, which needs to be written down and in the main interest of the user, but also a little bit before and after that sentence. Looking at the personal notes afterwards, the sequences can be adjusted, also by going from the note directly to the whole holistic record, because it is linked together.

During the testing of the raising finger function, a light is going on and points towards the person, who raised the hand. The participants were delighted and surprised by the light, but at the same time distracted. Therefore, long-term testing would be necessary, to test some functions like the "raising finger lights" to see, if it is different when they get used to it.

There is the risk, that the messaging function could get abused for unrelated chatting. To compromise unrelated chatting the system could recognize and hinder it.

There was a lack of usability of the word prediction because there were too many options and the participants did not know which option the best would be to choose. Therefore, the system needs to give a ranking list for the predicted words, which ranking is about the best word for the spoken context.

Further feedback on the low-fidelity-prototype was, that all participants thought it is very intuitive and all the given tasks were doable.

The whiteboard function did not get implemented into the low-fidelity prototype, because of its complexity. Therefore, it did not get evaluated through the wizard of oz and concurrent thinking aloud methods but made as a subject of discussion in the open interview after the usability testing. Every participant pointed out how useful such a whiteboard would be.

6 DISCUSSION

In the following, the previously presented study will be discussed, limitations, as well as an outlook for further studies and a conclusion, will be given.

Individuals enter a negotiation process in the form of meetings. Meetings are based on a cooperative approach, because it aligns with the process of integrative or interest-based negotiation, which aims for win-win solutions [22]. The assistant system *BusiMe* stands for business meetings, but also for the user ("me"). Through different functions, the individual, as well as the negotiation process, get supported.

Informal meetings are known to be productive because people get to say what they want to say. But also *BusiMe* gives everyone the chance to say what they need to say through its raising finger function.

If there is a need of quickly exchanging information during the meeting, there is a messaging function available for the meeting participants. Still the messaging happens within a meeting and messaging while listening would be multi-tasking. Kahneman states a limited amount of cognitive resources, which must be distributed in different mental operation to be efficient [18]. Reading, writing, listening, and giving hand signs to communicate with the system are different mental operations and contribute to the efficiency of the cooperation.

If people are talking off-topic subjects, there is the option to give the person feedback before the negotiation process gets out of hands. A holistic record is available at any time and the personal touch of it in the form of personal notes. Tasks and responsibilities need to be remembered correctly so that the division of labour is working out and the common goal can be reached.

To have a smooth conversation, there is the word prediction function. If the speaker stumbles in the meeting, *BusiMe* supports the speaker with predicted words. Business communication is a dynamic, multiply influenced, transformational translation process [11], *BusiMe* is trying to make it smoother. Also, meeting members who work cooperatively to bargain a solution are more likely to develop relationships of trust and to come up with a constructive resolution process [22].

Additionally, *BusiMe* not only supports the cooperative scenario of a meeting but also the collaborative scenario, such as a whiteboard which can be utilized anytime in the meeting.

According to different surveys, participants were selected through purposive sampling with the focus on people who have experience with meetings on a regular basis. The participants were not complete strangers to the researchers, which causes a vulnerability to errors in judgment. Furthermore, it could create a low level of reliability and a high level of bias. The researchers tried to have a minimum effect by creating awareness. On the one hand, the participants were from different fields, provided different perspectives on meetings; they were relatively young (28-31) and knew about new digital realities. On the other hand, older participants could have shown another more experienced perspective. The age factor was not included during the sampling, which causes a lower validity.

Additionally, the temporal limitation leads to a small quantity of participants; each phase was evaluated by 4-5 participants. Despite the small sample and relatively young participants, many fresh qualitative and quantitative insights on business meetings were revealed.

The thematic analysis was helpful and it was the key to find and structure the main issues, even it is a very time-consuming method. The code of insufficient preparation "having the wrong attitude towards the meeting" seemed to be an important issue at first but was not discussed further in the design workshop. Attitude is a complex topic and hard to implement in an assistant system. It is suggested that the association of these factors could be investigated in future studies.

The cooperative evaluation is based on a cooperative scenario, whic is a meeting. The findings are limited because the evalution did not provide more prototypes for more than one tester at the same time. To create a cooperative situation with one participant at a time, a role-play was set up to create a more realistic scenario. Creating a prototype for more than one person would was complex and beyond the scope of this study.

The prototype was based on a tablet. The tablet mimicked the projected area, but the fact that the projected area is a tablet was always in the back of the participant minds. The tablet comes also a limitation of the display size. The tablet had a further distance to the eyes than it usually got. Therefore, one feedback from most of the testers was that the display is too small to catch the information immediately. The implication for the future is to make the projection size adjustable to the user needs. Another limitation is in the design of the user interface, for example, that the people wanted to tap the predicted word because they thought the words are buttons.

One task was to read a text with blanks out aloud. This tasked could also cause the association to fill out the blanks with the predicted words also in the written form. Yet, filling out the blanks was working out smoothly. It would be interesting to assess the effects of the design to the user's reactions. Such technology for a high-fidelity prototype is not existing yet and accordingly, the Wizard-of-Oz method worked out perfectly to test the low-fidelity prototype.

The holistic record documents everything, but recording everything limitless causes privacy issues. There needs to be the opportunity to undo personal produced content.

Furthermore, During the open interview after the evaluation, the purpose of the system and ethic issues were discussed. Who should make the decisions? Should *BusiMe* just be assistant or operate as a moderator? Letting the system make some decisions, could make the meeting more efficient and improve productivity. Still, every participant stated to be against a system deciding for them. But one user added it could be different in 30 years: We might get used to systems deciding for us and it is a topic further research should be taken on.

It is recommended that further research be undertaken on *BusiMe* as not only being an embedded but also an ambient system. Based on the interview data concentration is limited. Therefore, if the meeting participants get tired the system could react to it by opening windows and adapting the room lights.

One major contribution of *BusiMe* is in the optimization of cooperative behavior during meetings, which increases productivity by optimizing the information flow. Face to face communication with its richness of information is on the one hand very important for a clear understanding, which again is essential for the cooperative negotiation process. On the other hand the diversity of information is complex and could confuse people. *BusiMe* enables every participant to express themselves prolifically during the meeting. The second main contribution lies in the knowledge management by the AI. Gathering and retrieving information during and after meetings has never been more convenient.

7 CONCLUSION

Meetings are unpredictable, and difficult to manage. Technologies have the potential to support cooperative work. The richness of information during face-to-face meetings is contributing to clear communication. The risk of misunderstanding or forgeting information can be reduced sufficiently by *BusiMe*'s functions. However, there is abundant room for further progress in determining *BusiMe*. Future work should be done on evaluating the video-prototype. The use of the video-prototype combined with an online survey could provide a large sample and be another approach of defining the meeting experience in digital realities. To have better decisions and results, the embedded assisting system *BusiMe* can be an innovative solution to support the cooperation during and after business meetings.

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